CATCH ME IF YOU CAN

JAVA ON WEARABLES

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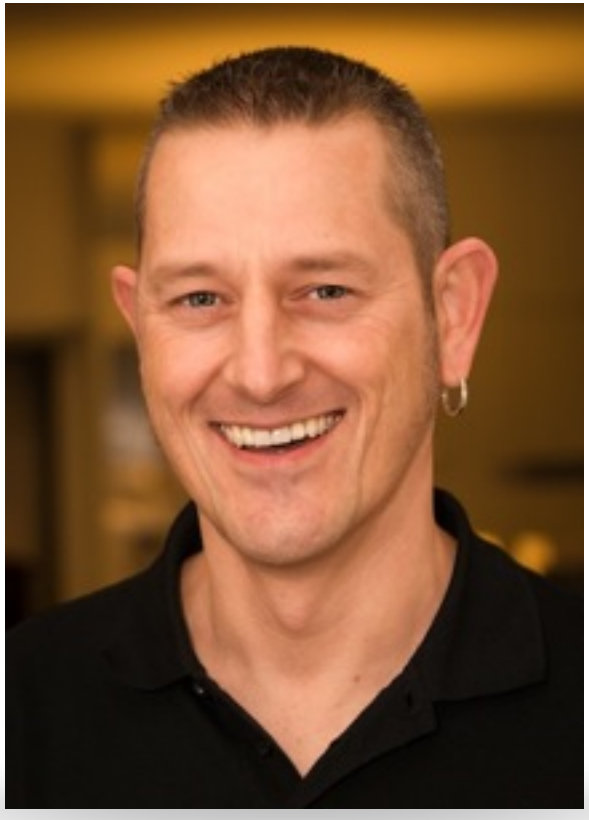
ABOUT ME



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WEARABLES

WHAT IS IT…?

WHAT IS IT…?

- Miniature electronic device
- Worn under, with or on top of clothing
- Needs more computational support than hardware coded logics
- Many things in common with smart phones

EXAMPLES

EXAMPLES

Earphones

Glasses

Watches

Insoles

Clothing

USE CASES…?

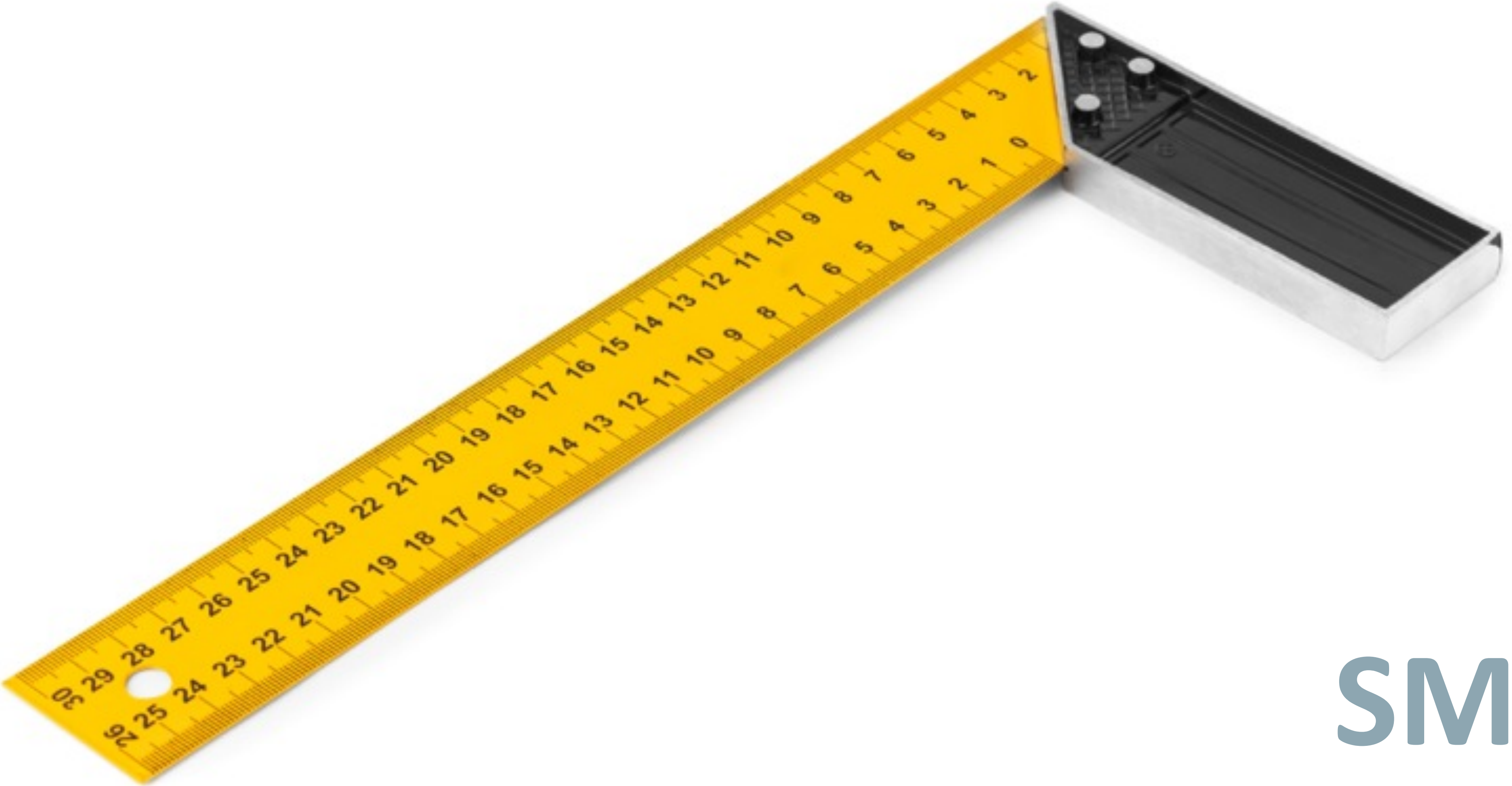
USE CASES

- Fitness- and Health-tracking
- Map and Directions
- Note-Taking and Productivity
- Informational

REQUIREMENTS

REQUIREMENTS

- Small form factor
- Smart power management
- Connectivity
- Life proof



SMALL FORMFACTOR

SMALL FORM FACTOR

- Small size
- Leightweight
- As few cables as possible

SMART POWER MANAGEMENT

SMART POWER MANAGEMENT

- Low power consumption
- Enhanced battery life
- Sleep mode strategy

CONNECTIVITY

CONNECTIVITY

- Cable
- Bluetooth
- WiFi
- 3G/4G

LIFE PROOF

LIFE PROOF

- Waterproof
- Drop proof
- Dust proof
- Sweat proof

SITUATION

SITUATION

- Lots of devices available
- Devices with predefined features
- No real standard
- Hard to combine products

WHAT IF YOU NEED SOMETHING SPECIAL ?

Do IT YOURSELF

JRUNNER PROJECT

idea

JRUNNER

- Track the location of a runner/biker
- Track the heart rate, temperature, pressure
- Live tracking on desktop application
- Ability to contact runner/biker
- Interact via Smart Watch/Smart Phone

THE WEARABLE

WHAT JRUNNER CAN DO

- Read gps data (lat, lon, alt, spd, dir)
- Read heart rate, temperature, pressure, accel. data
- Talk to the Runner (using TTS)
- Publish updates via MQTT to subscribers
- Gives haptic feedback through vibration motor
- Can be switched on and has auto shutdown
- Monitors it's battery status

PLATFORM

PLATFORM

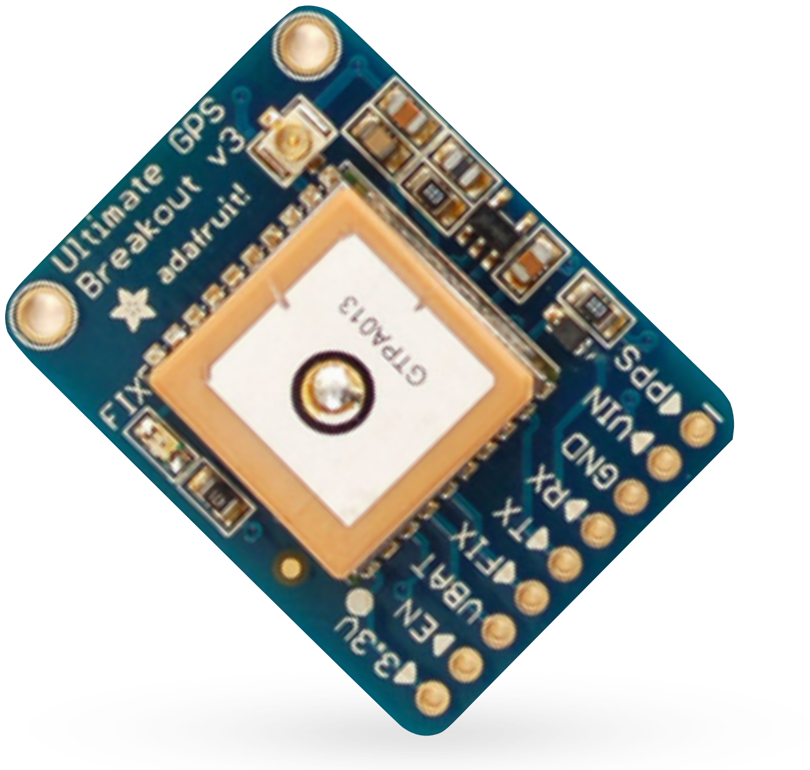
Raspberry Pi

SENSORS

TRACKING LOCATION

TRACKING LOCATION

Adafruit Ultimate GPS 66



- 👍 Easy to setup
- 👍 Easy to access
- 👍 "Cheap"

- 👎 GPS only
- 👎 Form factor

TRACKING LOCATION

Navspark SUP800F

- 👍 Easy to setup
- 👍 Easy to access
- 👍 "Cheap"
- 👍 Temperature
- 👍 Pressure
- 👍 Accelerometer
- 👍 FormFactor

ACCESS GPS SENSOR

```
private void initSerial() {
    try {
        SERIAL.open(Serial.DEFAULT_COM_PORT, BAUD_RATE);
    } catch (SerialPortException exception) {
        return;
    }

    SERIAL.addListener(event -> {
        final String[] DATA_ARRAY = event.getData().replaceAll("\r\n", ";").split(";");
        for (String data : DATA_ARRAY) {
            if (data.startsWith(GGASentence.HEADER)) {
                GGA_SENTENCE.parse(data);
            } else if (data.startsWith(VTGSentence.HEADER)) {
                VTG_SENTENCE.parse(data);
            } else if (data.startsWith(STISentence.HEADER)) {
                STI_SENTENCE.parse(data);
            }
        }
    });
}
```

TRACKING HEART RATE

TRACKING HEART RATE

Sparkfun Pulse Sensor

- 👍 Easy to setup
- 👍 Easy to access
- 👍 "Cheap"

- 👎 Cumbersome
- 👎 Optical approach

TRACKING HEART RATE

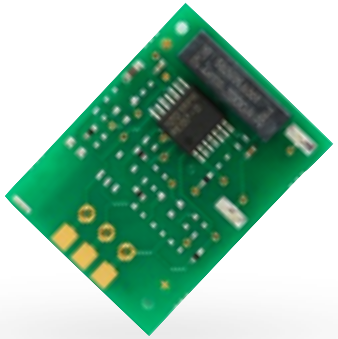
Polar Heart Rate Monitor

- 👍 Easy to setup
- 👍 Easy to access
- 👍 "Standard"
- 👍 Computes HR

- 👎 Form factor

TRACKING HEART RATE

Polar Heart Rate Sensor



- 👍 Easy to setup
- 👍 Easy to access
- 👍 "Standard"
- 👍 Form factor
- 👍 Pulse detection

ACCESS HEART RATE SENSOR

```
GpioController        gpio        = GpioFactory.getInstance();
GpioPinDigitalInput bpmSensor =
    gpio.provisionDigitalInputPin(RaspiPin.GPIO_04, PinPullResistance.PULL_DOWN);


private void initHeartRateSensor() {
    bpmSensor.addListener((GpioPinListenerDigital) event -> HEART_RATE_MONITOR.beat());
}
```

ACCESS HEART RATE SENSOR

```
public enum HeartRateMonitor {
    INSTANCE;
    private static final int    PULSE_TIME       = 15; // Milliseconds of each pulse send by the Polar board
    private static final int    BEATS_TO_STORE   = 10;
    private              long[] timeBetweenBeats = { 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 };
    private              int    beatCount        = 0;
    private              long   lastBeat         = System.currentTimeMillis();

    public void beat() {
        long now   = System.currentTimeMillis();
        long delta = now - lastBeat - PULSE_TIME;
        if (delta > 272 && delta < 1224) {
            timeBetweenBeats[beatCount] = delta;
            beatCount++;
            if (beatCount > 9) beatCount = 0;
        }
        lastBeat = now;
    }

    public int getHeartRate() {
        double average = LongStream.of(timeBetweenBeats).sum() / BEATS_TO_STORE;
        double rate    = 60 / (average / 1000);
        return (int) rate;
    }}
```

