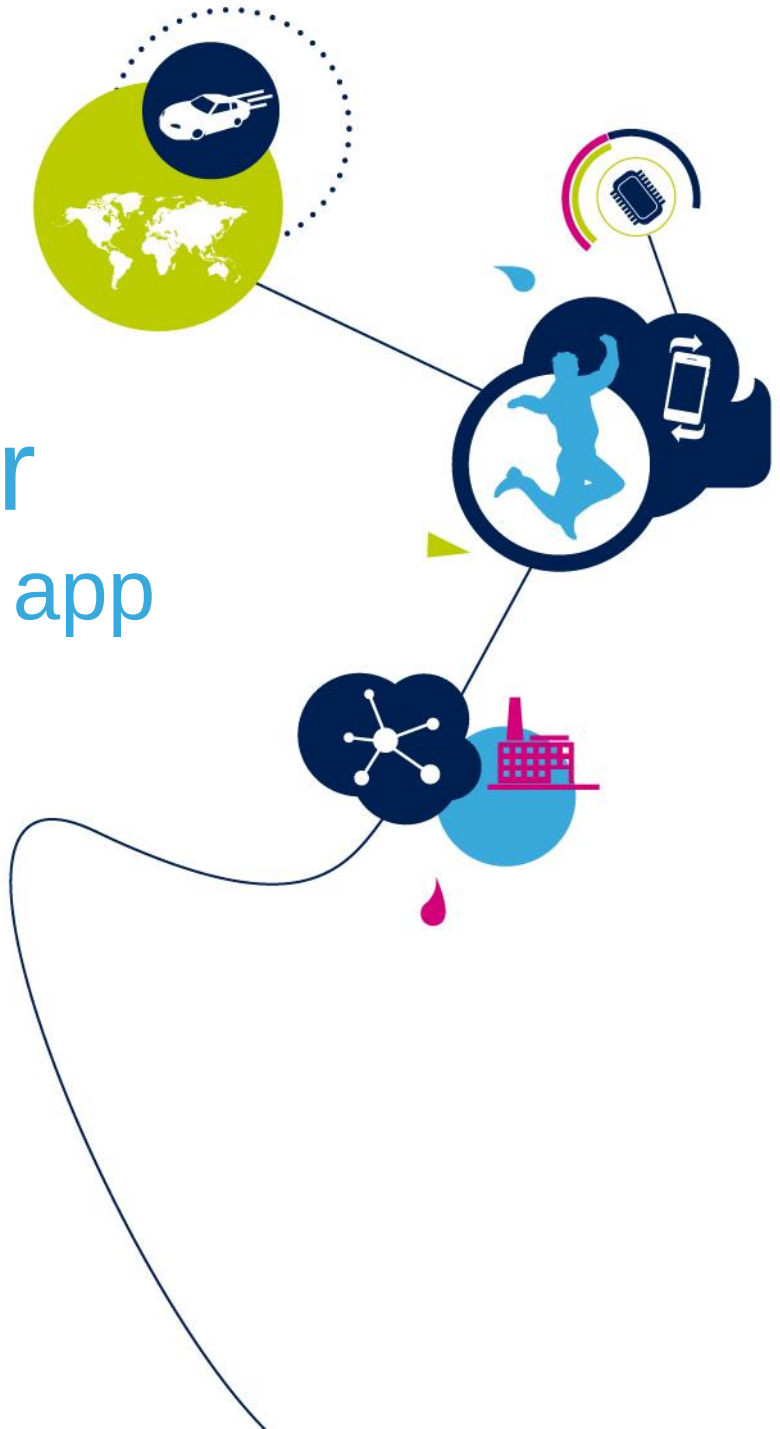
BlueCoin, the Electronic Ear

Hands-on LABs using BlueMS mobile app

STMicroelectronics



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LAB Preparation

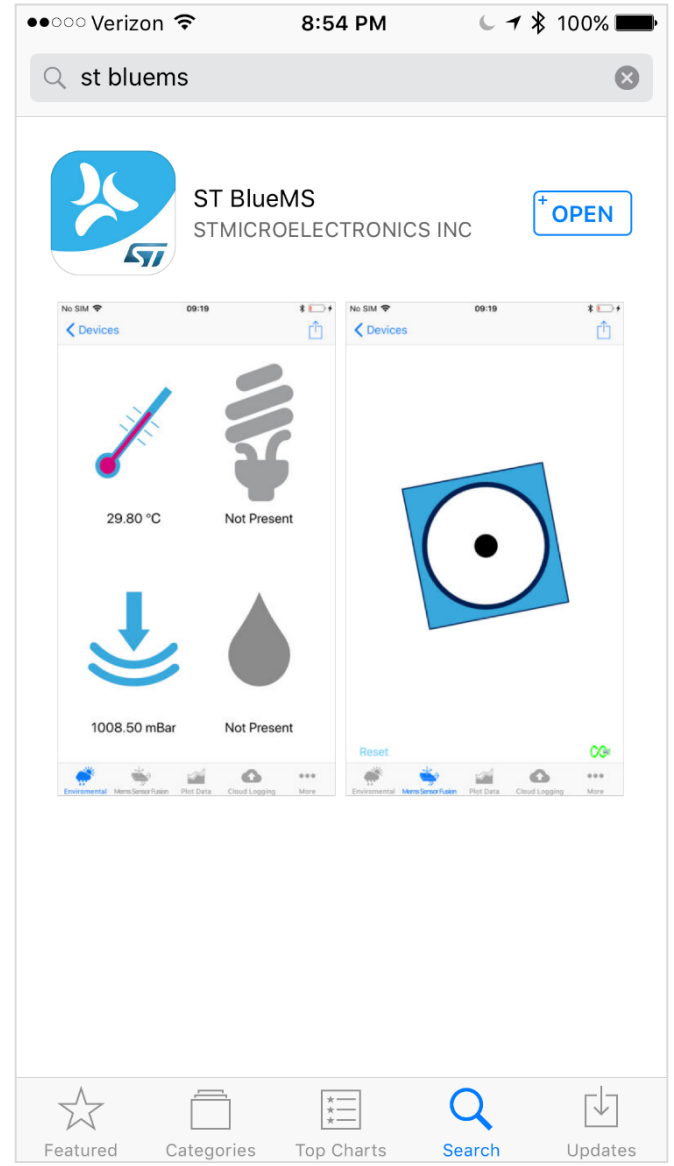
ON YOUR PHONE/TABLET

- Install **ST BlueMS app** on your smartphone
- On Google Play or iOS App Store look for "ST BlueMS"

Download on the App Store

GET IT ON Google Play

ST BlueMS
STMICROELECTRONICS INC
Version 3.8.0 (or newer)



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Agenda

www.st.com/bluecoin

- **BlueCoin** Overview
  - How to program the BlueCoin
  - Firmware and Software Overview
- **BlueCoin** Hands-on Using the **ST BlueMS App**
  - LAB1: Install the ST BlueMS app
  - DEMO: Firmware Over The Air Update
  - LAB2: Real-Time Data Plot and Log
  - LAB3: IBM Watson IoT
  - LAB4: Event Detection
  - LAB5: Voice over Bluetooth Low Energy
  - LAB6: IBM Watson Speech To Text

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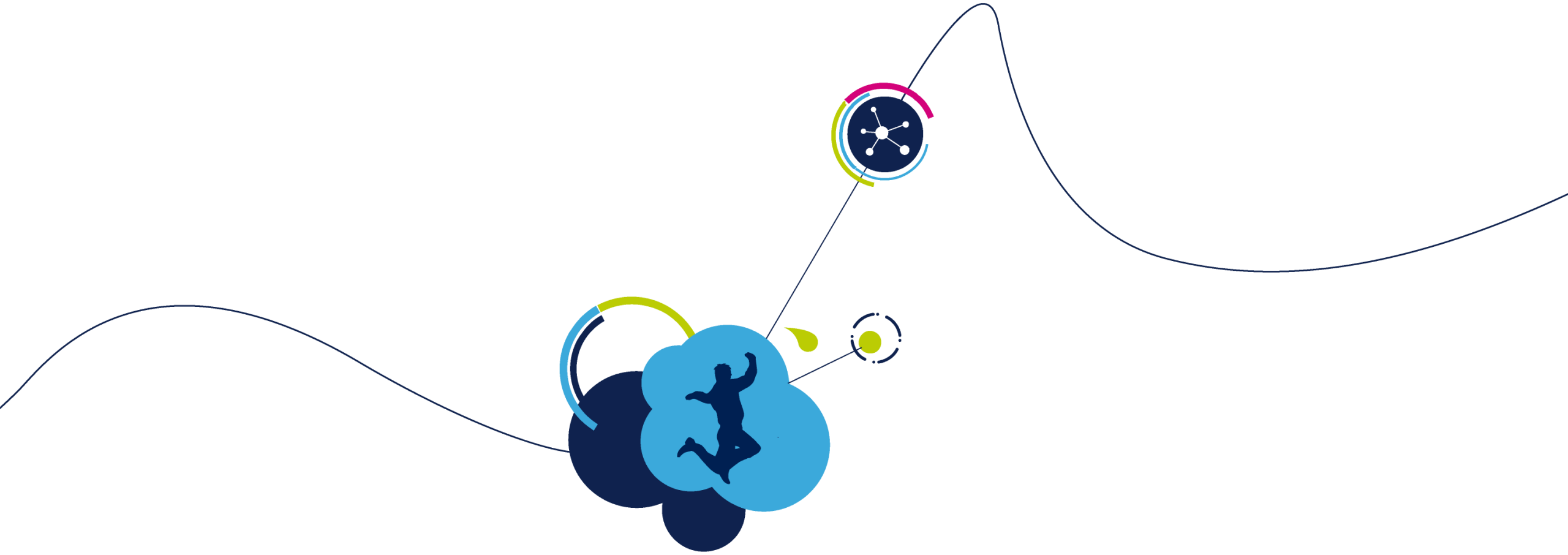

BlueCoin Overview

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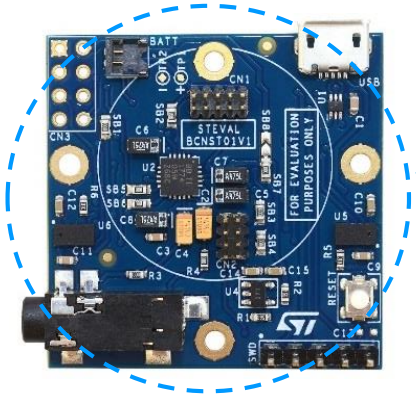
STEVAL-BCNKT01V1

BlueCoin Starter Kit

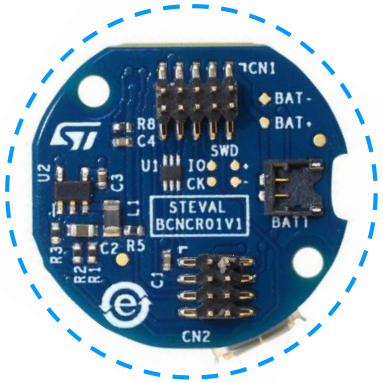
130mAh LiPo Battery (UN38.3 Certified)

ST-Link SWD Programming Cable

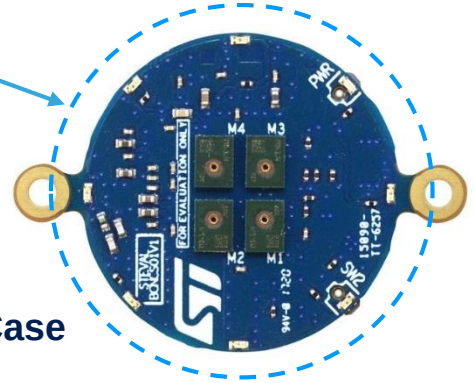
STEVAL-BCNST01V1 CoinStation



STEVAL-BCNCR01V1 Cradle



STEVAL-BCNCS01V1 Core System



Plastic Case

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BlueCoin - The Robotic Ear

Core System: STEVAL-BCNCS01V1

LSM303AGR

3DAcc+3DMag
200µA @ 20 Hz (HR mode)
Accel/Mag independent power down mode

LPS22HB

Barometer
1-75Hz, 3-12µA @ 1Hz

4x MP34DT04-C1

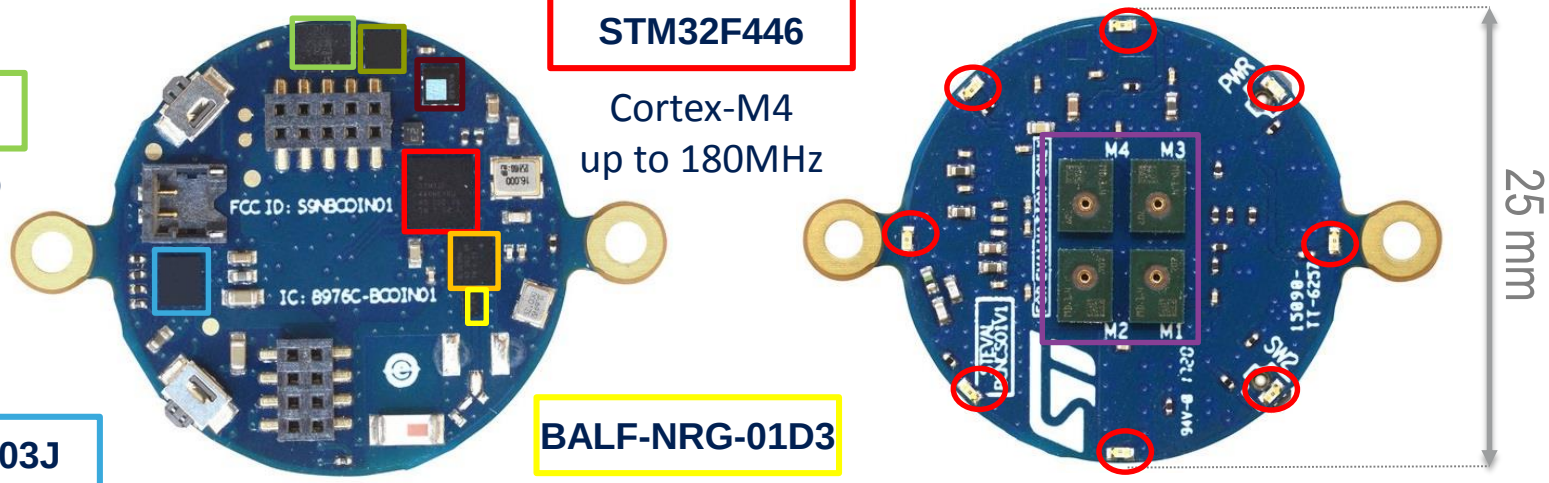
Digital MEMS Microphones
64dB SNR, 120dBSPL