CONNECTIVITY

MEANS…

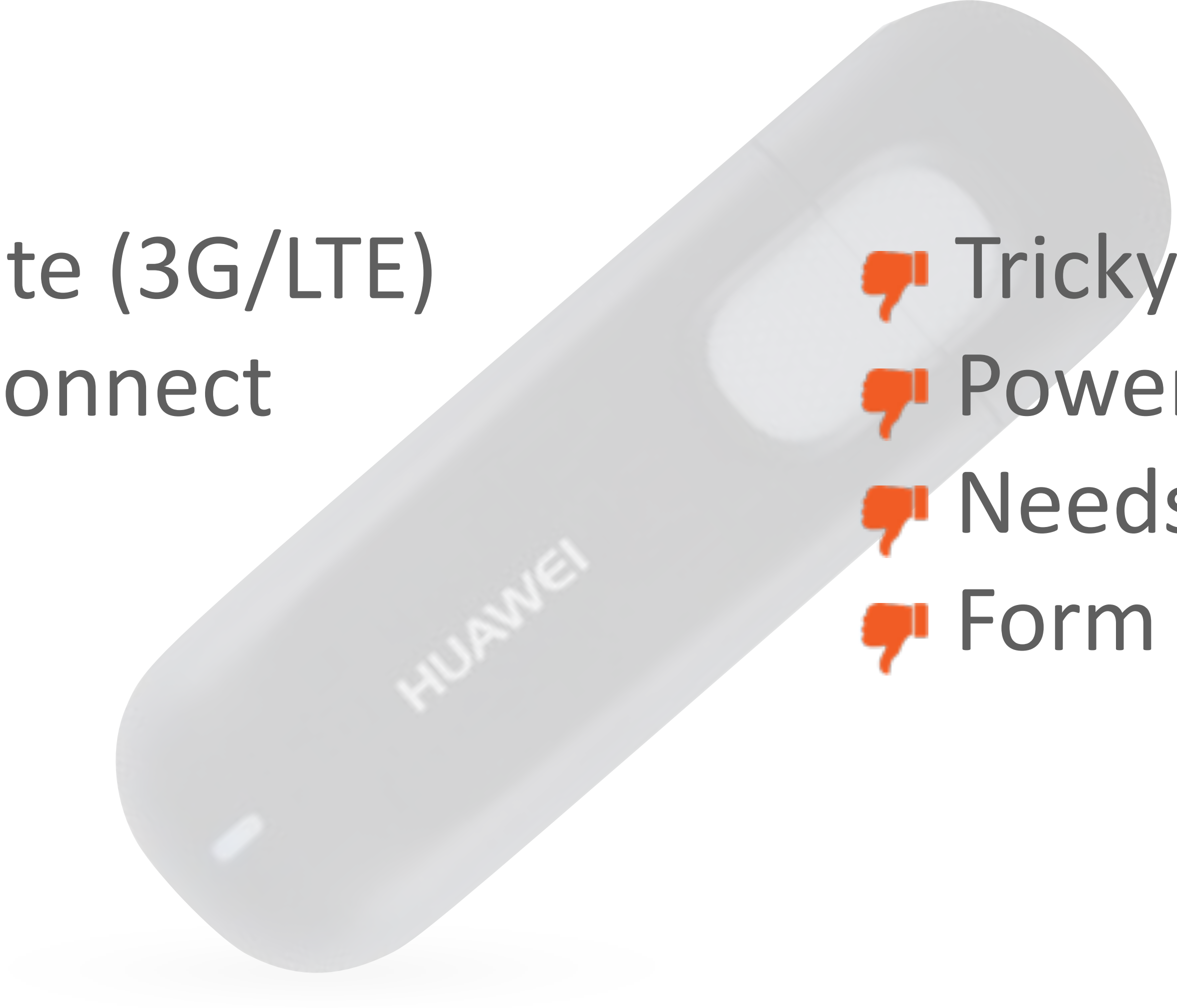
HEAVY LIFTING

COMMUNICATION

TECHNOLOGIES	*IrDA*	*NFC*	*ANT+*	*ZigBee*	*WiFi*	*Bluetooth*
MAX. THROUGHPUT	*200 kbps*	*424 kbps*	*20 kbps*	*250 kbps*	*6 Mbps*	*305 kbps*
LATENCY	*25 ms*	*1 s*	*0*	*25 ms*	*1.5 ms*	*2.5 ms*
RANGE	*1 m*	*5 cm*	*10 m*	*300 m*	*150 m*	*50 m*
PEAK CONSUMPTION	*10 mA*	*50 mA*	*17 mA*	*40 mA*	*116 mA*	*16 mA*

EXAMPLES…

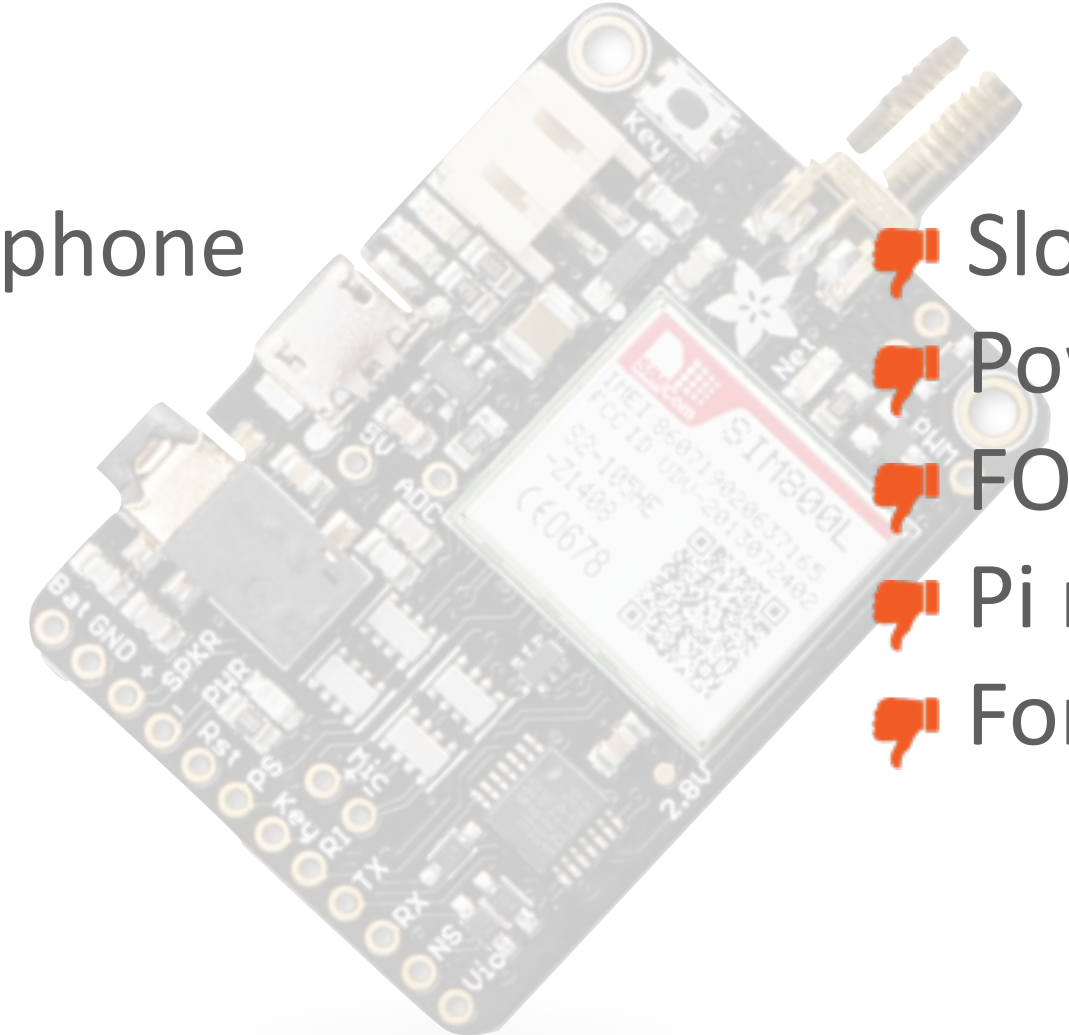
HUAWEI E303



- 👍 High data rate (3G/LTE)
- 👍 Automatic connect

- 👎 Tricky to setup
- 👎 Power cons. (~300mA)
- 👎 Needs big battery
- 👎 Form factor

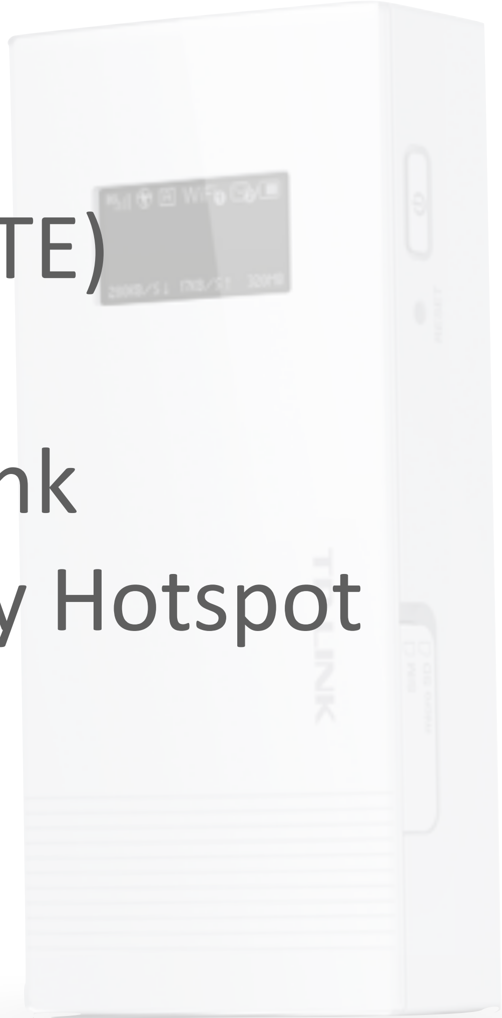
ADAFRUIT FONA



- 👍 Full mobile phone
- 👍 Flexible

- 👎 Slow data rate (2G)
- 👎 Power cons (>200mA)
- 👎 FONA needs battery
- 👎 Pi needs battery
- 👎 Form factor

TP-LINK M5360 + WIFI ADAPTER

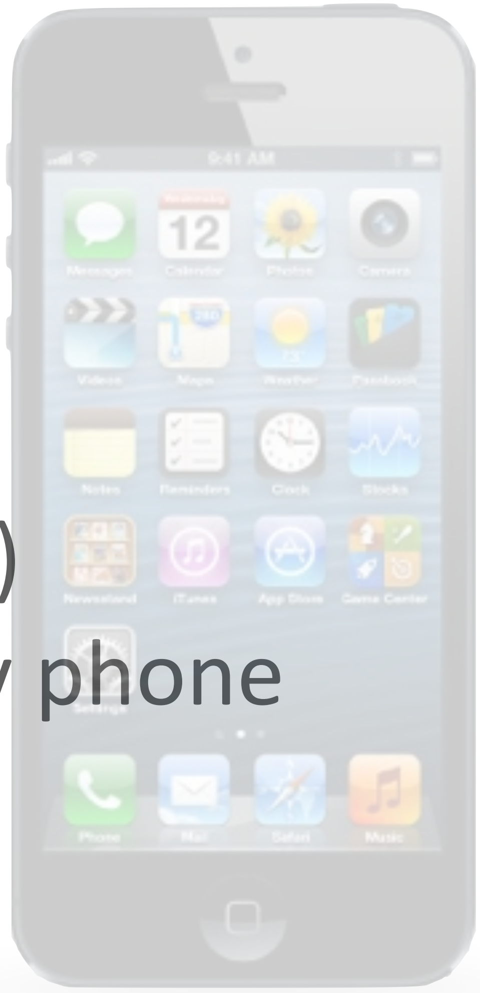


- 👍 High data rate (3G/LTE)
- 👍 Automatic connect
- 👍 Pi can use power bank
- 👍 Heavy lifting done by Hotspot

- 👎 Form factor
- 👎 Power cons. (~116mA)

MOBILE PHONE + BLE ADAPTER

- 👍 Fast connection
- 👍 Automatic connect
- 👍 Flexible 3G/LTE
- 👍 Power cons. (~16mA)
- 👍 Heavy lifting done by phone