LSM6DSM

3DAcc+3DGyro
0.65mA @ 1.6kHz
9µA @ 12.5Hz

STM32F446

Cortex-M4
up to 180MHz



STBC03J

Li-Ion linear battery charger with LDO

BALF-NRG-01D3

Balun Filter

BlueNRG-MS

Bluetooth low-energy
Concurrent master/slave BT4.1

8 LEDs

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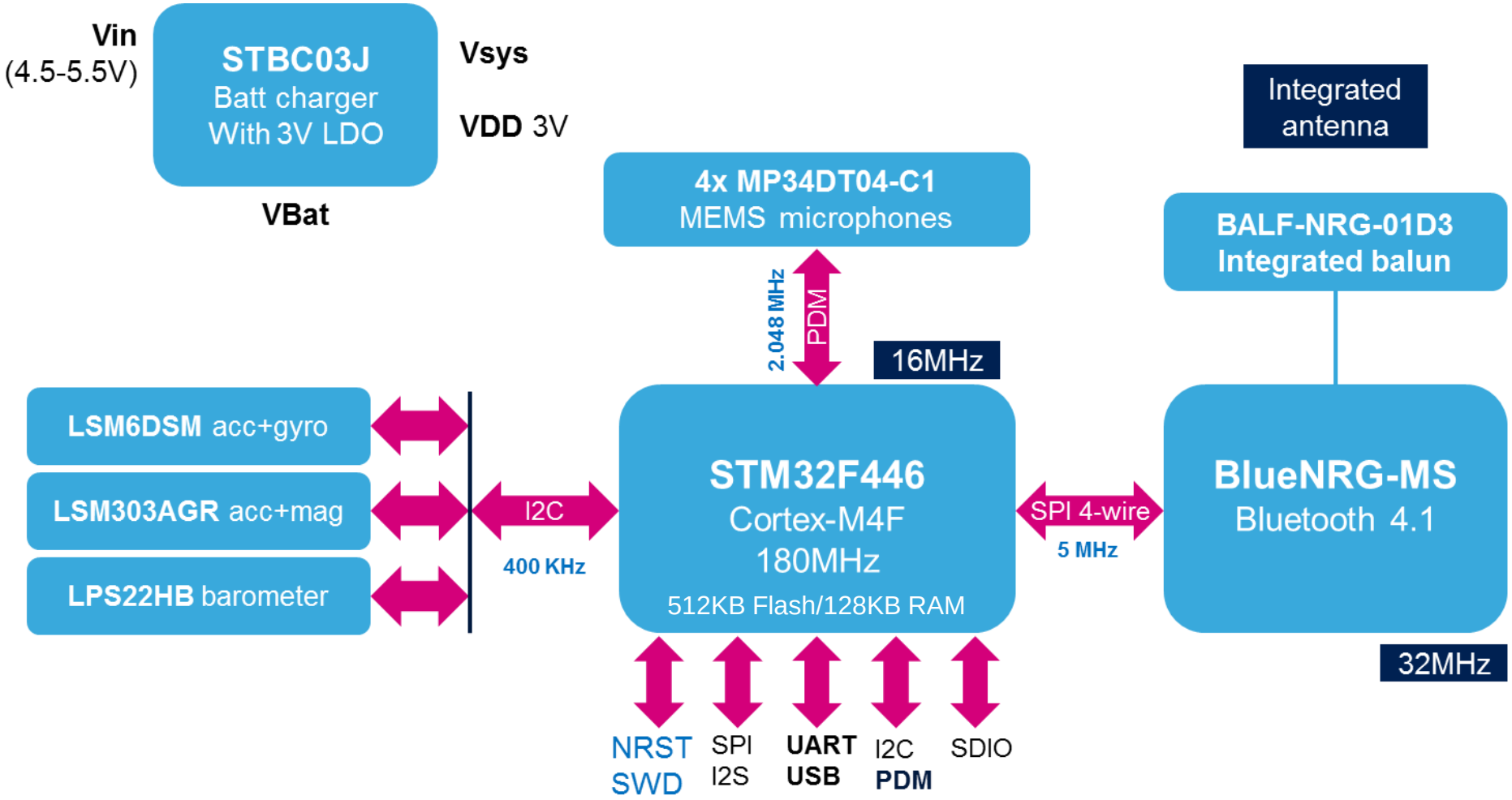
BlueCoin Platform – Hardware overview

BlueCoin Block Diagram



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BlueCoin CoinStation

CoinStation: STEVAL-BCNST01V1

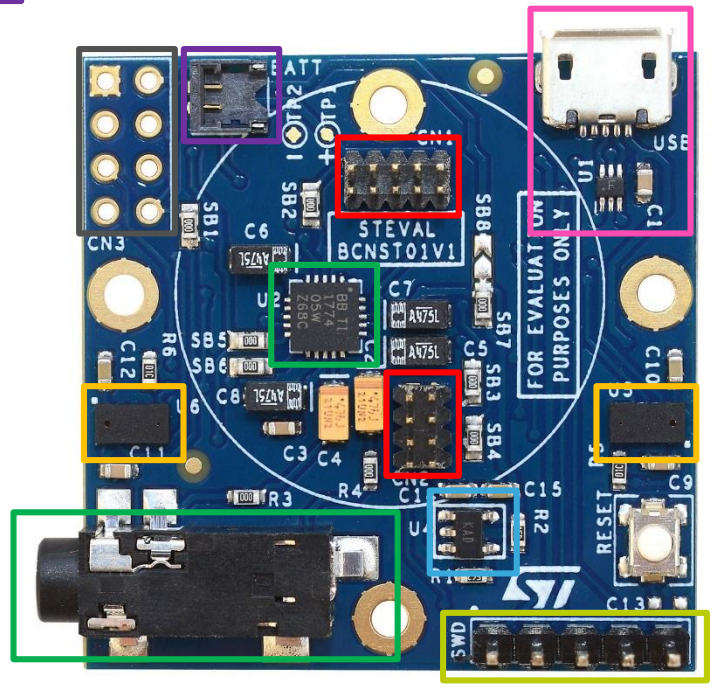
Battery Connector

BlueCoin Connectors

USBLC6-2P6

ESD protection for USB

Expansion Connector



2x VL53L0X

Time-of-Flight ranging sensors

Stereo Audio DAC and 3.5mm Jack

LDK120M

2.8V LDO

SWD Connector

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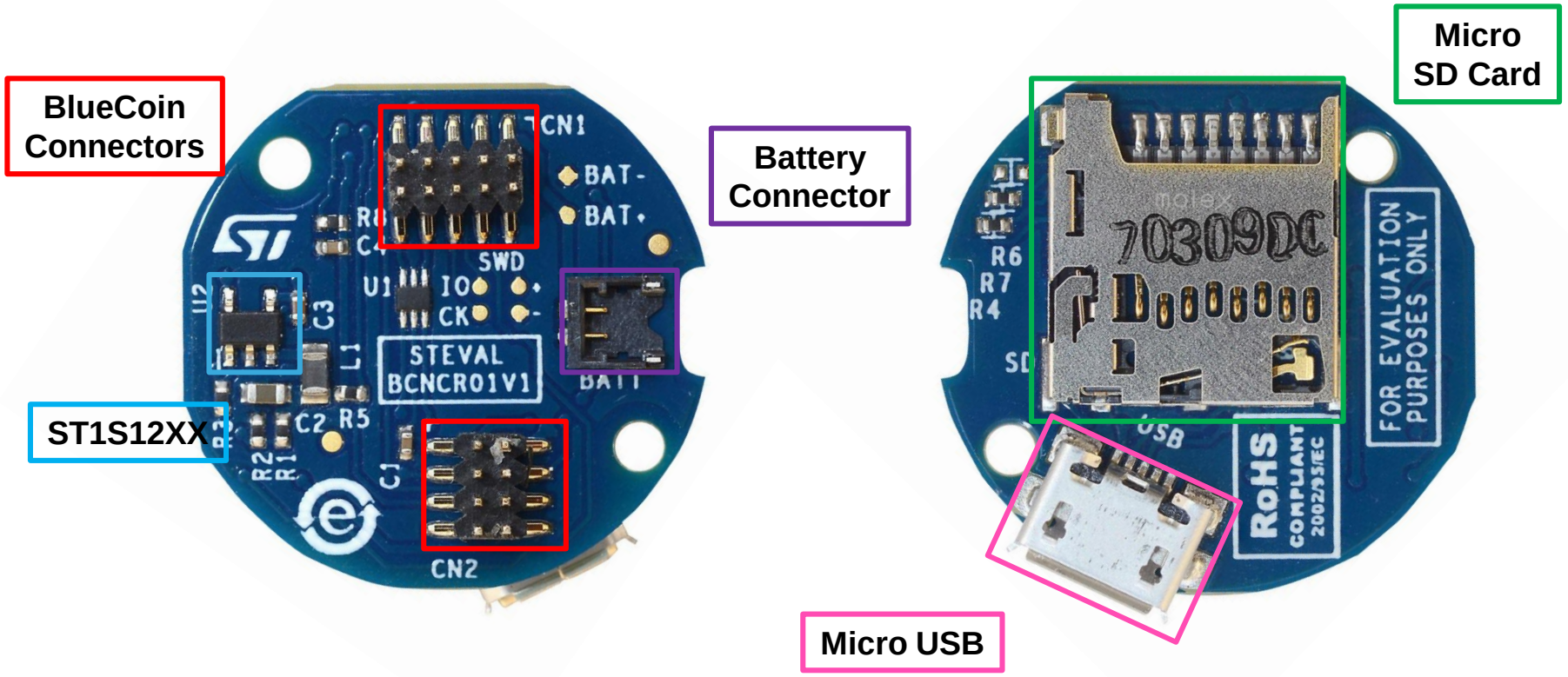
BlueCoin Cradle

BlueCoin Cradle: STEVAL-BCNCR01V1

TOP VIEW

BOTTOM VIEW



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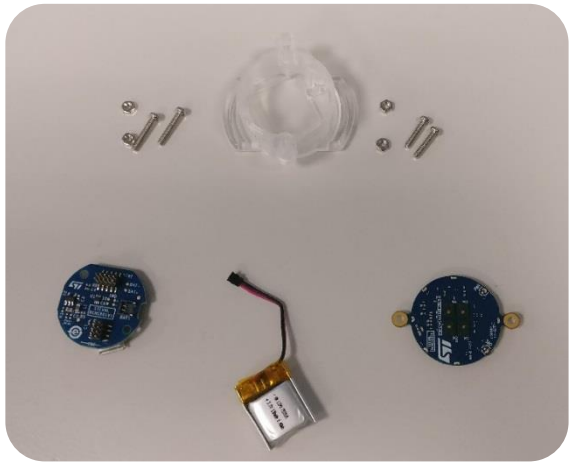
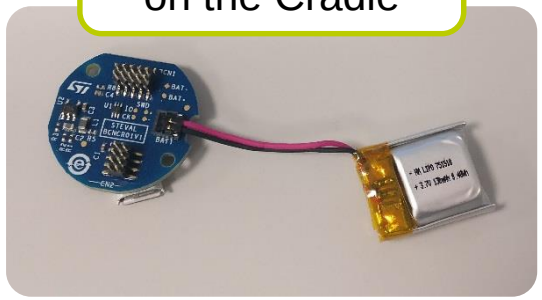
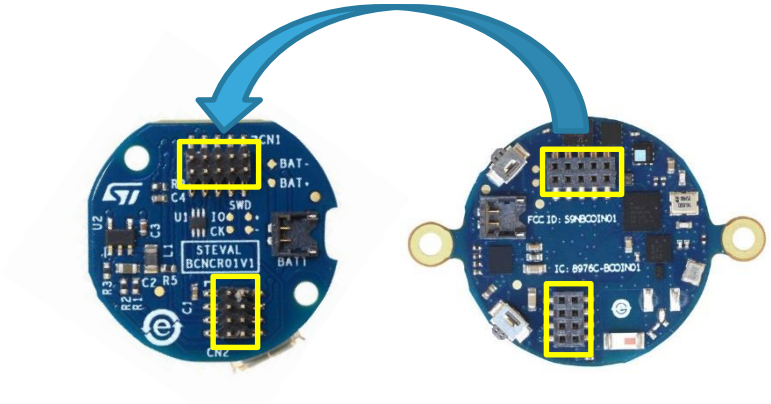
How to assemble the portable demo



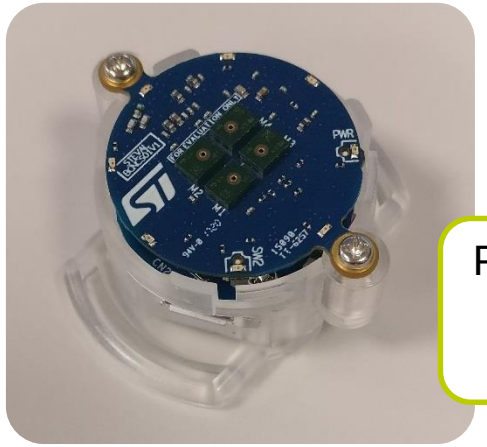
Plug the battery on the Cradle



Fold the Battery below the cradle, insert in the plastic case and secure with the bolts