- 👎 Pi needs battery

	3G Stick	FONA	*WiFi*	BLE
AUTONOMOUS	YES	YES	NO	NO
SPEED	7 Mbps	10 kbps	6 Mbps	305 kbps
FORM FACTOR	CLUNKY	CLUNKY	SMALL	SMALL
WEIGHT	LEIGHTWEIGHT	MEDIUM	LEIGHTWEIGHT	LEIGHTWEIGHT
POWER CONSUMPTION	300 mA	200 mA	116 mA	16 mA
INDEPENDENT	YES	YES	NEEDS HOTSPOT	NEEDS PHONE
BATTERY	1 BIG	2 SMALL	1 BIG	1 SMALL

COMMUNICATION

PUBLISH

&

SUBSCRIBE

PUBLISH & SUBSCRIBE

- XMPP
(eXtensible Messaging and Presence Protocol)
- MQTT
(Message Queue Telemetry Transport)

XMPP

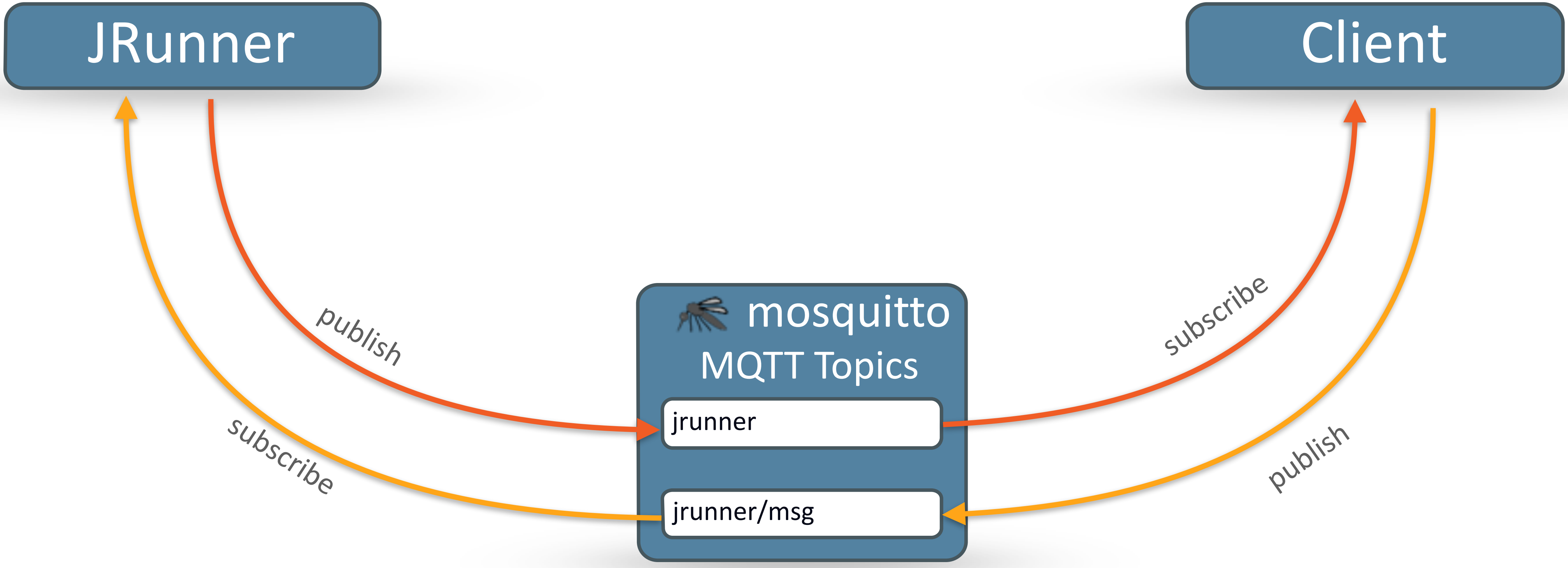
- Perfect for Person to Person
- No support for QoS
- Text based due to XML
- Public free infrastructure
- Ignite Realtime Smack Java library

MQTT

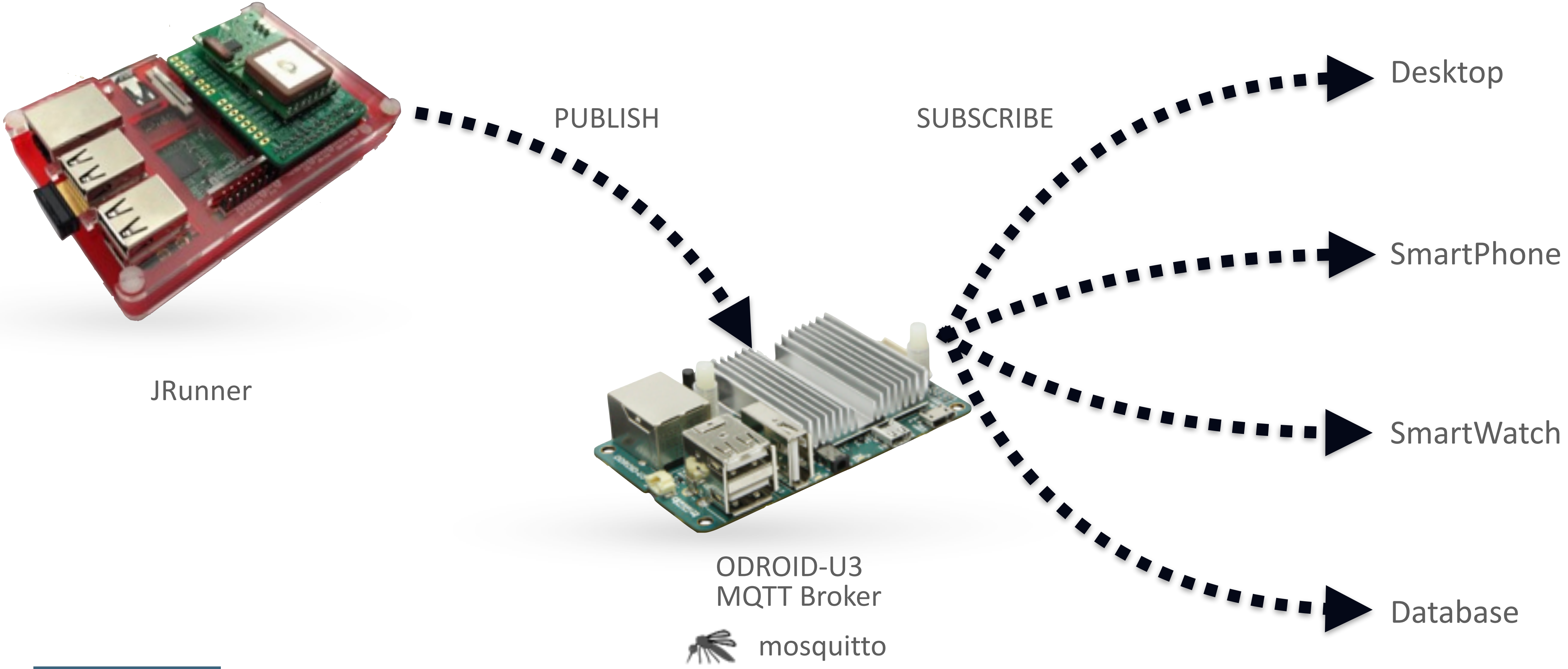
- Perfect for M2M
- Lightweight
- Low power
- Support for QoS
- Eclipse Paho Java library

INTERACTION

INTERACTION



INTERACTION



PUBLISH

SUBSCRIBE

JRunner

ODROID-U3
MQTT Broker

mosquitto

Desktop

SmartPhone

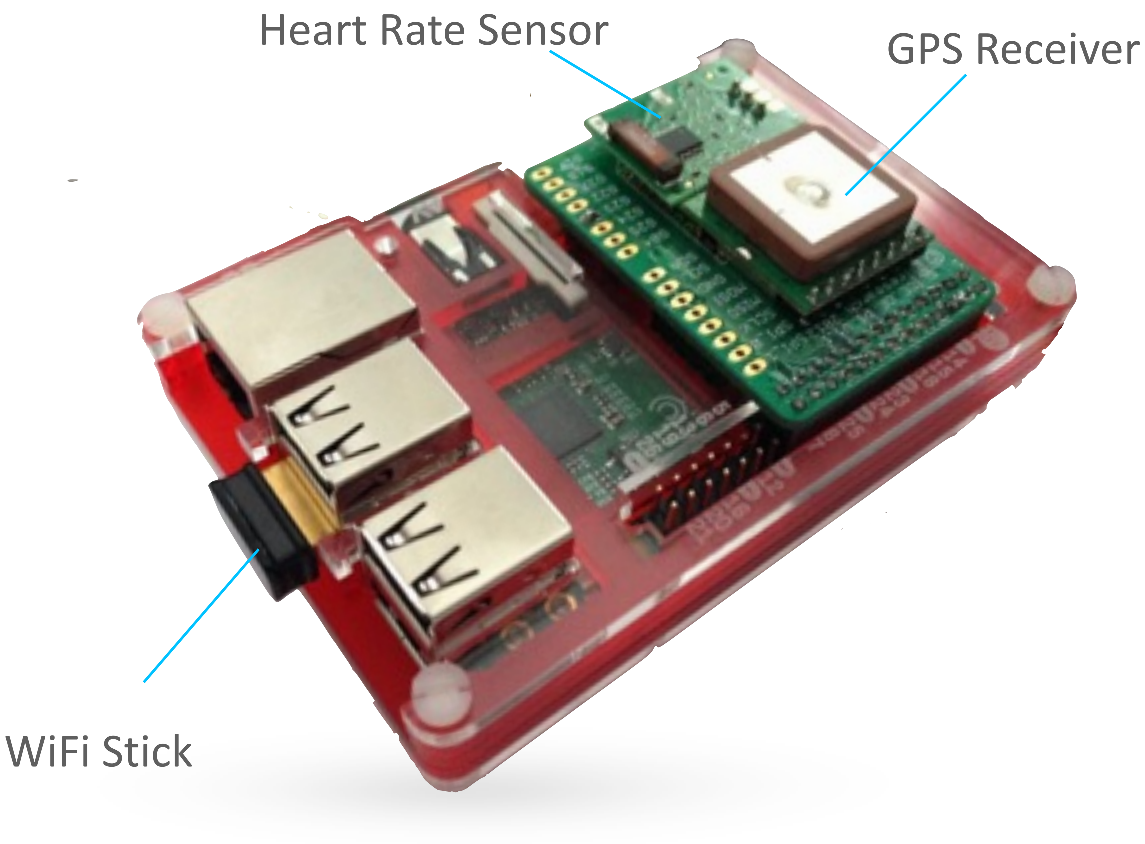
SmartWatch

Database

HARDWARE

VERSION 1

THE WEARABLE V1 (WIFI BASED)



PROBLEM…

POWER SUPPLY

SOLUTION

POWER SUPPLY

THE WEARABLE V1 (WIFI BASED)

+

DRAWBACK...