Warning: Connectors are SMD mounted and VERY delicate



Plug the BlueCoin and secure with the bolts

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How to program the BlueCoin

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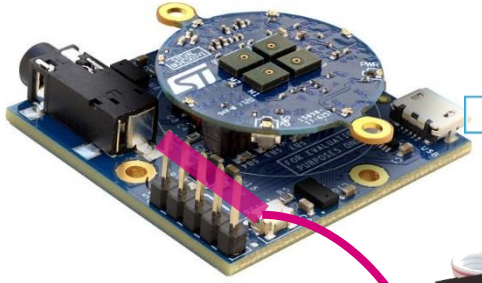
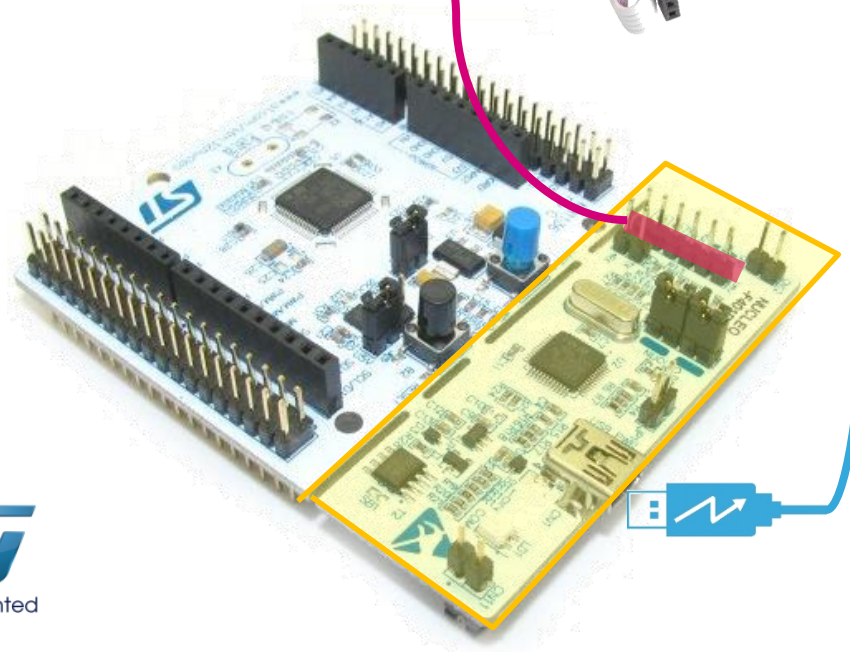
Jump Start Your Project

Plug the BlueCoin to its Cradle



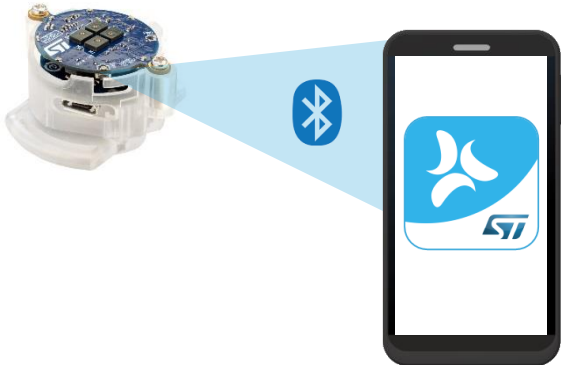
Connect with your development environment



STLINK-V2 in Every Nucleo

Compile & Run the your application

Field test your application



Note: The preloaded firmware on BlueCoin Kit is the FP-AUD-SMARTMIC1

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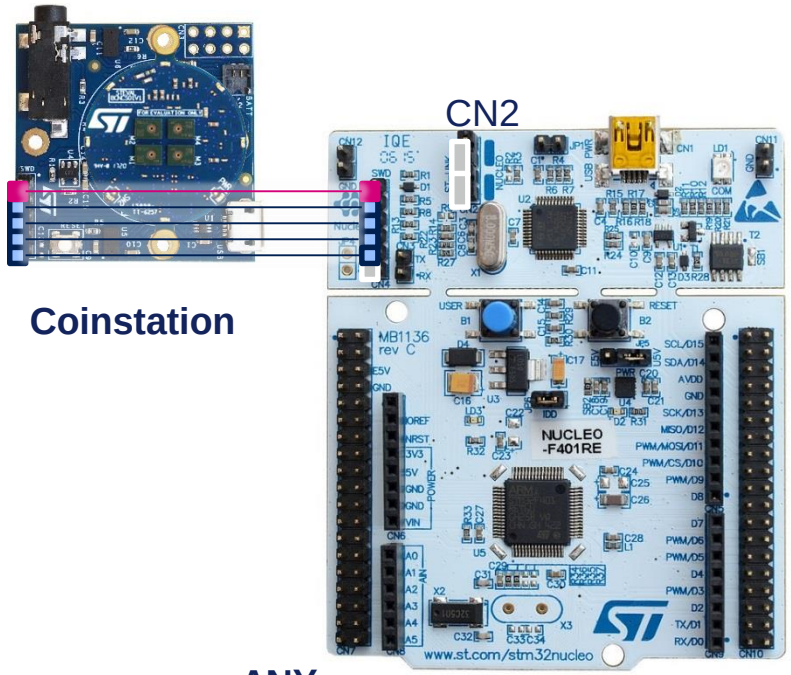
How to Flash the BlueCoin

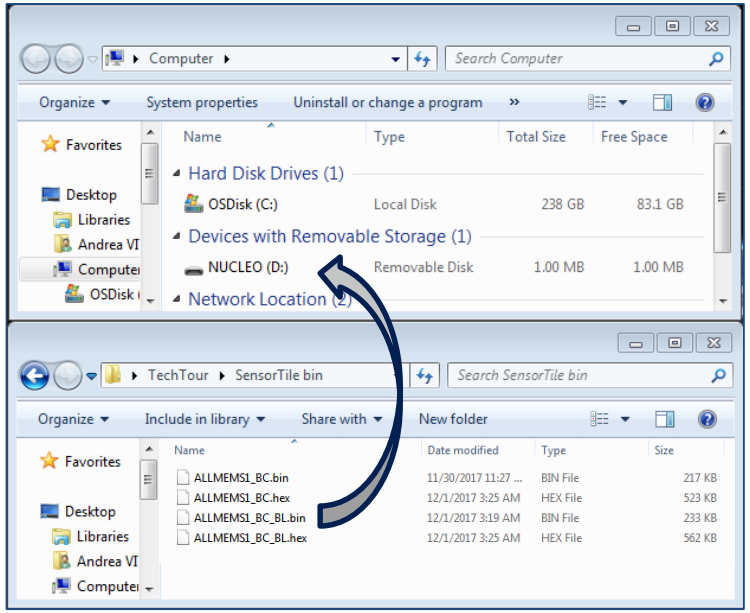
1. Remove two jumpers on CN2 of the Nucleo board
2. Plug the 5-pin cable to the SWD connectors (pin1 is square, highlight in red below)
3. Plug the USB cable of the cradle (if there is a switch: turn it ON) to power the target STM32F446
4. Plug the USB cable of the Nucleo board to power the ST-Link/V2
5. Drag and drop the *_BL.bin on the virtual device (or flash the .bin/.hex using STM32CubeProgrammer)



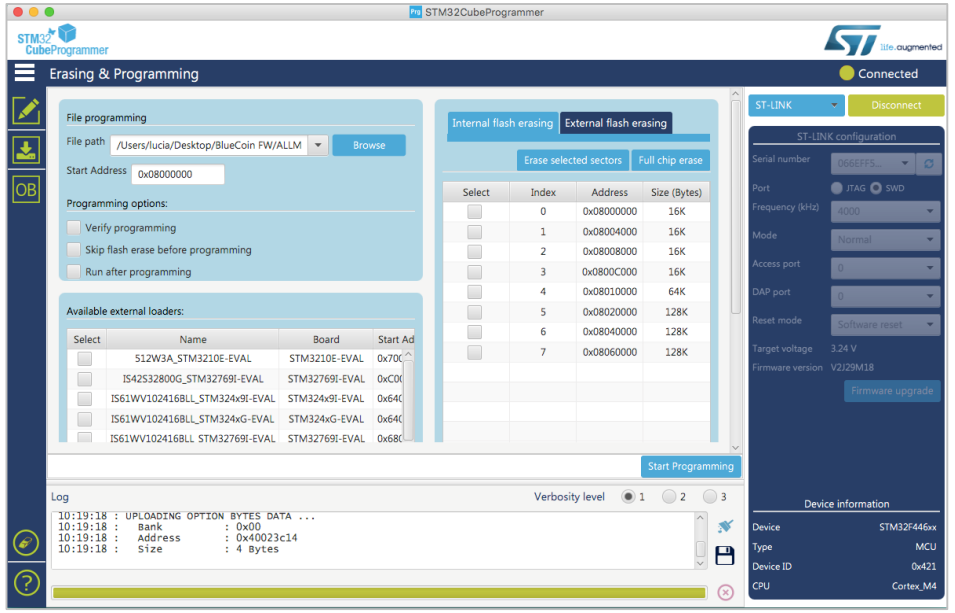
How to Flash the BlueCoin

1. Remove two jumpers on CN2 of the Nucleo board
2. Plug the 5-pin cable to the SWD connectors (pin1 is square, highlight in red below)
3. Plug the USB cable of the cradle (if there is a switch: turn it ON) to power the target STM32L4
4. Plug the USB cable of the Nucleo board to power the ST-Link/V2
5. Drag and drop the ***_BL.bin** on the virtual device (or flash the .bin/.hex using STM32CubeProgrammer)

Drag and drop on virtual device (Windows Only)



STM32CubeProgrammer (Win, MacOS, Linux)



Use ALLMEMS1_BC_BL.bin
(from FP-SNS-ALLMEMS1)

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Firmware and Software Overview

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Technical Documentation

Datasheet

User Manual

Presentations (**Quick start guide**)

Product Specifications

	Description	Version	Size
	DB3258: BlueCoin Starter kit	3.0	474 KB

User Manuals

	Description	Version	Size
	UM2240: Getting started with the STEVAL-BCNKT01V1 BlueCoin kit: augmented acoustics and motion sensing development platform	1.0	2 MB

Presentations & Training Material

Presentations

	Description	Version	Size
	STEVAL-BCNKT01V1 Quick start guide	1.0	1 MB

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Hardware Resources

3D CAD and Gerbers

BOM

Schematics

License agreements and certifications

Board Manufacturing Specifications

	Description	Version	Size
	STEVAL-BCNKT01V1 3D cad files	1.0	3 MB

Bill of Materials

	Description	Version	Size
	STEVAL-BCNKT01V1 BOM	1.0	207 KB

Schematic Pack

	Description	Version	Size
	STEVAL-BCNKT01V1 schematics	1.0	553 KB

Legal

License Agreement

	Description	Version	Size
	Evaluation products license agreement	1.4	128 KB

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Tools and Software

Firmware packages

Android/iOS app and corresponding SDK

Embedded Software

EVALUATION TOOL SOFTWARE

Part Number	Manufacturer	Description
STSW-BCNKT01	ST	Embedded software samples for BlueCoin: data streaming via USB and BLE, logging on SD card, gesture recognition, audio acquisition and playback

MCUS EMBEDDED SOFTWARE

Part Number	Manufacturer	Description
FP-AUD-BVLINK1	ST	STM32 ODE function pack for half-duplex voice streaming over Bluetooth low energy
FP-AUD-SMARTMIC1	ST	STM32 ODE function pack for MEMS microphone acquisition, advanced audio processing and audio output
FP-SNS-ALLMEMS1	ST	STM32 ODE function pack for IoT node with BLE connectivity, digital microphone, environmental and motion sensors

WIRELESS CONNECTIVITY SOFTWARE

Part Number	Manufacturer	Description
BlueMS	ST	BlueMS Application for Android and iOS
BlueST-SDK	ST	Bluetooth Low Energy and Sensors Technology Software Development Kit (SDK)

Hardware, Software, Documentation

HARDWARE

- **STEVAL-BCNKT01V1** BlueCoin kit

FIRMWARE

Today

- **STSW-BCNKT01** FW for beginners (bin + src code)
- **FP-SNS-ALLMEMS1** recommended FW (bin + src code)
  - IoT node with BLE connectivity, digital microphone, environmental and motion sensors
- **FP-AUD_BCLINK1** (bin + src code)
  - Half Duplex Voice Streaming over BLE

Out-of-Box

- **FP-AUD_SMARTMIC1** (bin + src code)
  - MEMS Microphone acquisition, advanced audio processing and audio output

APPS

- **ST BlueMS** iOS/Android app (bin)
- **BlueST-SDK** iOS/Android app dev kit (src code)

GitHub

DOCUMENTATION

- **UM2240** getting started with BlueCoin kit
- **UM2249** getting started with STSW-BCNKT01
- **UM2059** getting started with FP-SNS-ALLMEMS1
- **UM2196**: Getting started with the FP-AUD-BVLINK1 STM32 ODE function pack based on half-duplex voice streaming over BLE
- **UM2219**: Getting started with STM32 ODE function pack for MEMS microphones acquisition, advanced audio processing and audio output
- **UM1997** getting started with ST BlueMS app