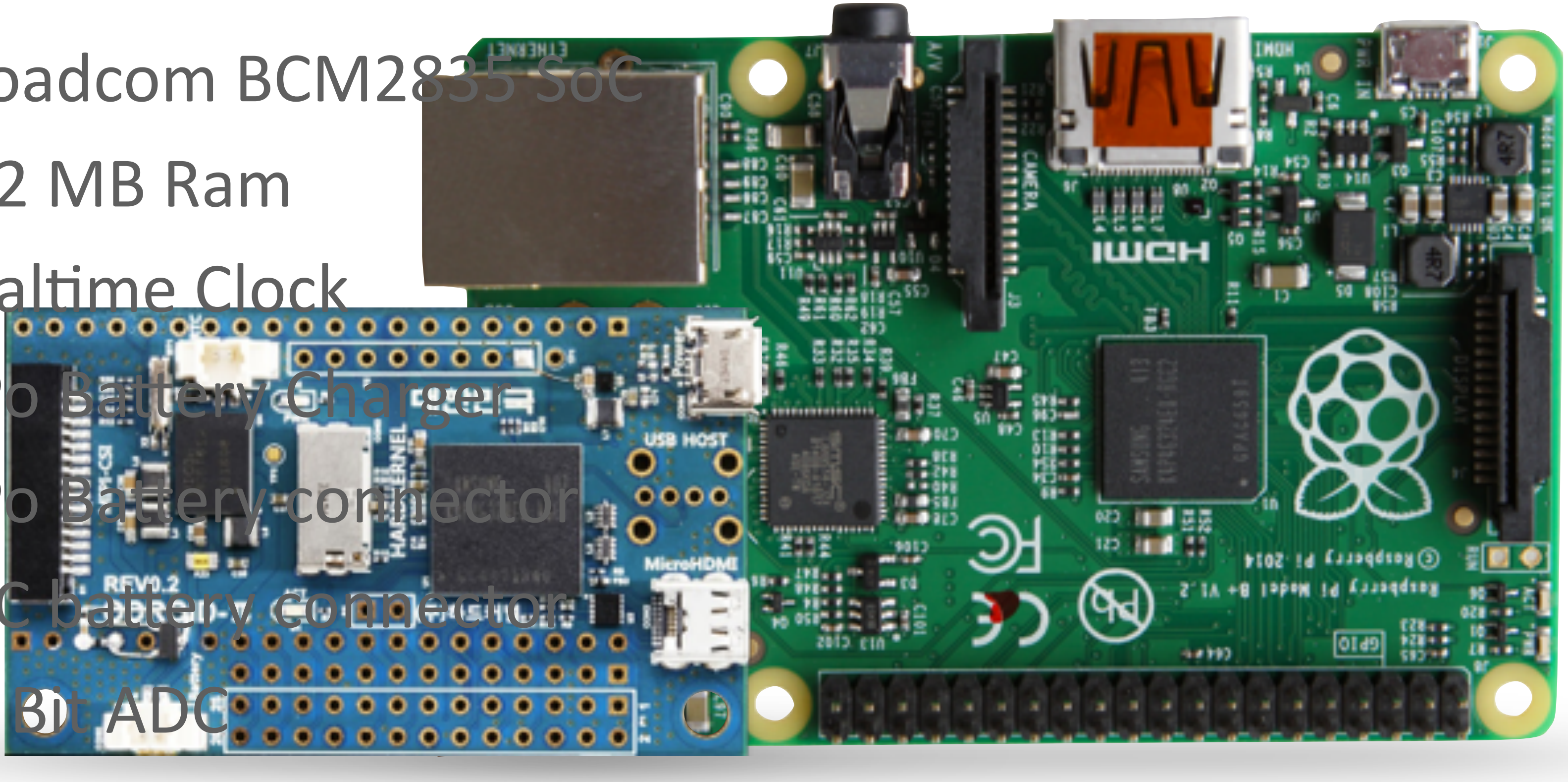
WiFi
TM

VERSION 2

VERSION 2

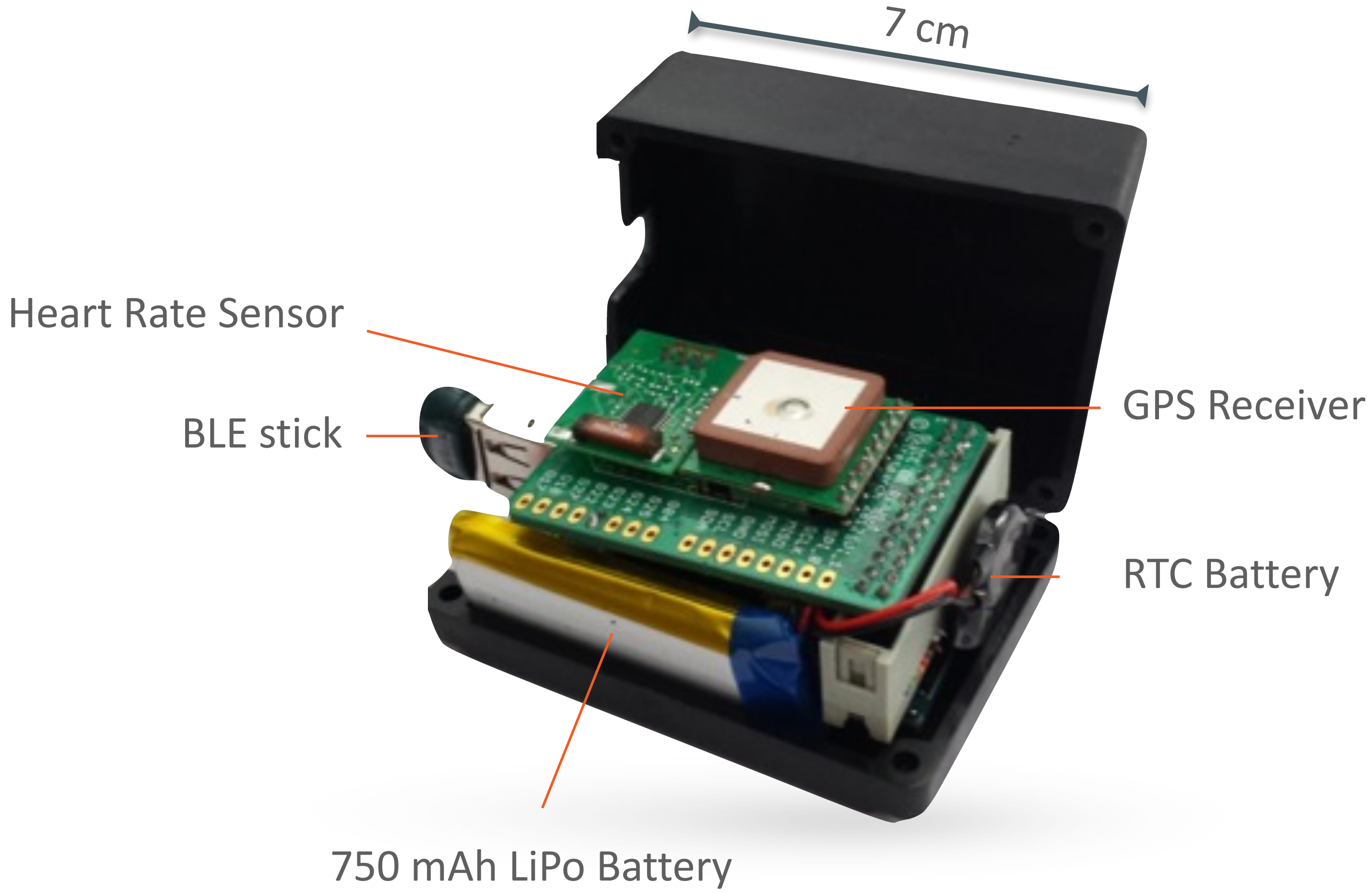
Odroid-W Raspberry Pi Model B+

- Broadcom BCM2835 SoC
- 512 MB Ram
- Realtime Clock
- LiPo Battery Charger
- LiPo Battery connector
- RTC battery connector
- 12 Bit ADC

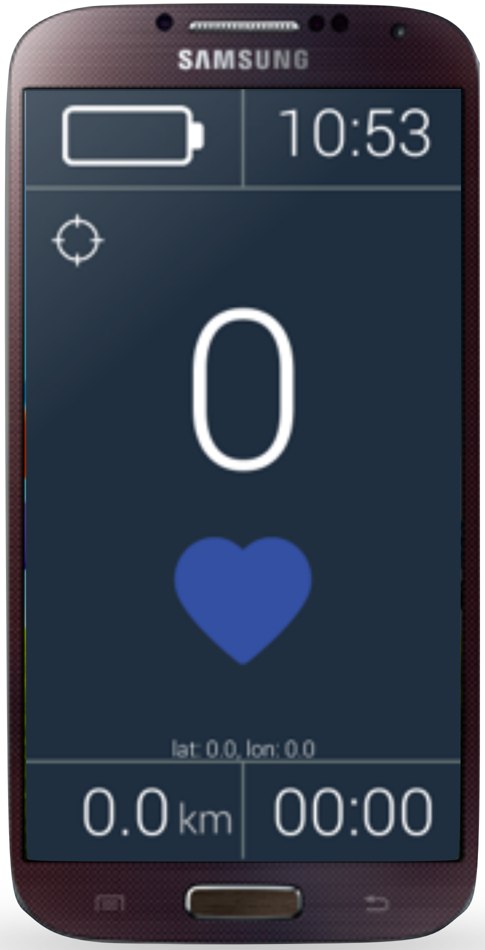


THE WEARABLE V2 (BLE BASED)

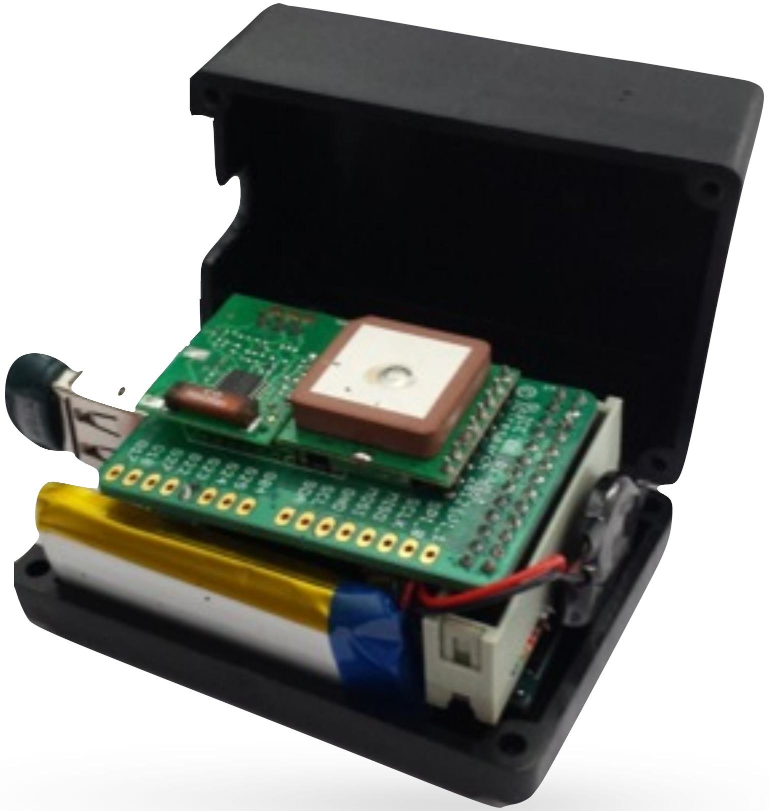
- Odroid-W
- 750 mAh LiPo Battery
- Slice of Pi
- SUP800F GPS
- Polar Heart Beat Sensor
- BLE USB Stick
- ON Switch
- Vibration motor



THE WEARABLE V2 (BLE BASED)



+

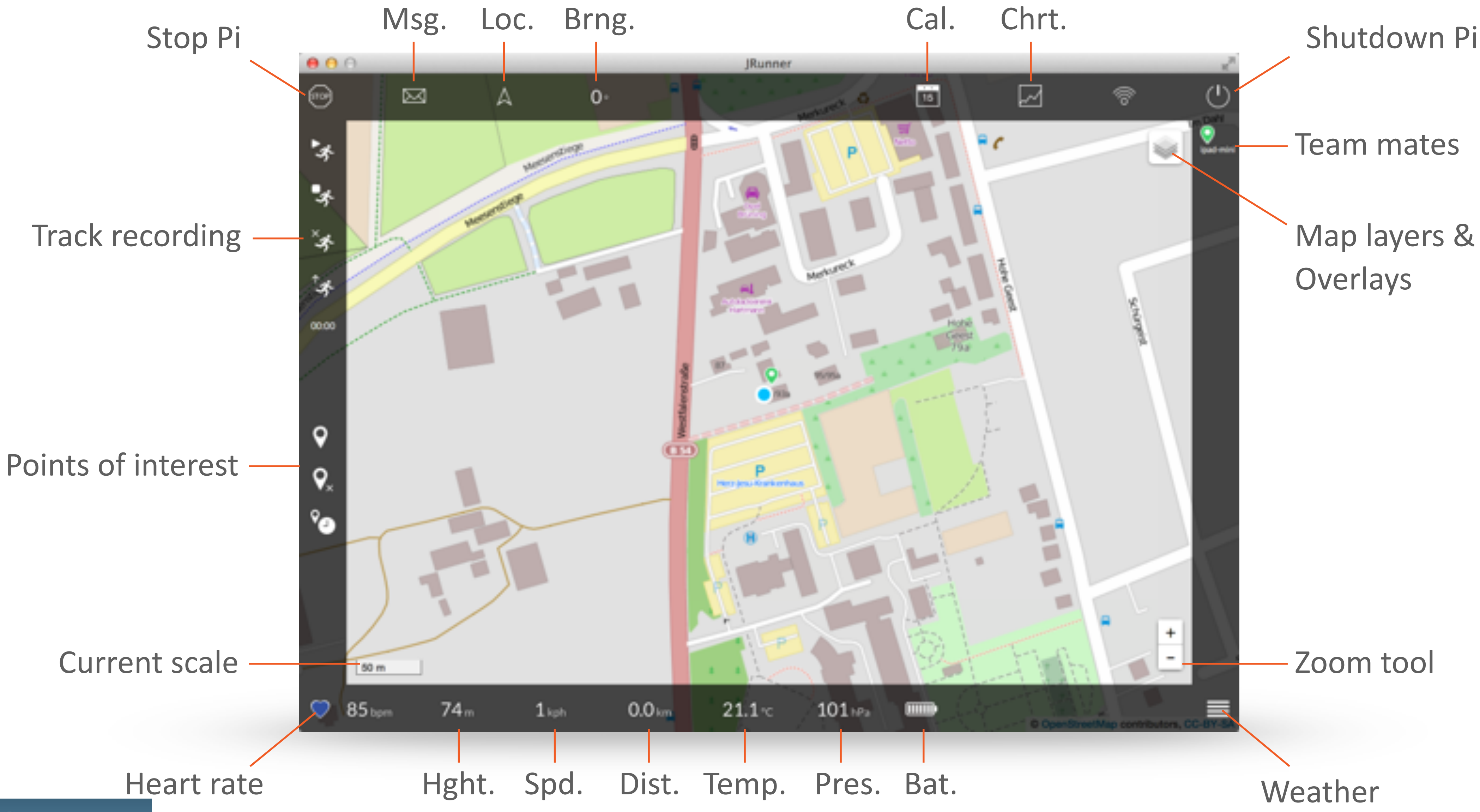


ADVANTAGE...