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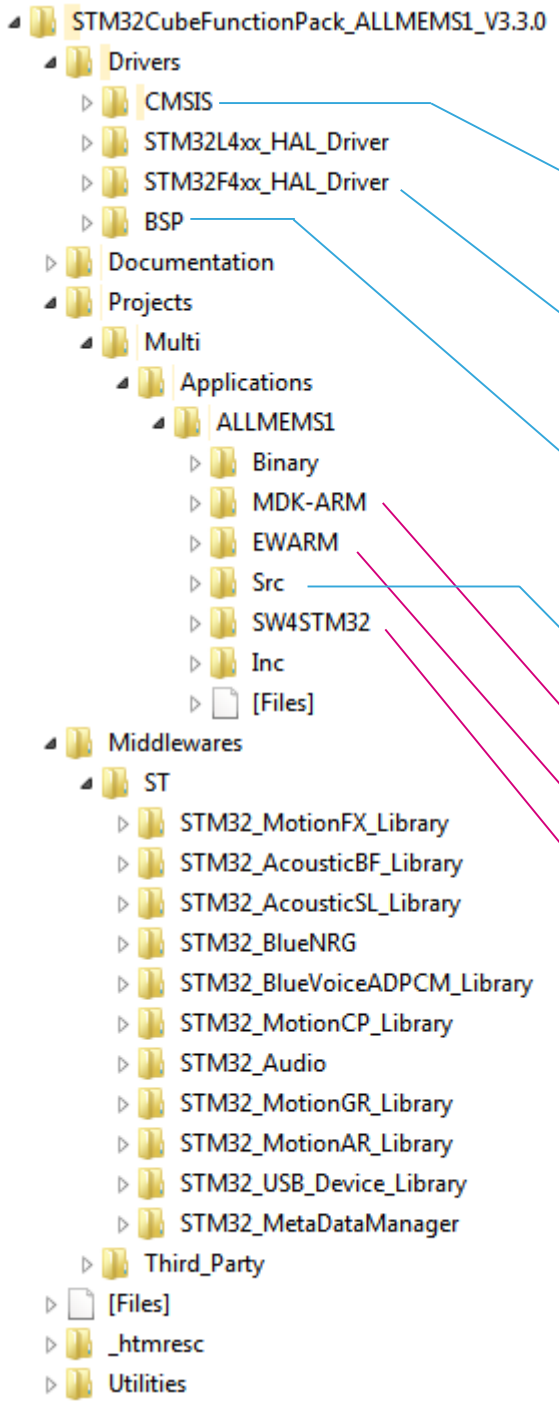
FP-SNS-ALLMEMS1

Folder Structure



CMSIS = Cortex Microcontroller Software Interface Standard

- DSP library collection (fixed / float)

HAL = Hardware Abstraction Layer

- STM32 specific hardware drivers

BSP = Board Support Package

- Components (typ. MEMS sensors)
- Boards (BlueCoin, SensorTile, Nucleo, Nucleo-expansion)

Main.c is in Applications\...\Src\

MDK-ARM	Keil project files
EWARM	IAR project files
SW4STM32	SystemWorkbench

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Software Library Licensing

- The software libraries are distributed as binaries, with example source code on how to use them.
- A free license agreement is granted.
- The Libraries can run on any STM32 microcontroller, with a generic STM32 MCU locking.

SW Libraries in Function Packages

STM32ODE software package

Open Development Environment – src code		Software Libraries
• **FP-SNS-ALLMEMS1**	BLE + MEMS + digital microphone	MotionFX, MotionAR, MotionCP, MotionGR, AcousticSL, AcousticBF, BlueVoice
• **FP-AUD-BVLINK1**	BLE + digital microphone	BlueVoice
• **FP-AUD-SMARTMIC1**	Digital microphone	AcousticSL, AcousticBF, AcousticEC

BlueVoice (Voice over BLE)

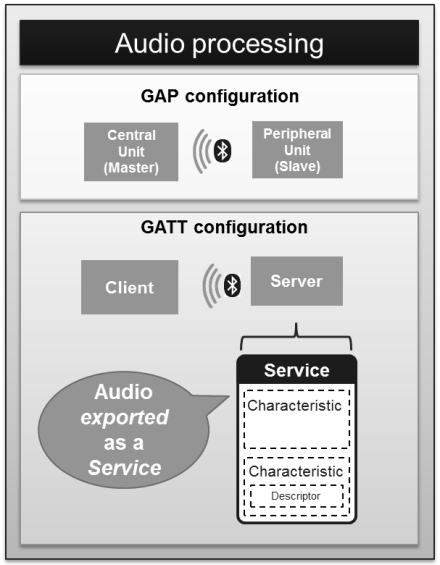
Audio libraries are distributed as binaries, with example source code on how to use them.

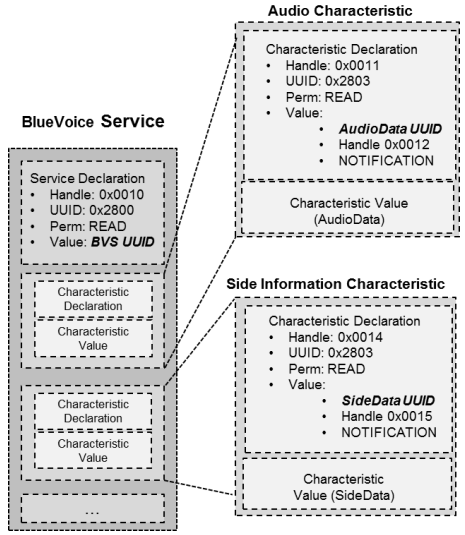
A free license is granted. They can run on every STM32 microcontroller.

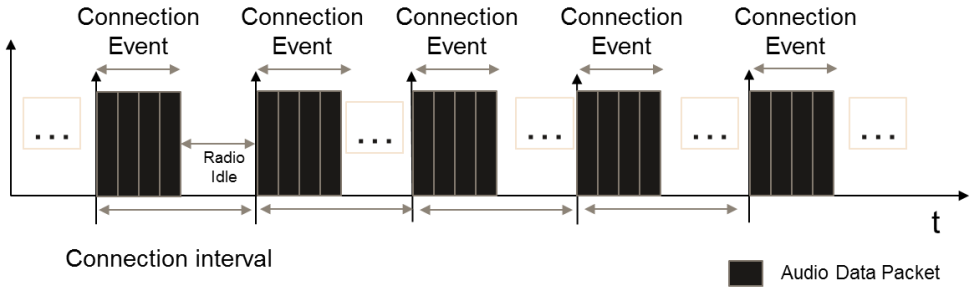
This library is included in the **FP-AUD-BVLINK1** and in the **FP-SNS-ALLMEMS1** software package.

- **BlueVoice** (in FP-AUD-BVLINK1) voice streaming over BLE (needs 1 digital microphone, 8kHz PCM, ADPCM compression)

- AcousticBF (in X-CUBE-MEMSMIC1) beam-forming (needs 2 digital mic, cardiod or narrow cardiod, denoise optional filter)
- AcousticSL (in X-CUBE-MEMSMIC1) sound source localization (needs 2/4 mic for 180/360 deg range, three DOA algo)
- AcousticEC (in FP-AUD-SMARTMIC1) echo cancellation (adaptive filter to subtract noise-ref signal, SPEEX MDF algo)







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AcousticBF and AcousticSL

Audio libraries are distributed as binaries, with example source code on how to use them.

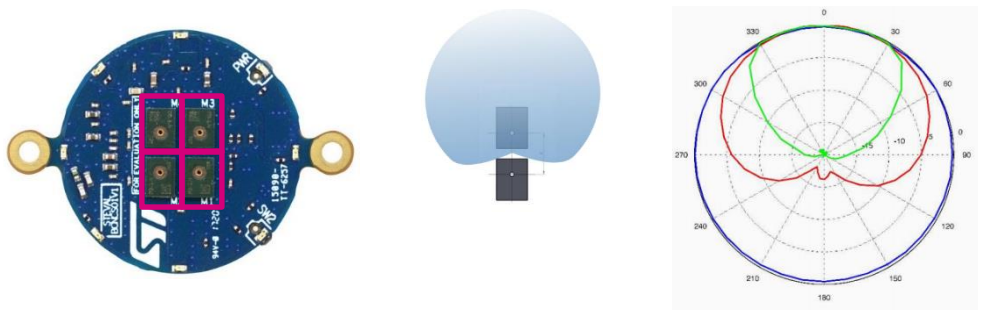
A free license is granted. They can run on every STM32 microcontroller.

These libraries are included in the **FP-SNS-ALLMEMS1** software package.

- **BlueVoice** (in FP-AUD-BVLINK1) voice streaming over BLE (needs 1 digital microphone, 8kHz PCM, ADPCM compression)

- **AcousticBF** (in X-CUBE-MEMSMIC1) beam-forming (needs 2 digital mic, cardiod or narrow cardiod, denoise optional filter)
- **AcousticSL** (in X-CUBE-MEMSMIC1) sound source localization (needs 2/4 mic for 180/360 deg range, three DOA algo)
- **AcousticEC** (in FP-AUD-SMARTMIC1) echo cancellation (adaptive filter to subtract noise-ref signal, SPEEX MDF algo)

BEAMFORMING



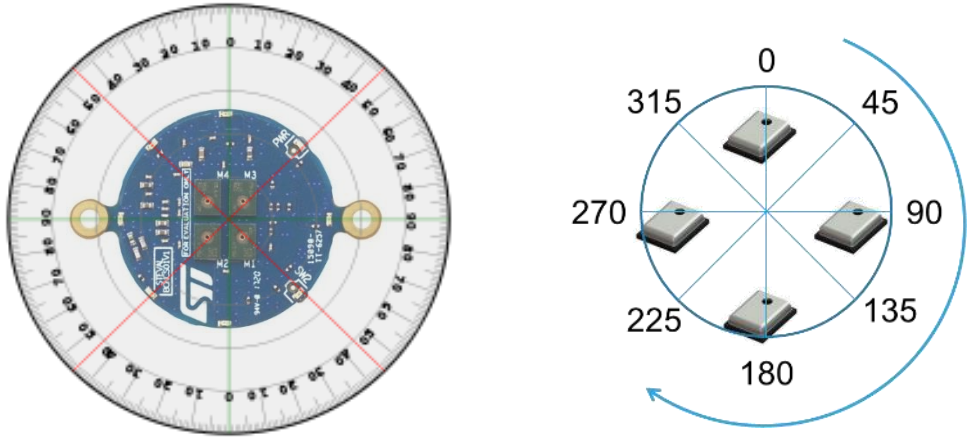
Beam pattern

Blue: omnidirectional microphone

Red: «Basic cardioid» mode

Green: «Strong» mode

SOURCE LOCALIZATION



2 mic 180deg, 4 mic 360 deg

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BlueCoin Hands-on
Using the ST BlueMS App

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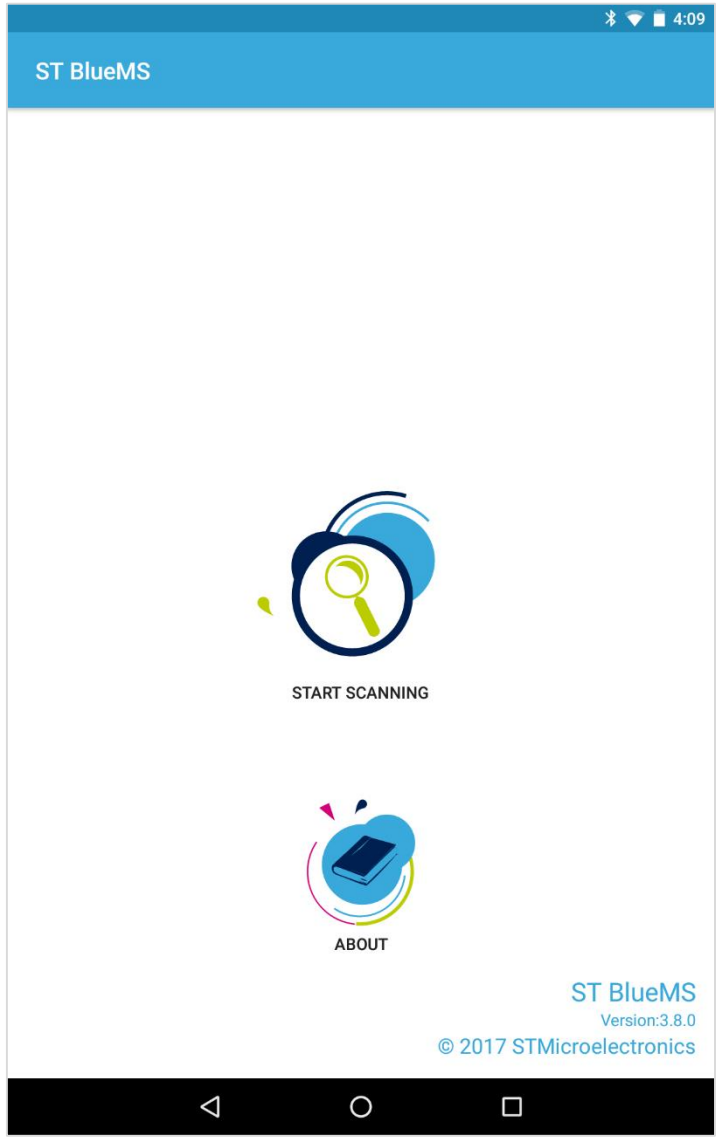
LAB1: BlueMS App

Download on the App Store

GET IT ON Google Play

ST BlueMS
STMICROELECTRONICS INC

Launch the ST BlueMS app
(V3.8.0 or newer)
previously installed



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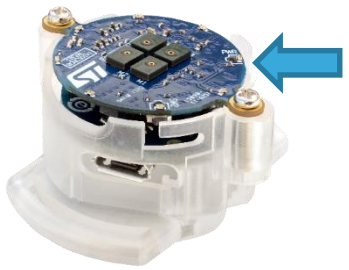
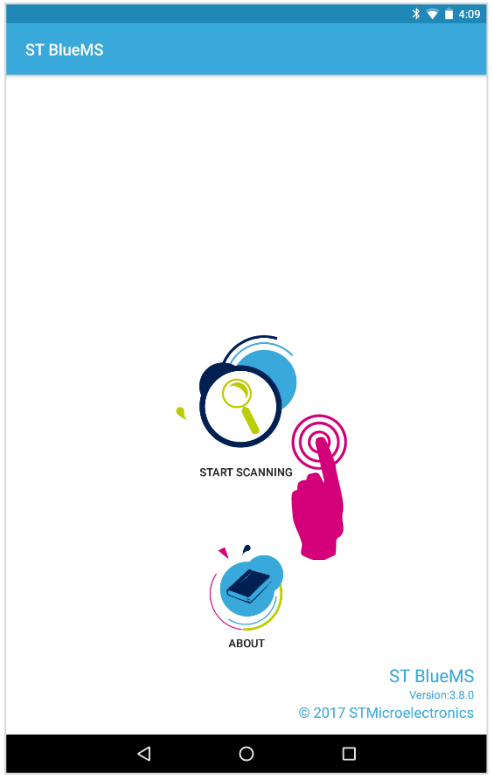
LAB1: BlueMS App



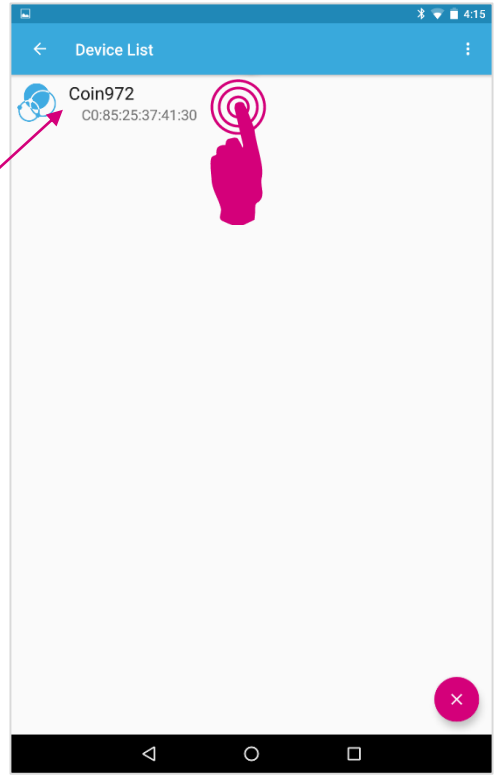
Press PWR for 1s
And wait for the 8 LED to start blinking

Touch
“Start discovering”



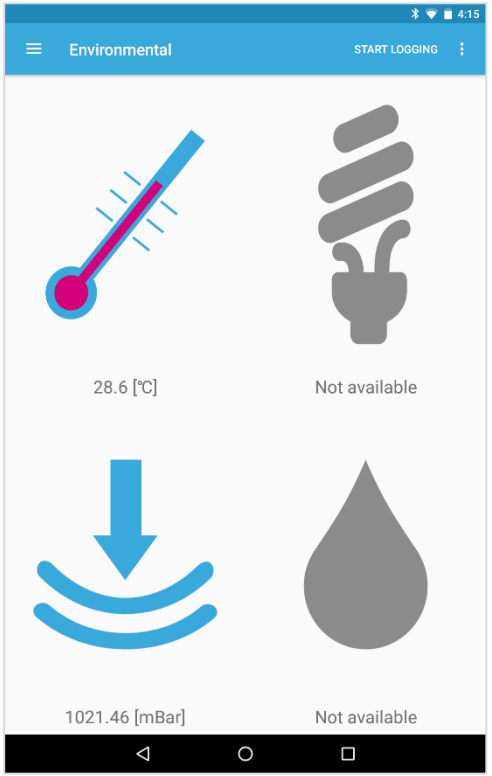
The name is
“CoinXXX”
(look at the label on the box)

Select your
BlueCoin



NOTE: 2nd line is the MAC address of the specific sample

You are
connected



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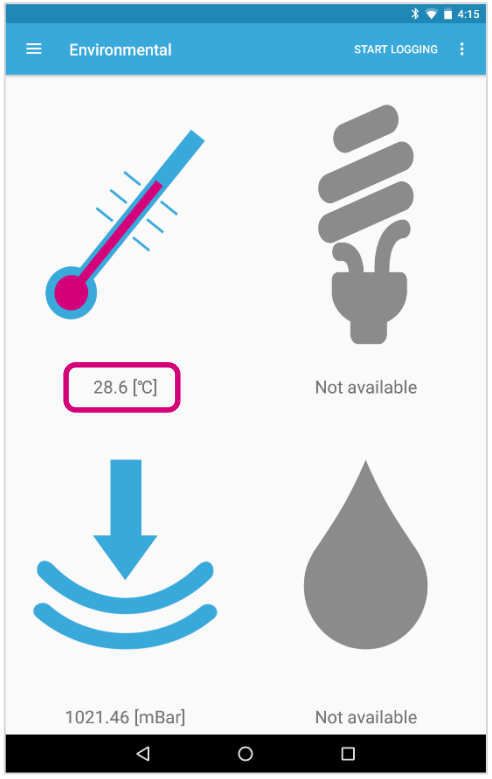
LAB1: BlueMS App

View the BlueCoin Environmental sensor real-time data



Swipe left for more

LAB: temperature

Try to blow some hot air on the BlueCoin to see temperature changes

- Temperature measured using:
  - Internal Temperature sensor of pressure sensor (±1.5C deg accuracy)

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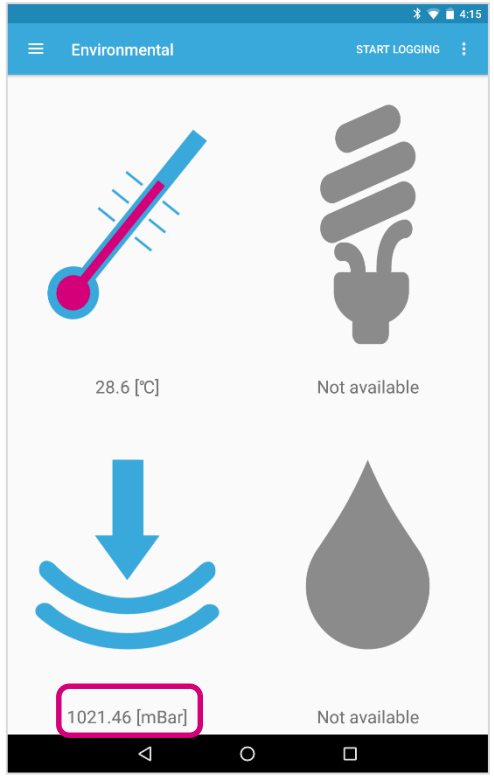
LAB1: BlueMS App

View the BlueCoin Environmental sensor real-time data



1021.46

Swipe left for more

LAB: pressure sensor

Try to move the BlueCoin up/down by 20-30cm (7-12in),

wait a few seconds and observe the change in the barometer reading (mbar).

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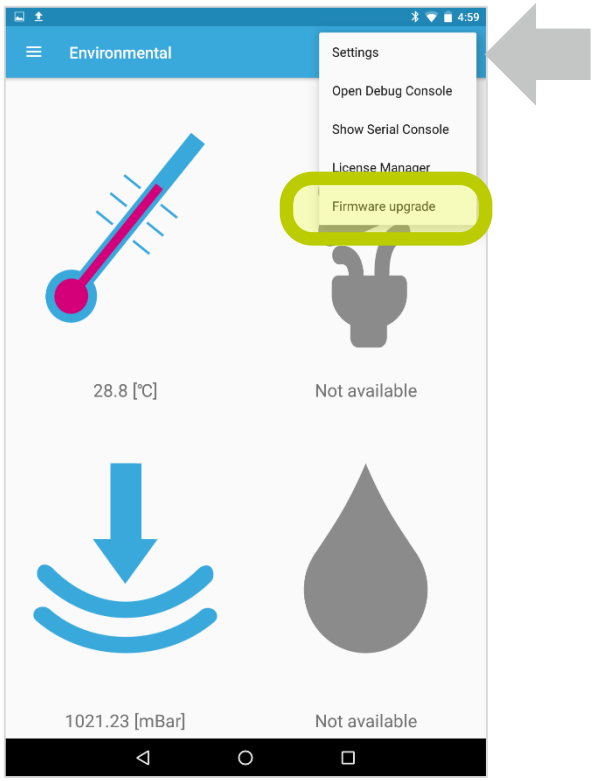
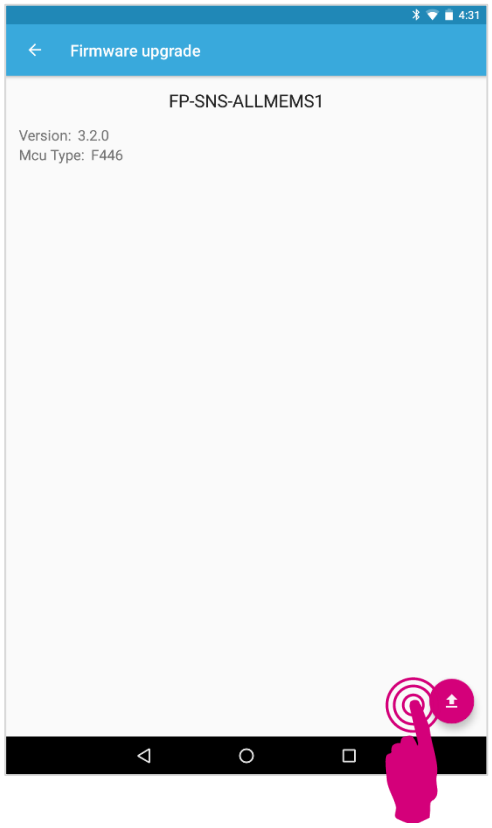
DEMO: Firmware Update Over-the-air

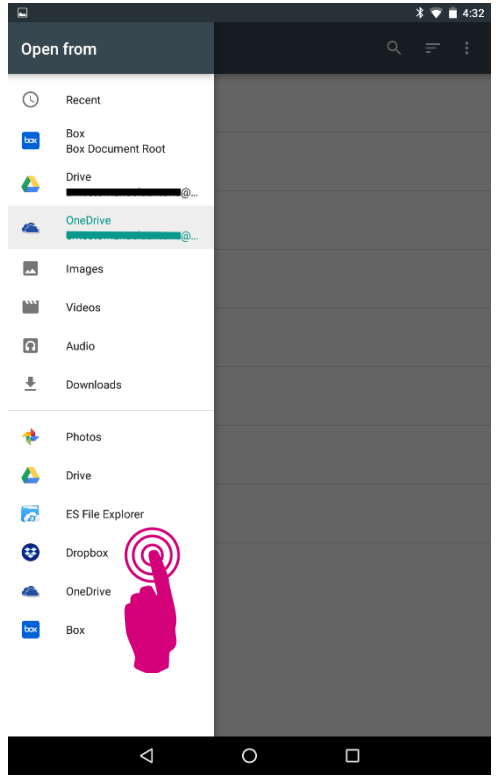


Select

"Download & Flash"



Enable and Select the repository



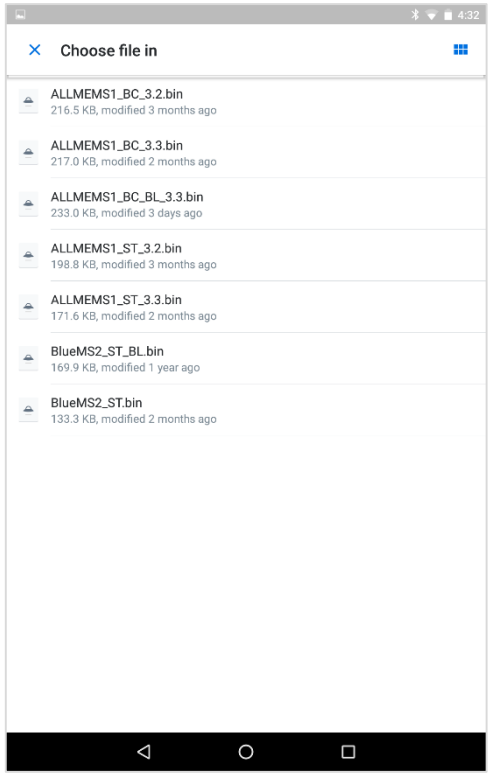
life.augmented

DEMO: Firmware Update Over-the-air

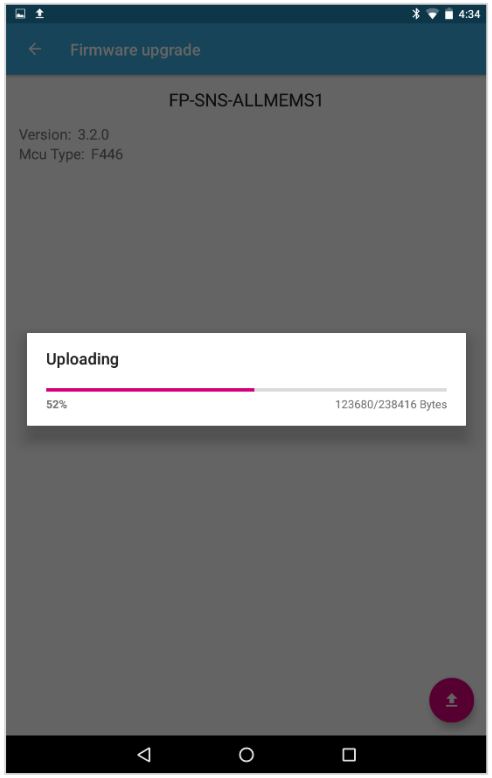
BlueCoin will confirm the integrity of the selected firmware binary before overwriting the current Flash memory image.