Bluetooth® SMART

DESKTOP APP

DESKTOP APP



Stop Pi

Msg.

Loc.

Brng.

Cal.

Chrt.

Shutdown Pi

Team mates

Track recording

Map layers & Overlays

Points of interest

Current scale

Zoom tool

Heart rate

Hght.

Spd.

Dist.

Temp.

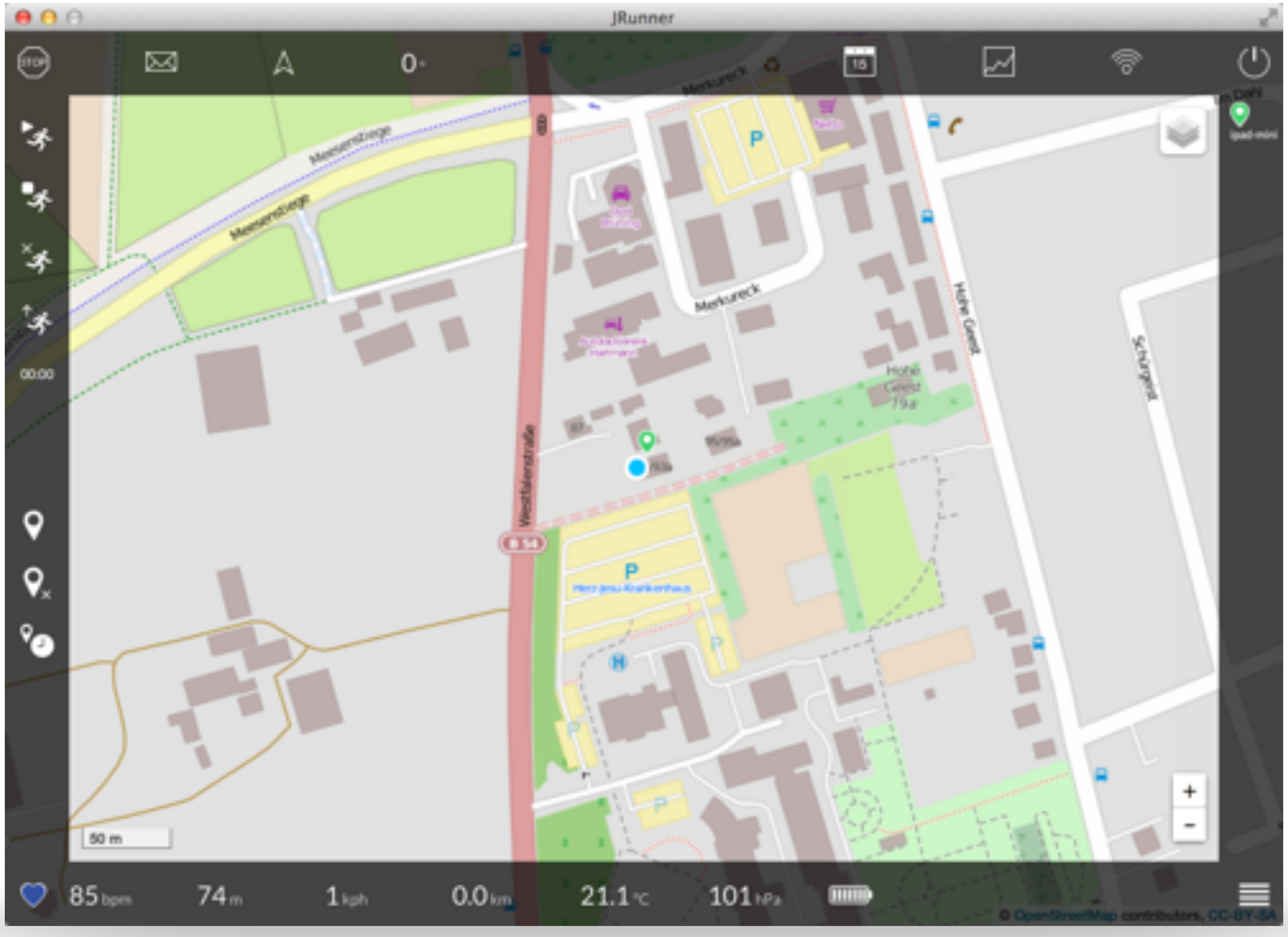
Pres.

Bat.

Weather

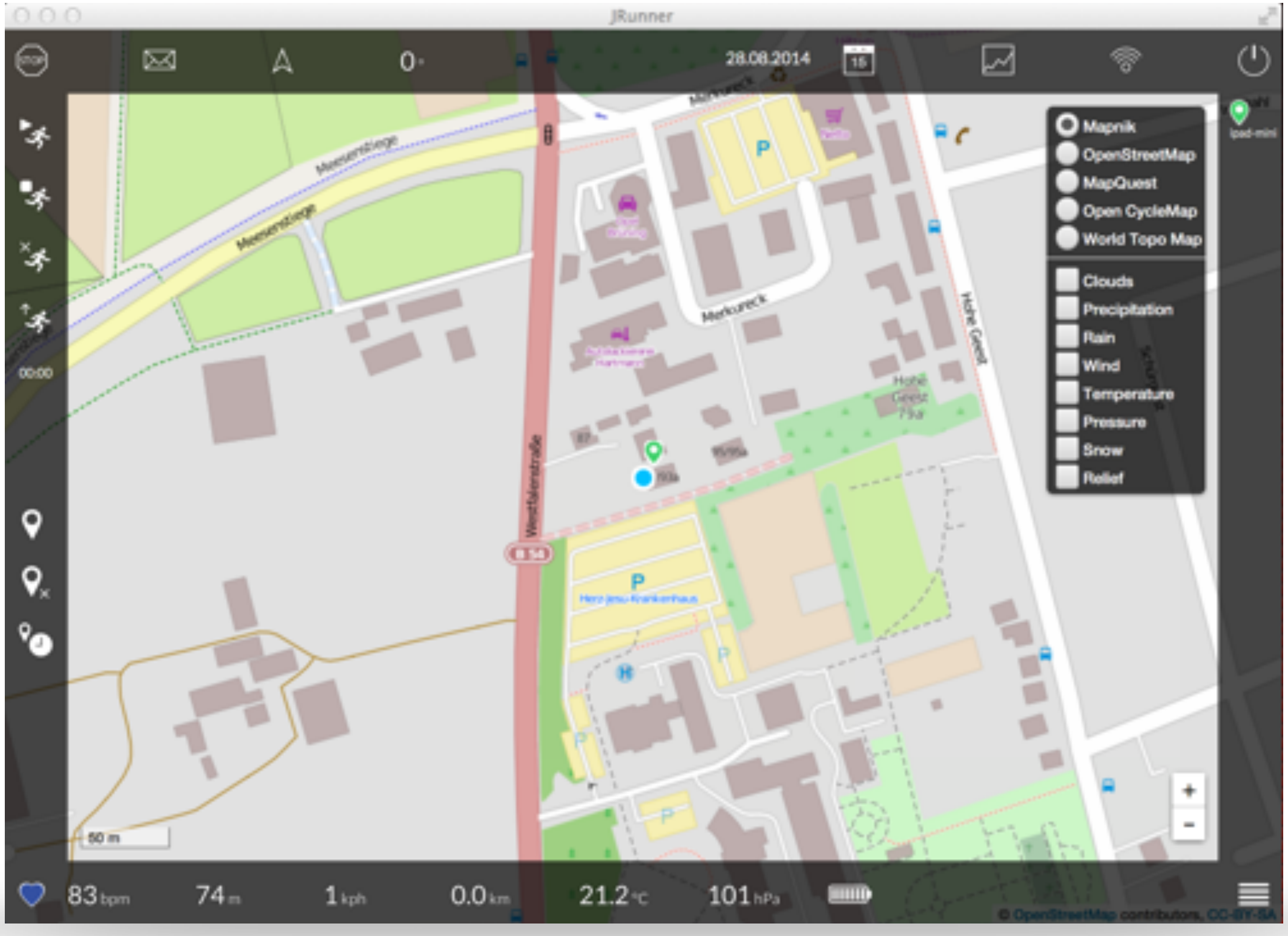
DESKTOP APP

- Runner location
- BPM, height, speed, distance, temperature, pressure, battery
- Friends location