- Bootloader at 0x 0800 0000
- Current application at 0x 0800 **4**000
- New application at 0x 080**4** 0000

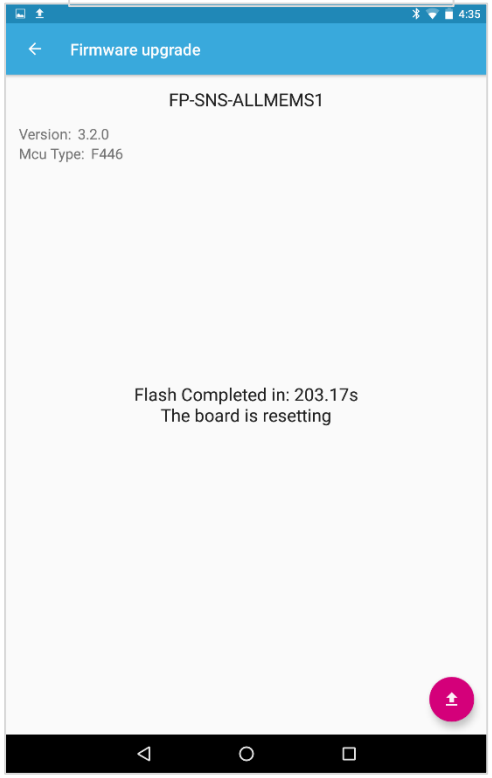
Select the firmware binary image



Uploading and Flashing



Confirmation!

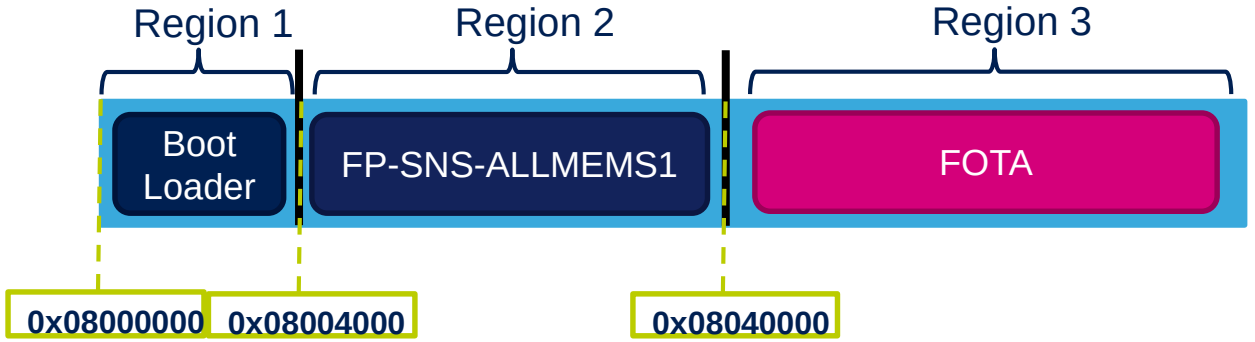


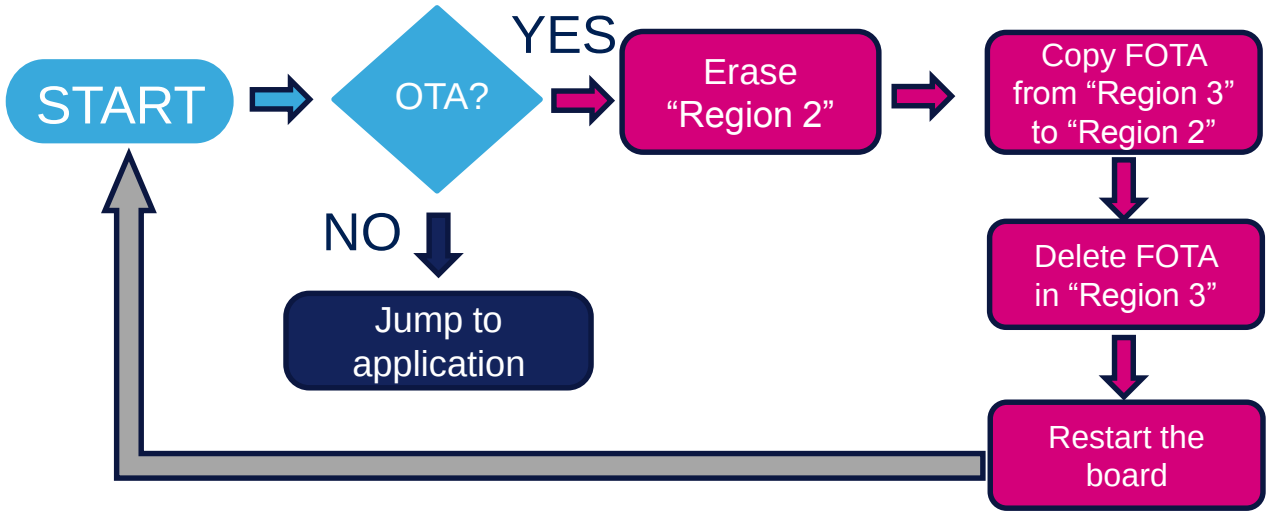
life.augmented

DEMO: Firmware Update Over-the-air

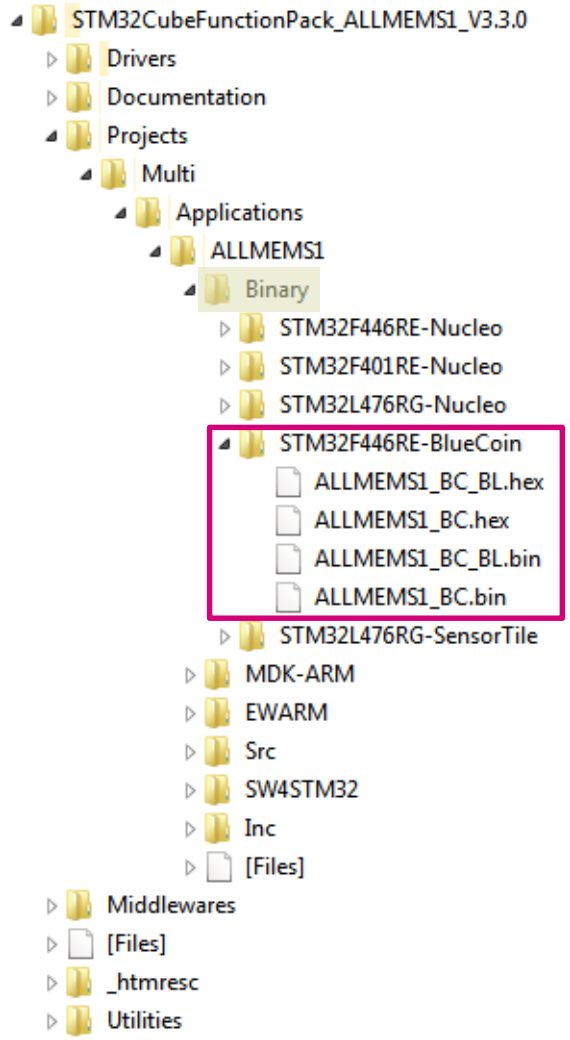
MEMORY ORGANIZATION

- By default, all BlueCoin FW applications use a bootloader that resides in the first part of the flash memory of the STM32.
- For this reason the memory is organized into 3 different regions
- The **bootloader** manages the installation of On-The-Air upgrades, if any.
- Otherwise it jumps to the application





DEMO: Firmware Update Over-the-air



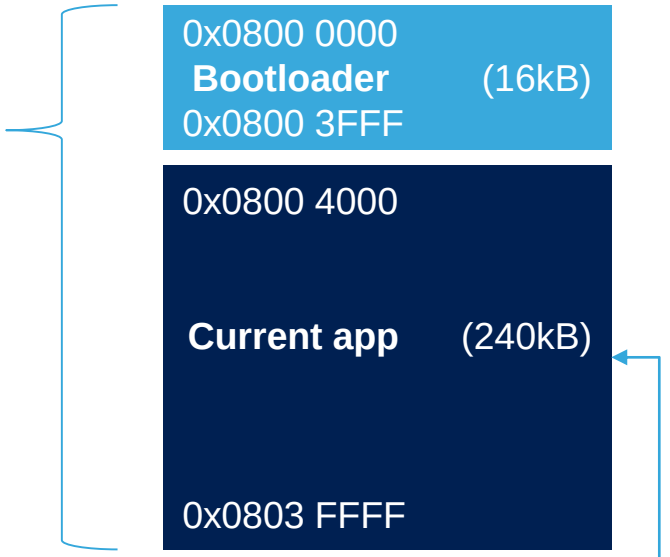
FP-SNS-ALLMEMS1 software package:
Binary folder contains two binaries

Bootloader + App, flash at 0x0800 0000

- **ALLMEMS1_BC_BL.bin**
- **ALLMEMS1_BC_BL.hex**

Application, flash at 0x0800 **4**000

- **ALLMEMS1_BC.bin**
- **ALLMEMS1_BC.hex**



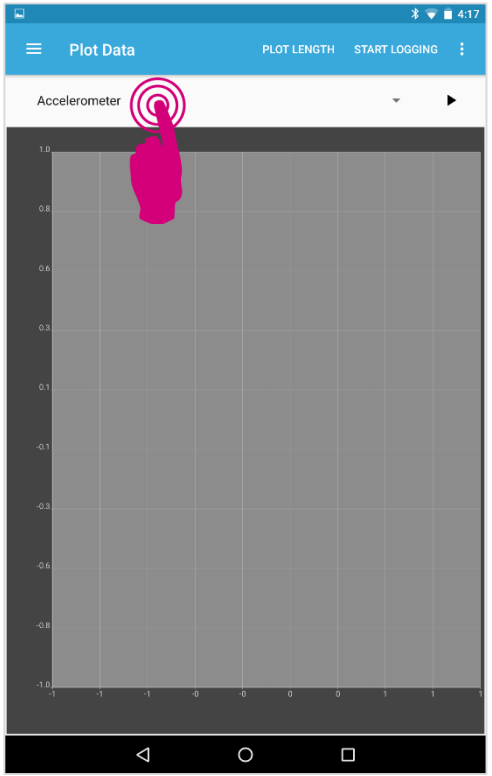
Use this for FOTA!

life.augmented

LAB2: Real-time Data Plot

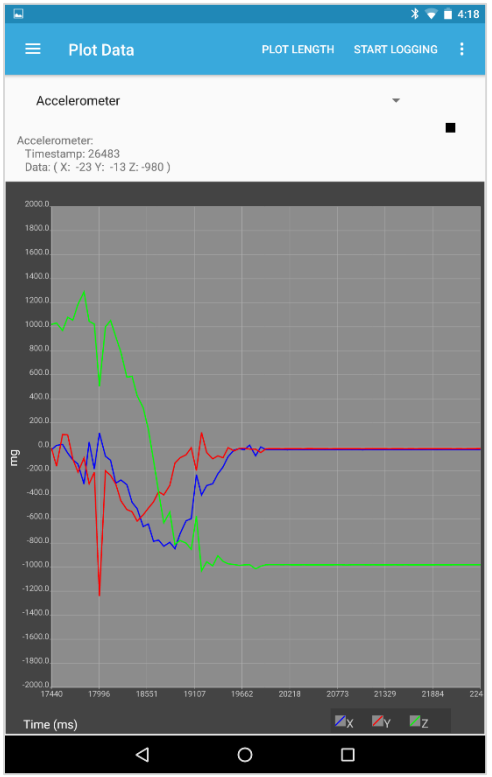
Swipe left to view the real-time data plot

Select the sensor device to plot



Select the Plot lenght

View the real-time data plot



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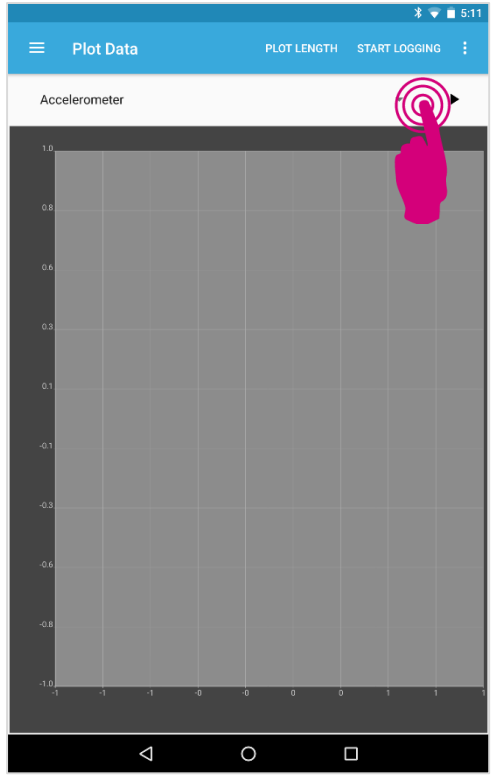
Swipe left for more