DESKTOP APP

- Different map layers
- Additional map overlays

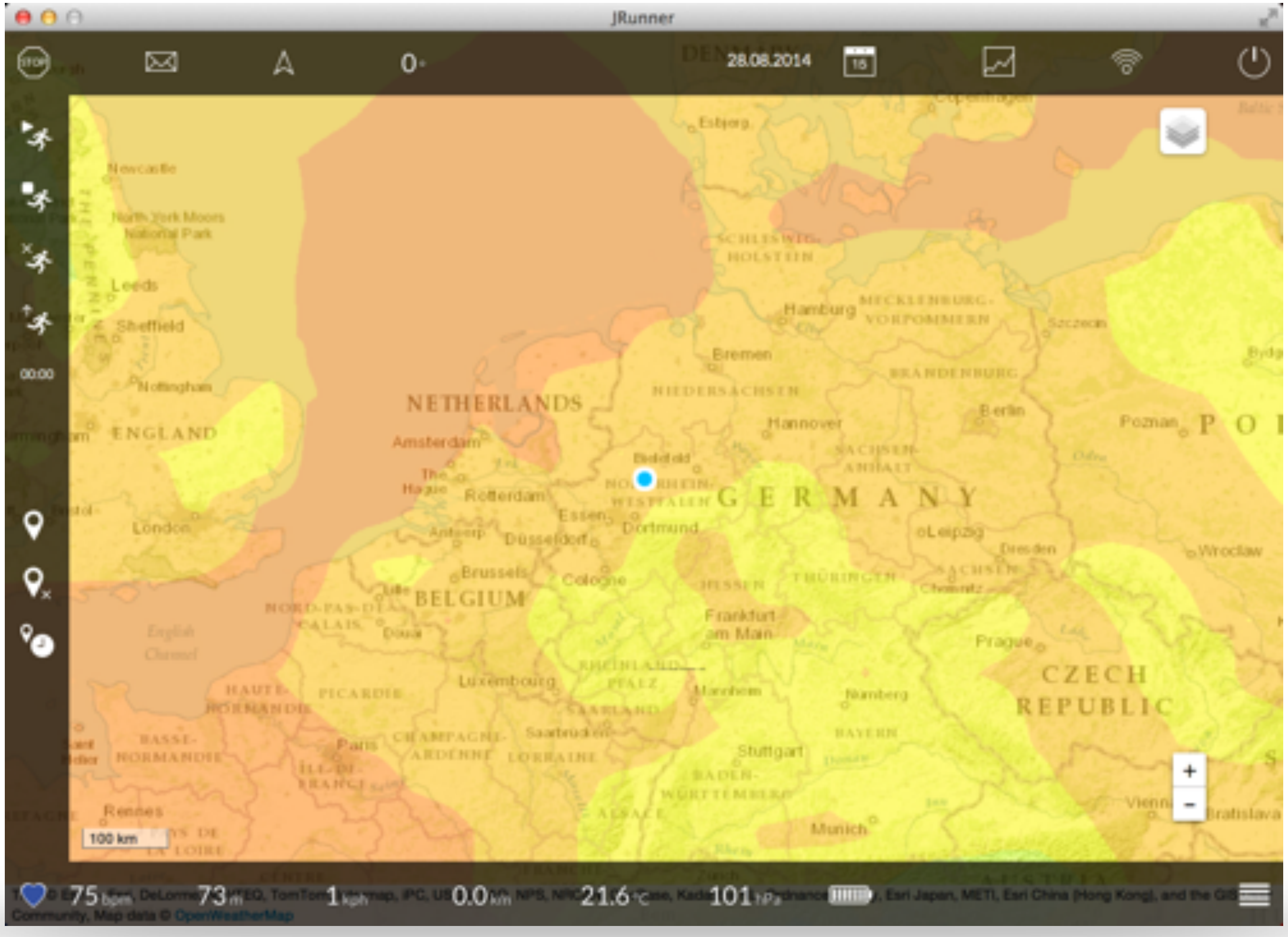


● Mapnik
○ OpenStreetMap
○ MapQuest
○ Open CycleMap
○ World Topo Map

□ Clouds
□ Precipitation
□ Rain
□ Wind
□ Temperature
□ Pressure
□ Snow
□ Relief

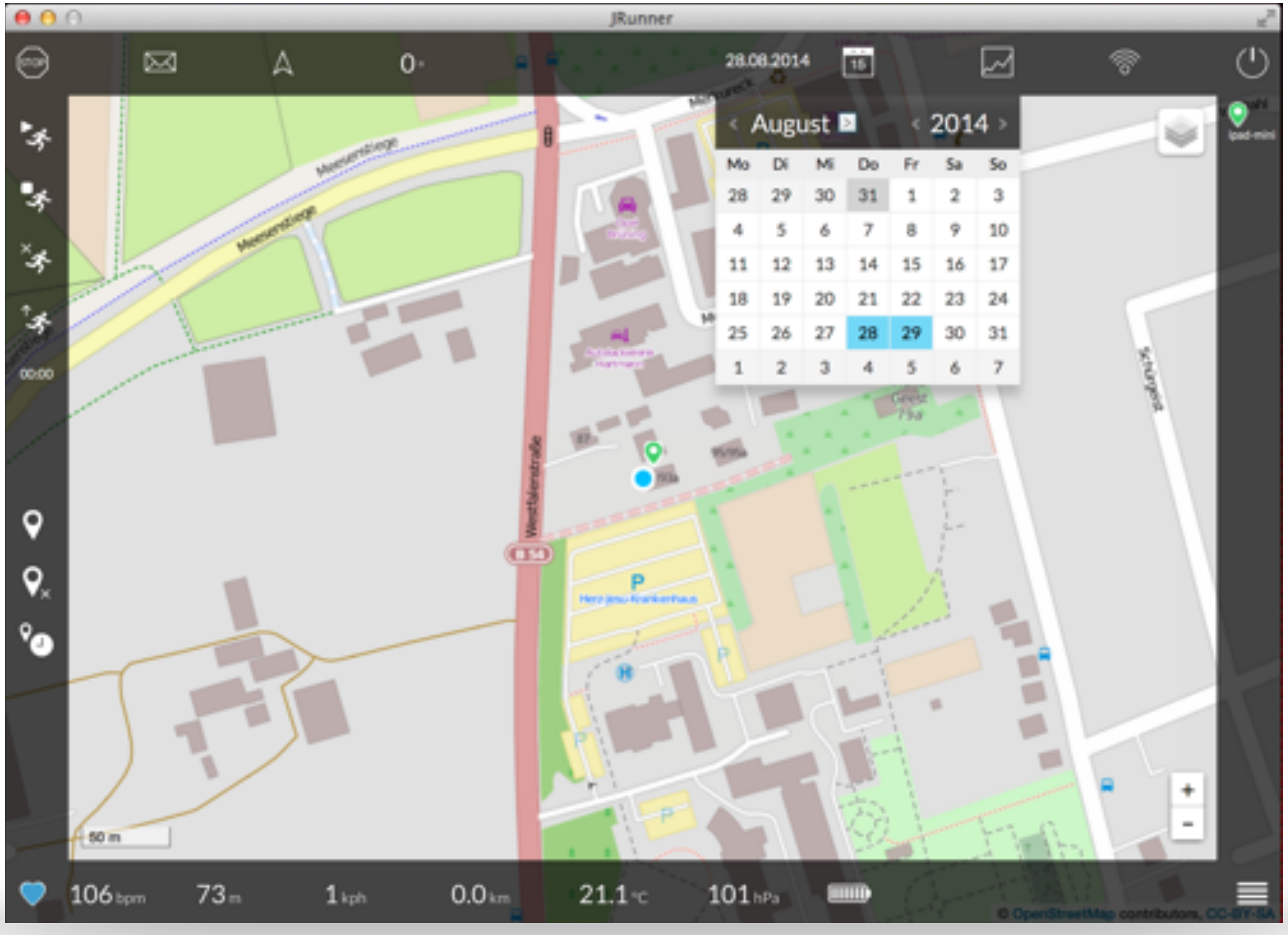
DESKTOP APP

- e.g. Temperature



DESKTOP APP

- Show dates with recordings
- Restore saved recordings

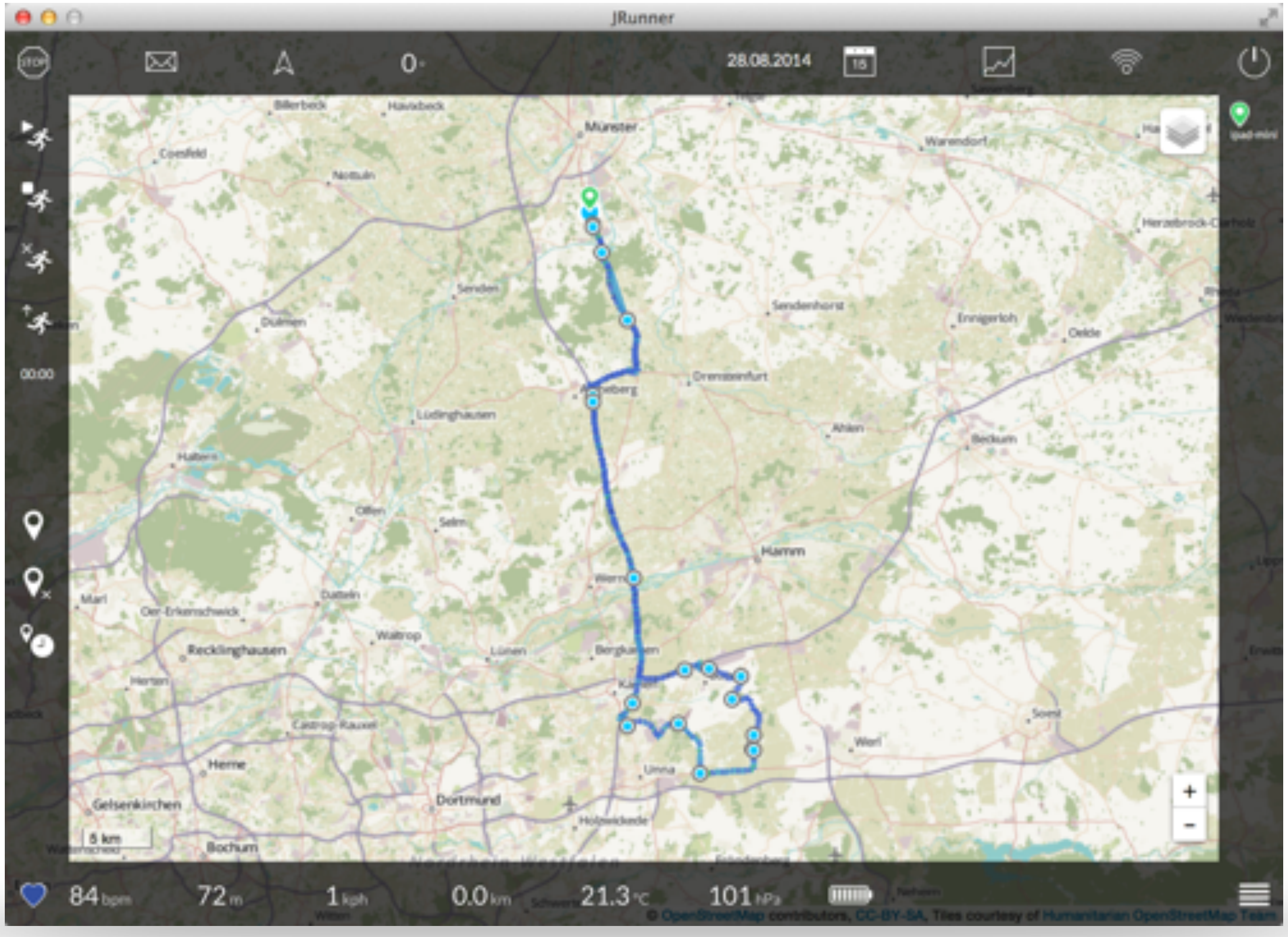


‹ August › ‹ 2014 ›

Mo	Di	Mi	Do	Fr	Sa	So
28	29	30	31	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31
1	2	3	4	5	6	7

DESKTOP APP

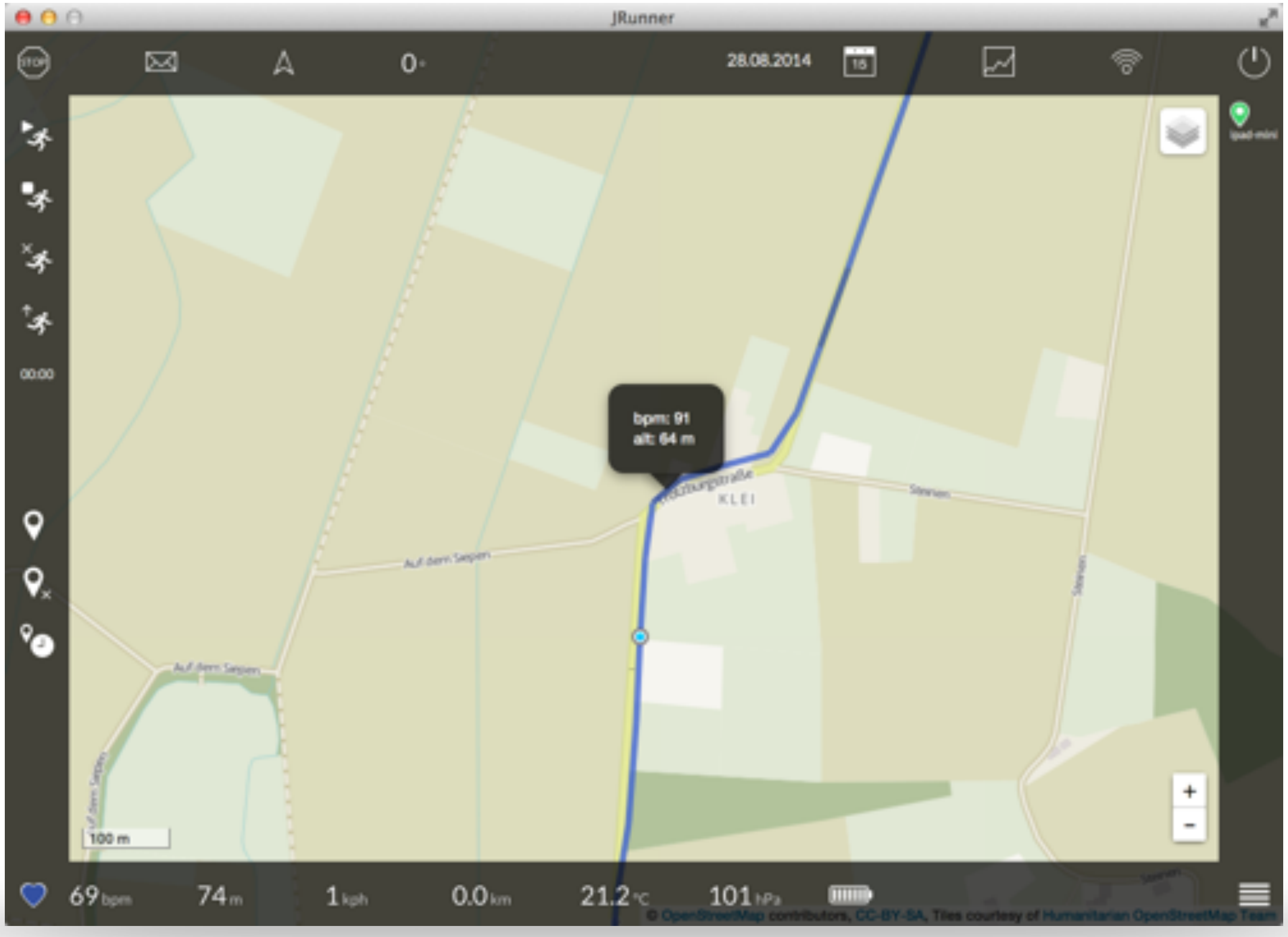
- Show track on map
- Track segments are colored dependent on heart rate
- Show points of interests