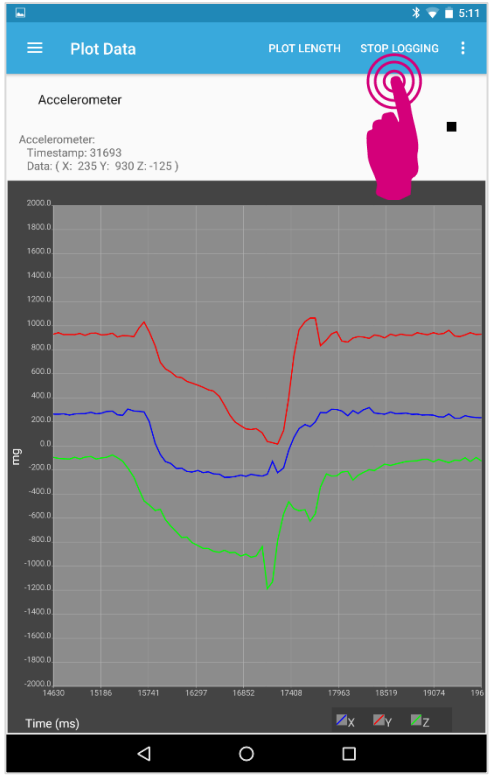
LAB2: Real-time Data Log

Start Streaming

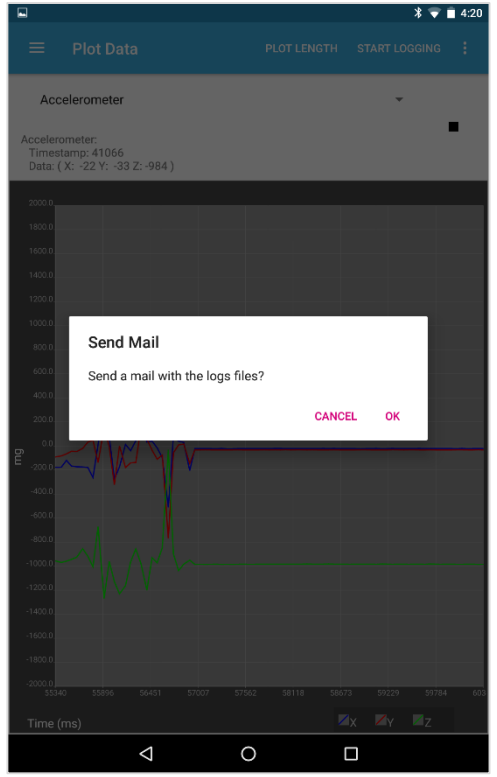


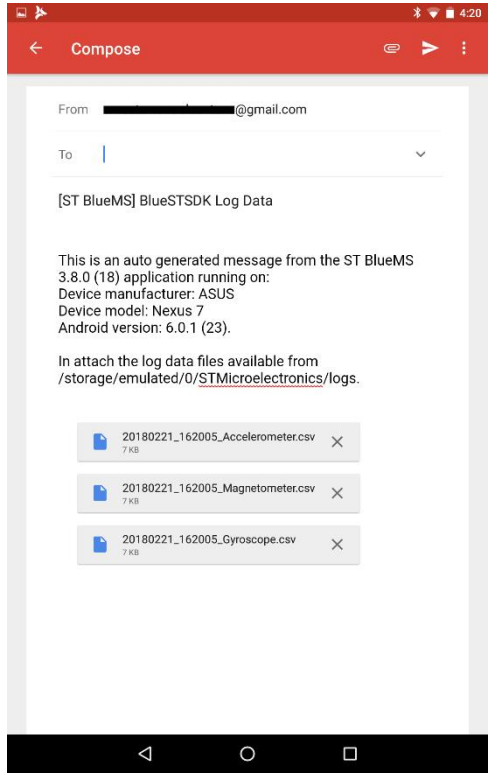
Start logging

Stop logging



Send log data using email





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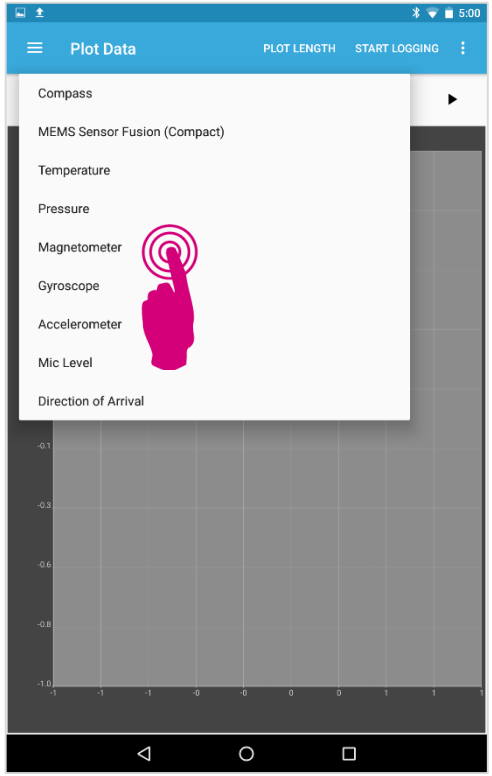
LAB2: Real-time Data Plot

Effects of Magnetic Interference

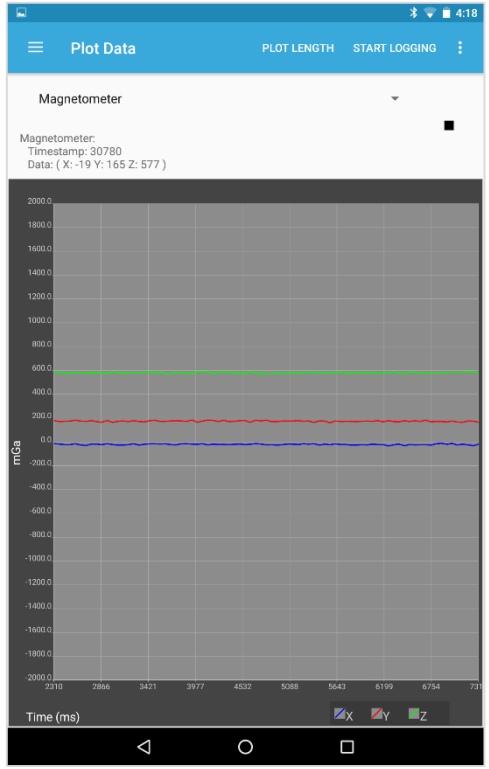
Swipe left to view the real-time data plot

Select the magnetometer



Select the time frame

Magnetic field plot

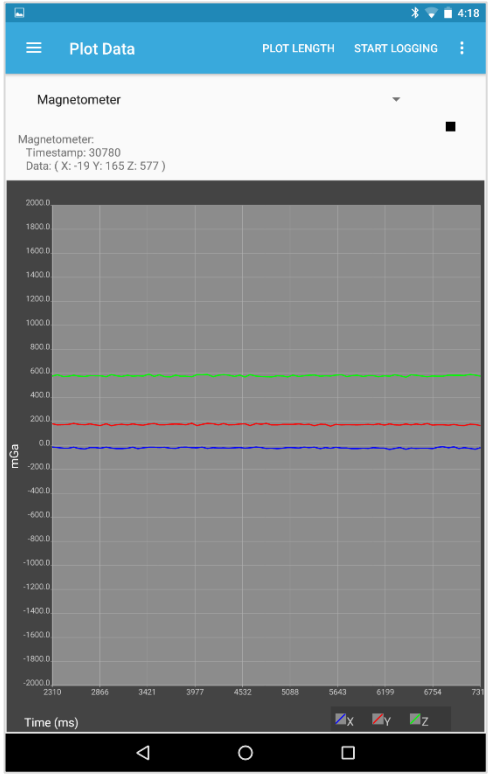


Swipe left for more

life.augmented

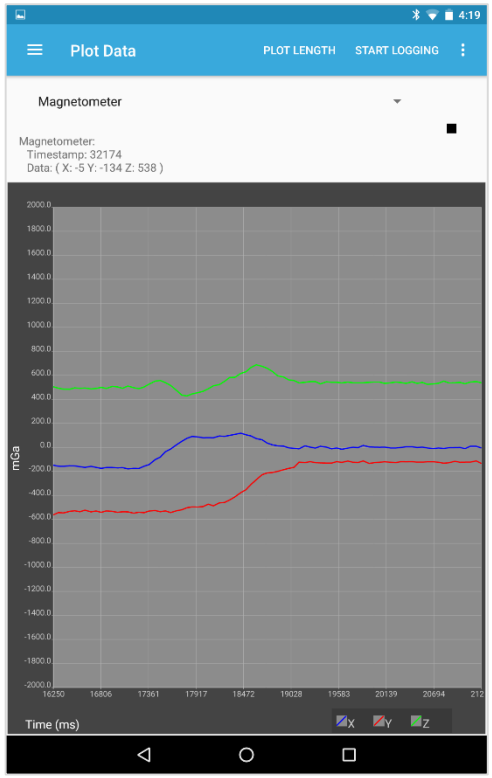
LAB2: Real-time Data Plot

Effects of Magnetic Interference



LAB

Move the smartphone over the BlueCoin



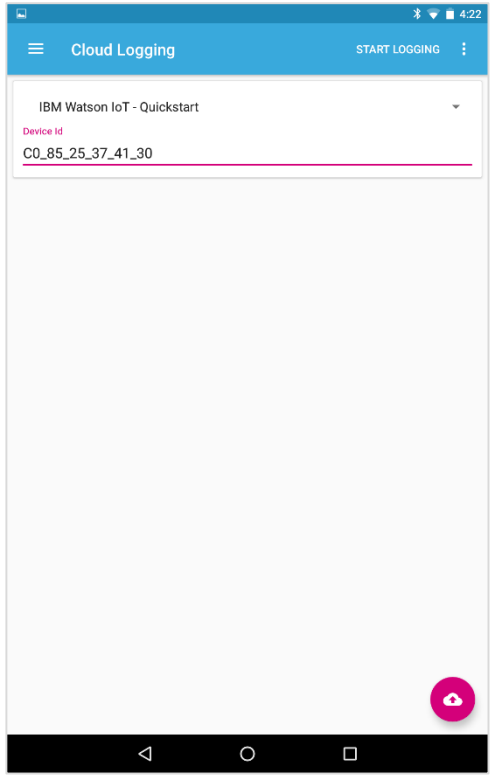
The magnetic field measured by the sensor has changed because of the magnetic field induced by the smartphone (speakers, antennas, battery, currents)

LAB3: IBM Watson IoT Quickstart

Post BlueCoin Sensor Data on IBM Watson

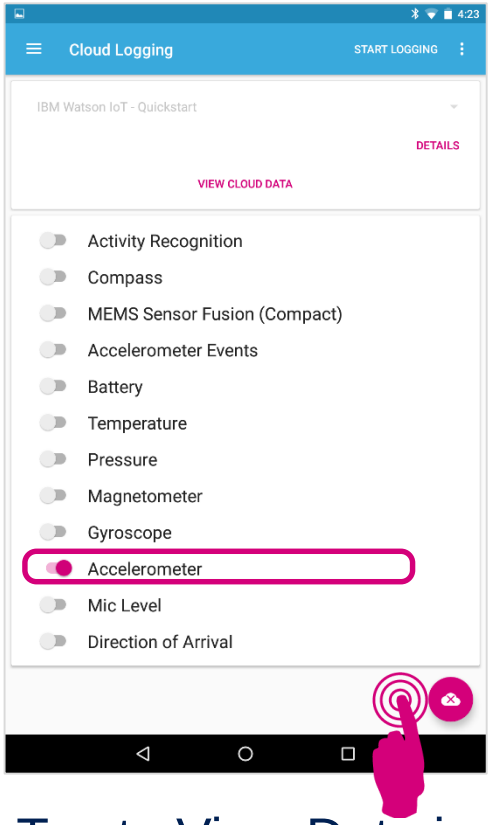
Select “IBMQuickstart”

Click “Connect”



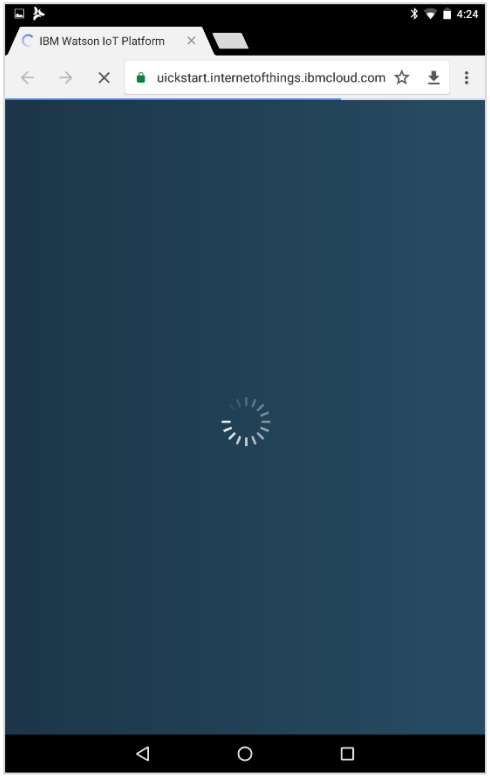
NOTE: MAC address is used is Device Id (see slide 29)

Select a feature



Tap to View Data in the Cloud”

Wait a few seconds



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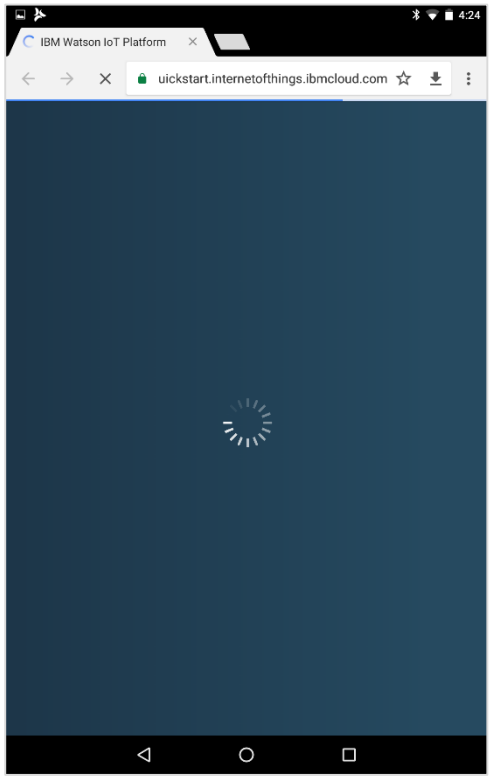
LAB3: IBM Watson IoT Quickstart