DESKTOP APP

JavaFx

- Click on track segments will show altitude and bpm of selected segment



bpm: 91
alt: 64 m

69 bpm 74 m 1 kph 0.0 km 21.2 °C 101 hPa

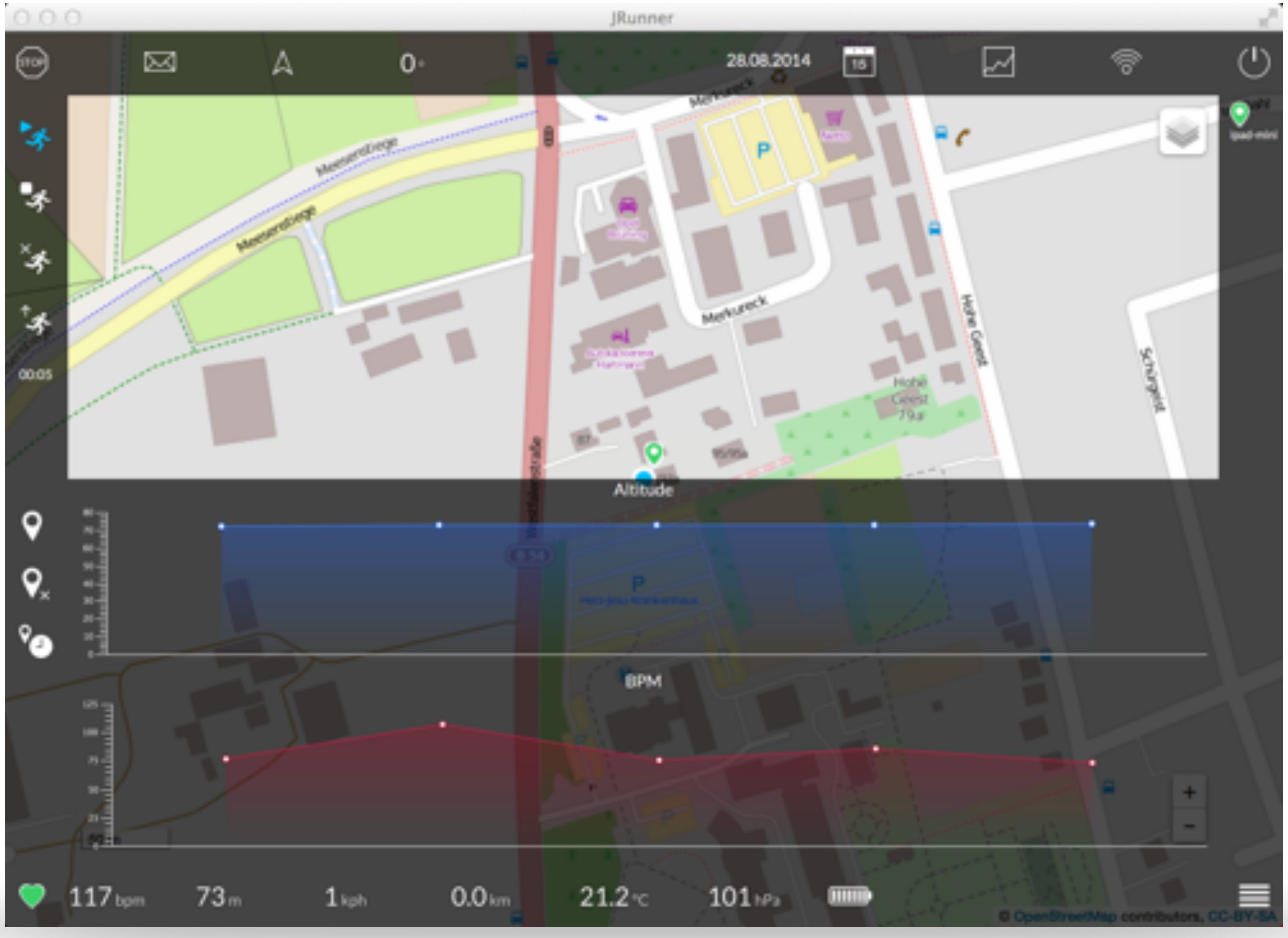
© OpenStreetMap contributors, CC-BY-SA, Tiles courtesy of Humanitarian OpenStreetMap Team

Java ORACLE

DESKTOP APP

- Visualizes altitude over time

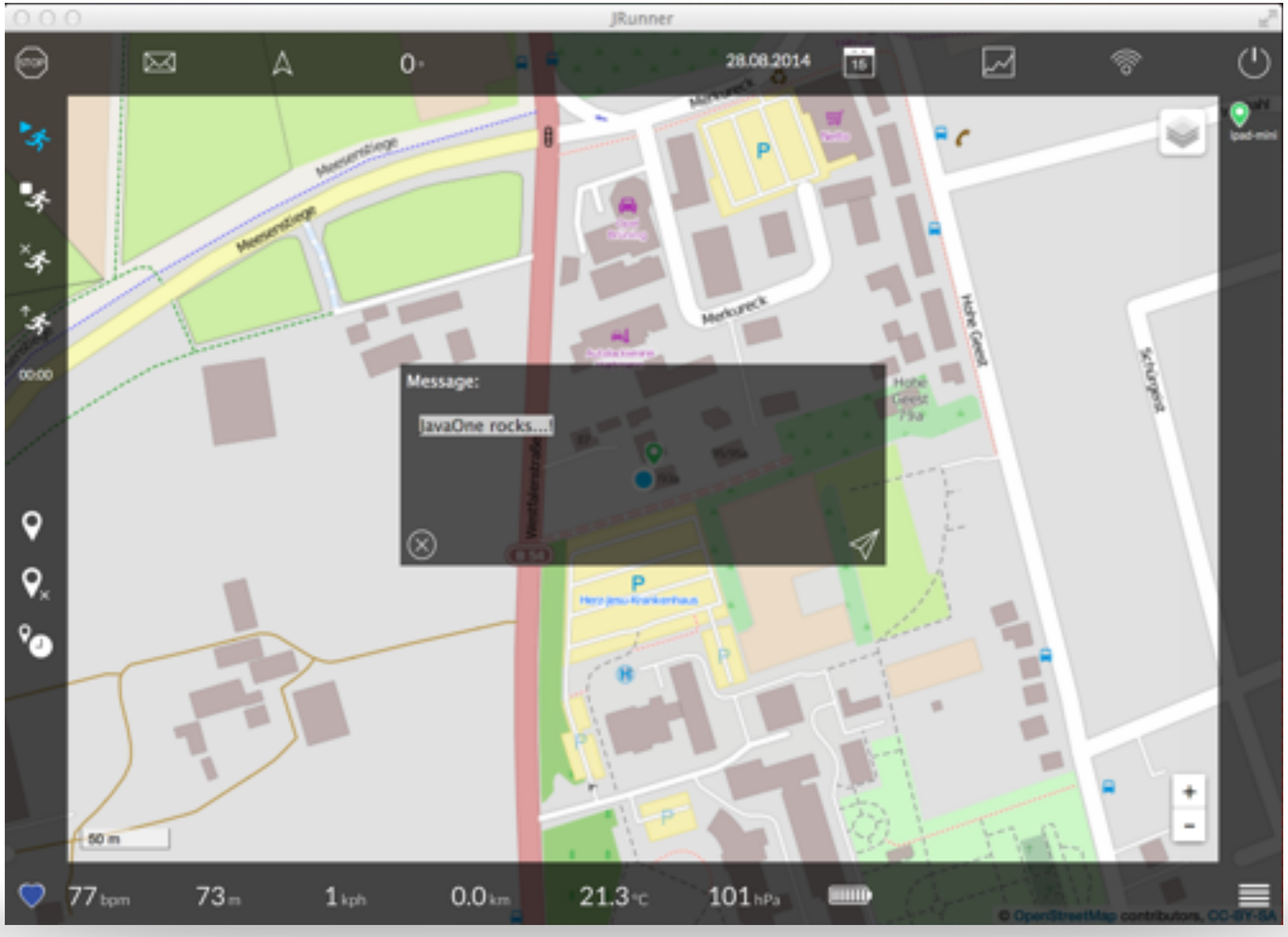
- Visualizes heart rate over time



DESKTOP APP

JavaFx

- Can send text messages via MQTT to Runner
- Tell the Runner the current heart rate

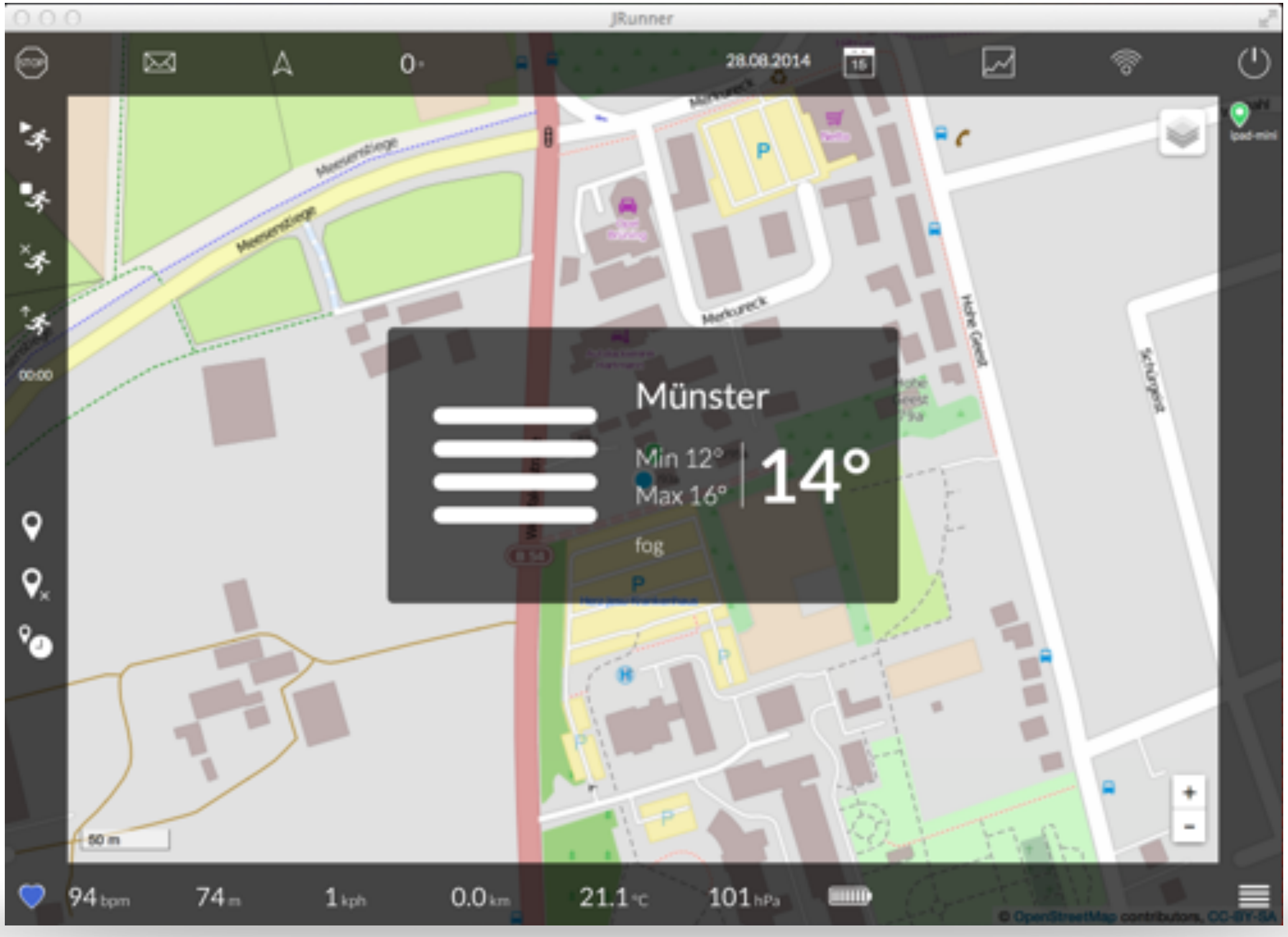


Message:

JavaOne rocks...!

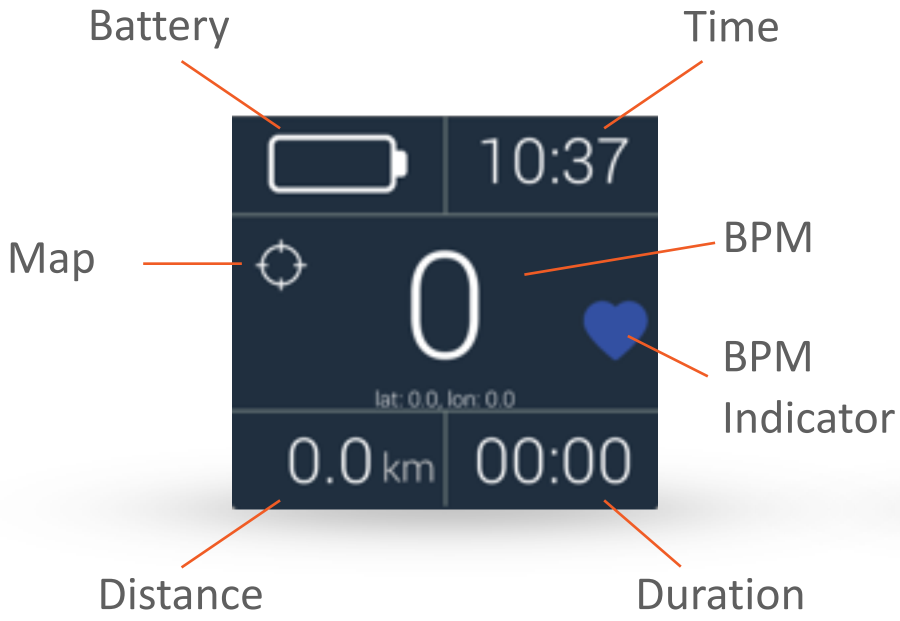
DESKTOP APP

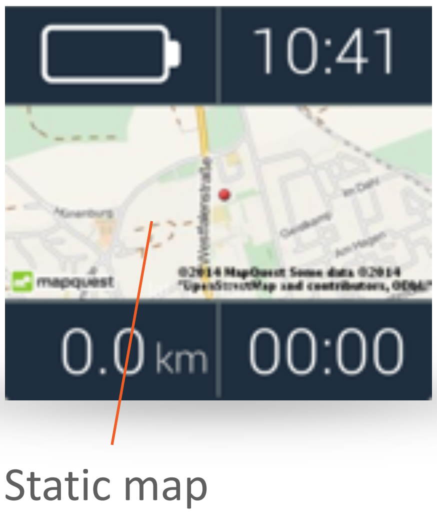
- Visualizes weather information at runner location

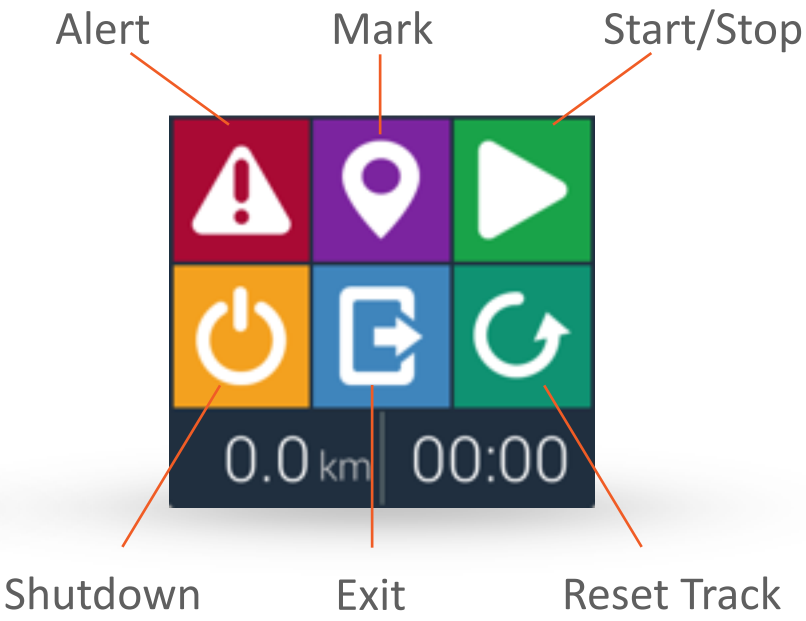


MOBILE APP

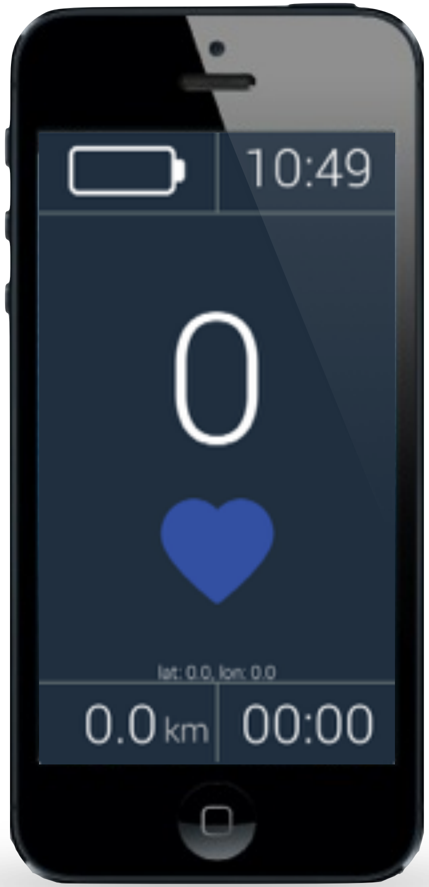
MOBILE APP


Battery
Time
10:37
Map
BPM
0
BPM Indicator
lat: 0.0, lon: 0.0
0.0 km
00:00
Distance
Duration


10:41
mapquest
0.0 km
00:00
Static map

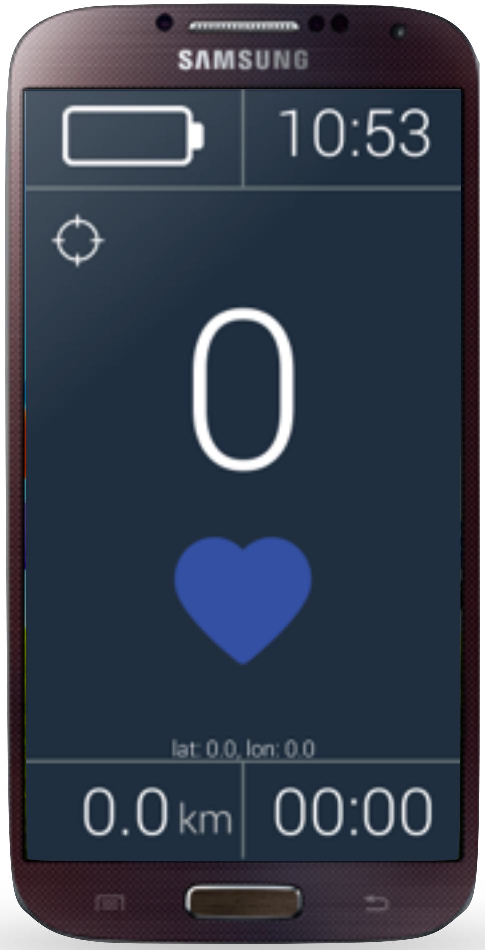

Alert
Mark
Start/Stop
0.0 km
00:00
Shutdown
Exit
Reset Track

MOBILE APP



CPU	1.3 GHz ARM A7 DualCore
GPU	PowerVR SGX543 MP3 Triple Core
RAM	32 GB (1 GB for apps)
RES	640x1136
OS	iOS

MOBILE APP



CPU	1.6 GHz ARM A15 QuadCore
GPU	PowerVR SGX544 MP3
RAM	16 GB (2 GB for apps)
RES	1080x1920
OS	Android

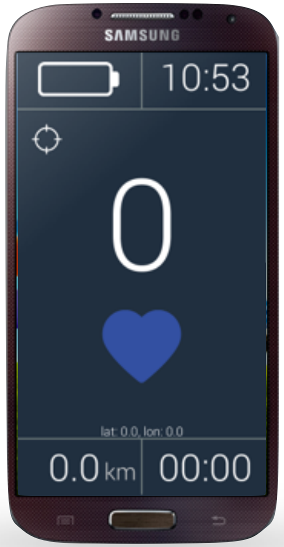
MOBILE APP

CPU	1 GHz ARM A9 DualCore
GPU	PowerVR SGX531
RAM	2 GB (512 MB for apps)
RES	320x320
OS	Android

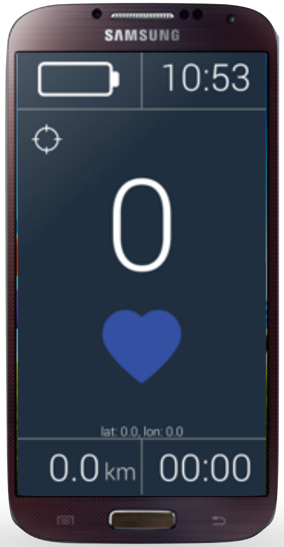
SETUPS

TP-LINK

POLAR
T31


SAMSUNG
10:53
0
lat: 0.0, lon: 0.0
0.0 km
00:00

POLAR
T31

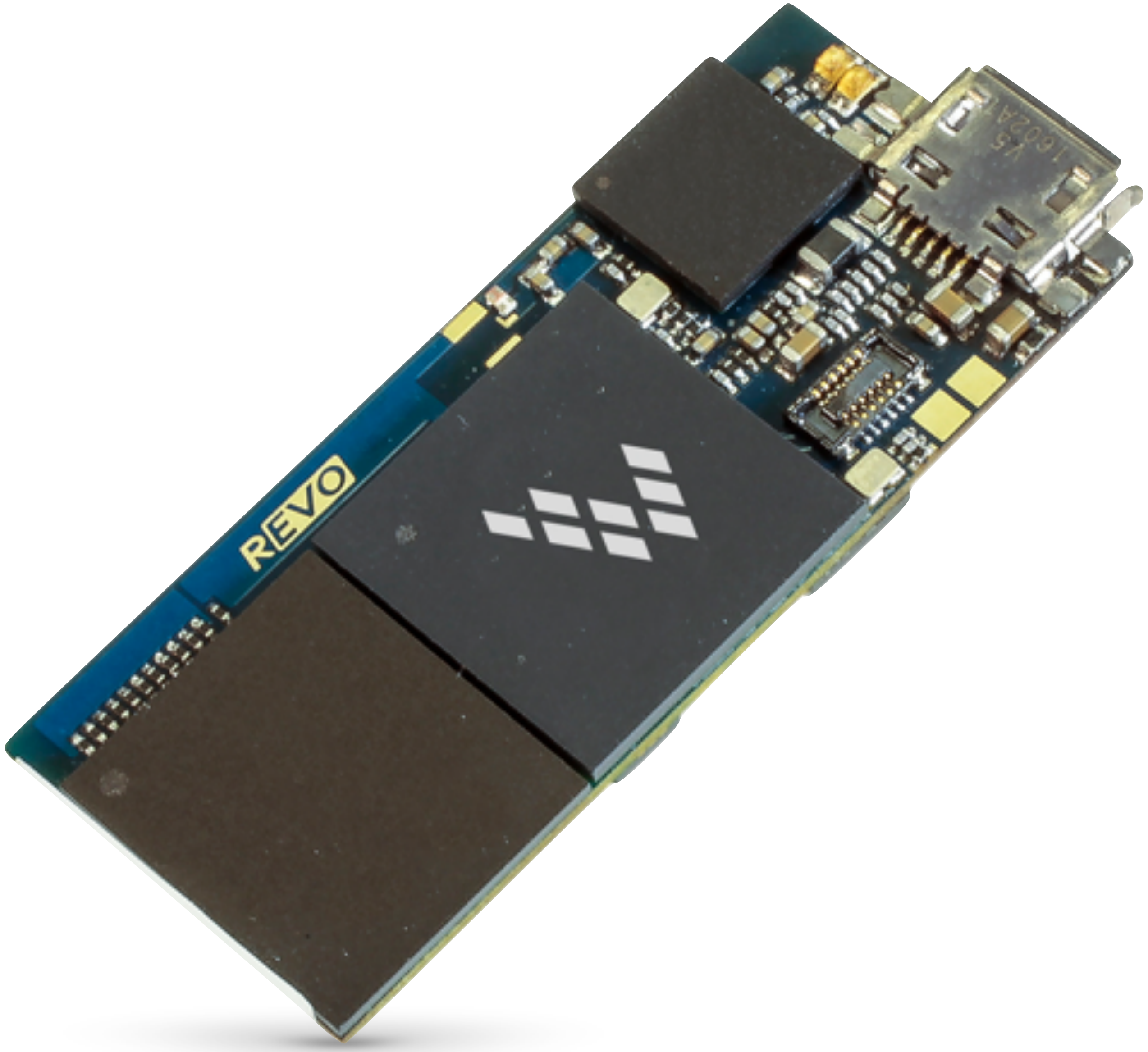

SAMSUNG
10:53
0
lat: 0.0, lon: 0.0
0.0 km
00:00

POLAR
T34

FUTURE IMPROVEMENTS

WARP BOARD

- 1 GHz i.MX6 CPU
- WiFi
- BlueTooth Low Energy
- Accelerometer
- Magnetometer
- ~ 18 x 42 mm



SO…WHY JAVA

WHY JAVA

- Re-use a lot of classes/code
- Great Java IDEs
- Use your build infrastructure
- Use your test environment