Post BlueCoin Sensor Data on IBM Watson

Quickstart will appear



You will see the Plot of selected feature

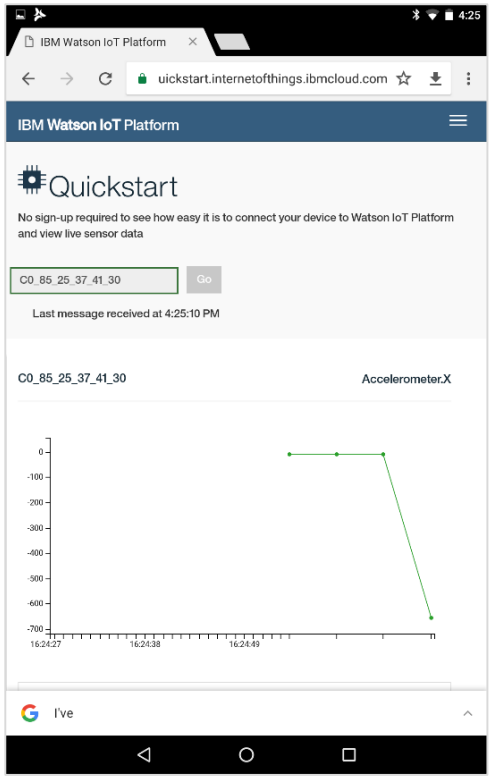
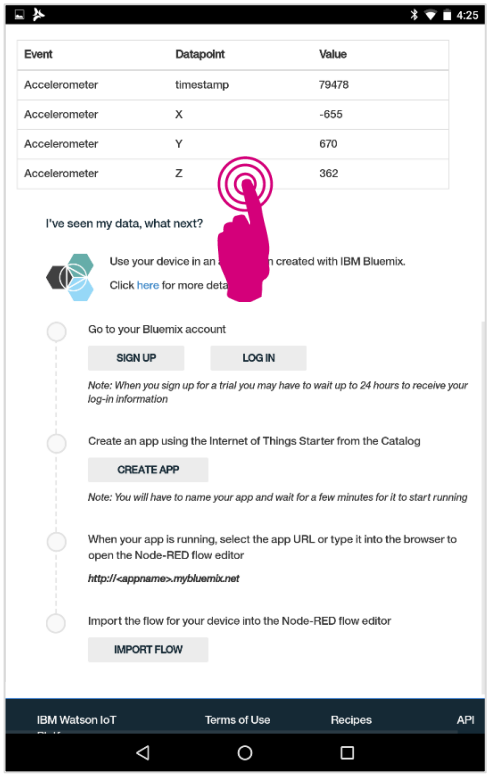
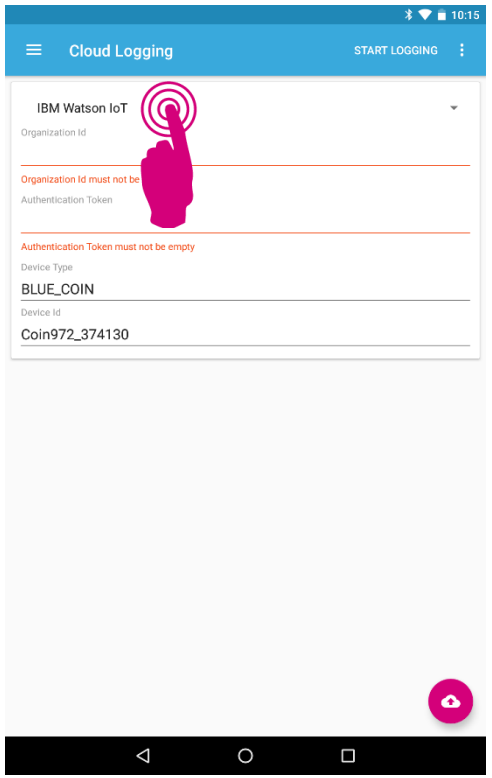


Table of available features



IBM Watson IoT Registered Mode



Scroll down to change sensor data or axes

Organization ID and Authentication Token needed

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LAB4: Event Detection

- Smart embedded functions: pedometer, step detector and step counter, significant motion and tilt
- Standard interrupts: free-fall, wakeup, 6D/4D orientation, click and double-click

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LSM6DSM

iNEMO inertial module:
always-on 3D accelerometer and 3D gyroscope

Datasheet - production data

LGA-14L
(2.5 x 3 x 0.83 mm) typ.

d gyroscope
ormal mode
ce mode
tures set

roscope and

sensor

- ±125/±245/±500/±1000/±2000 dps full scale
- Analog supply voltage: 1.71 V to 3.6 V
- SPI & I^2C serial interface with main processor data synchronization
- Dedicated gyroscope low-pass filters for UI and OIS applications
- Smart embedded functions: pedometer, step detector and step counter, significant motion and tilt
- Standard interrupts: free-fall, wakeup, 6D/4D orientation, click and double-click

Description

The LSM6DSM is a system-in-package featuring a 3D digital accelerometer and a 3D digital gyroscope performing at 0.65 mA in high-performance mode and enabling always-on low-power features for an optimal motion experience for the consumer.

The LSM6DSM supports main OS requirements, offering real, virtual and batch sensors with 4 kbyte for dynamic data batching.

ST's family of MEMS sensor modules leverages the robust and mature manufacturing processes already used for the production of micromachined accelerometers and gyroscopes.

The various sensing elements are manufactured using specialized micromachining processes, while the IC interfaces are developed using CMOS technology that allows the design of a dedicated circuit which is trimmed to better match the characteristics of the sensing element.

The LSM6DSM has a full-scale acceleration range of ±2/±4/±8/±16 *g* and an angular rate range of ±125/±245/±500/±1000/±2000 dps.

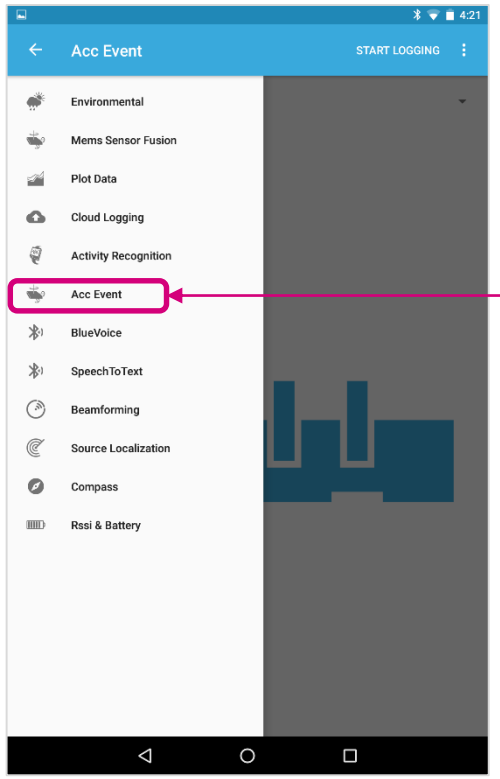
The LSM6DSM fully supports EIS and OIS applications as the module includes a dedicated configurable signal processing path for OIS and auxiliary SPI configurable for both the gyroscope and accelerometer.

High robustness to mechanical shock makes the LSM6DSM the preferred choice of system designers for the creation and manufacturing of reliable products.

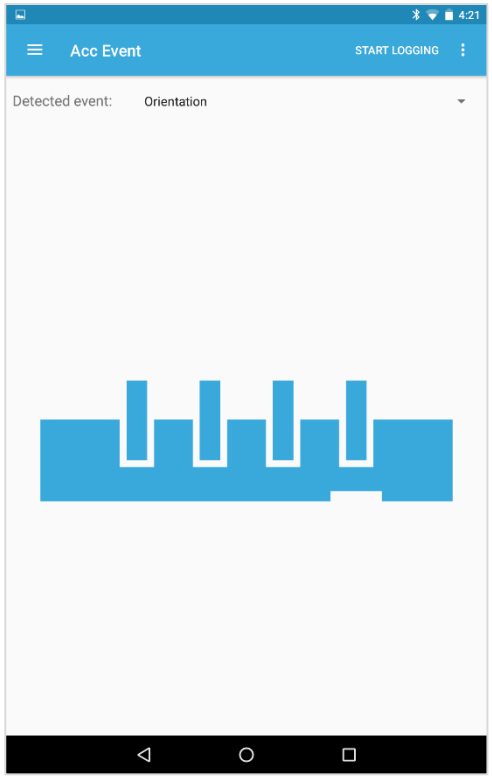
The LSM6DSM is available in a plastic land grid array

LAB4: Event Detection

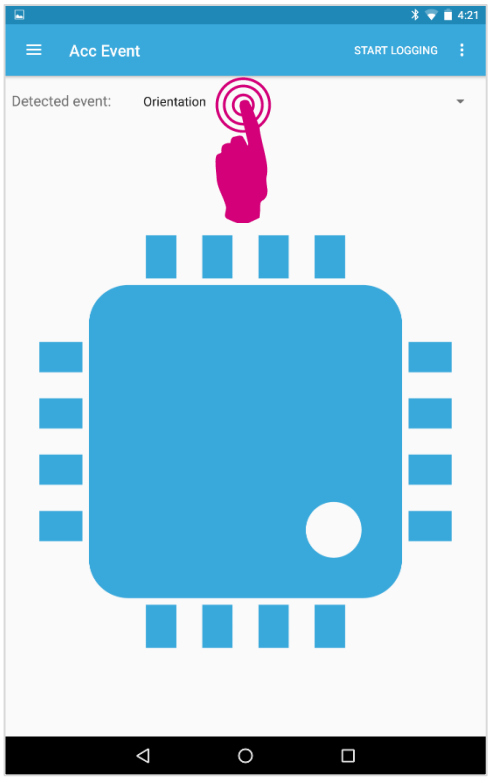
Select “more”
Select “Acc Event”



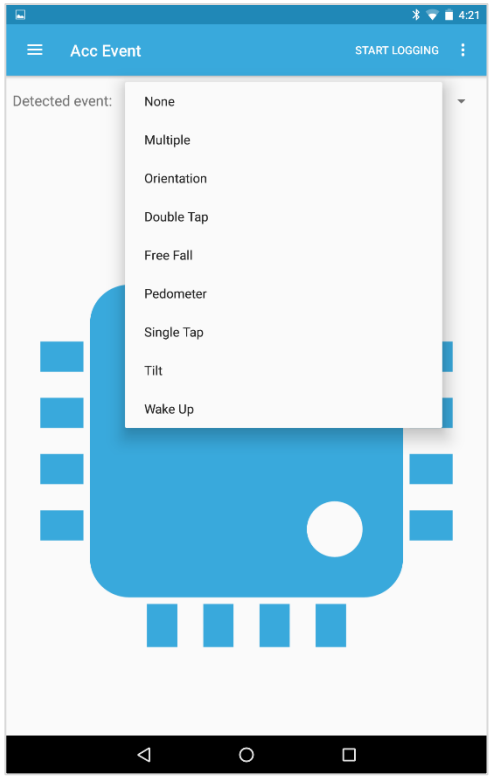
Change orientation



Touch “Event Enabled”



Select another event

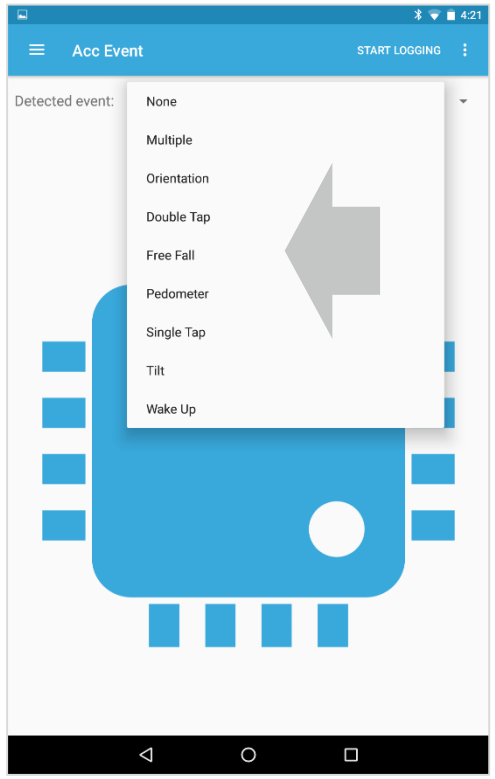


life.augmented

LAB4: Event Detection

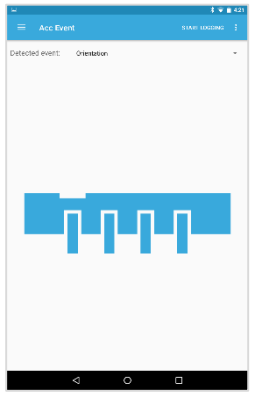
The MEMS sensor hardware performs event detection recognition using a programmable interrupt logic block

Select another event

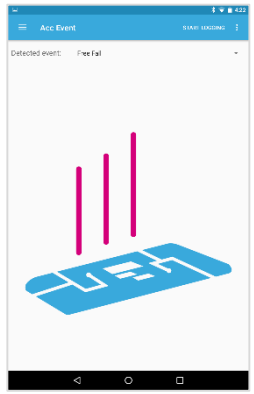


No event

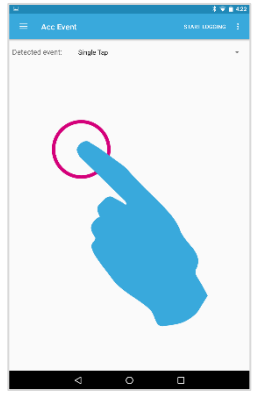
Orientation



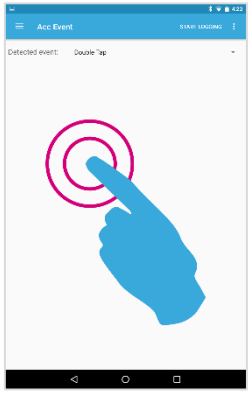
Free fall



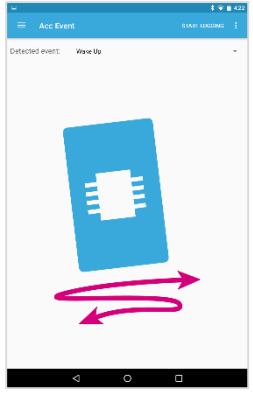
Single tap



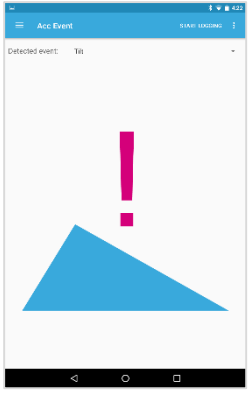
Double tap



Wake up



Tilt



Pedometer

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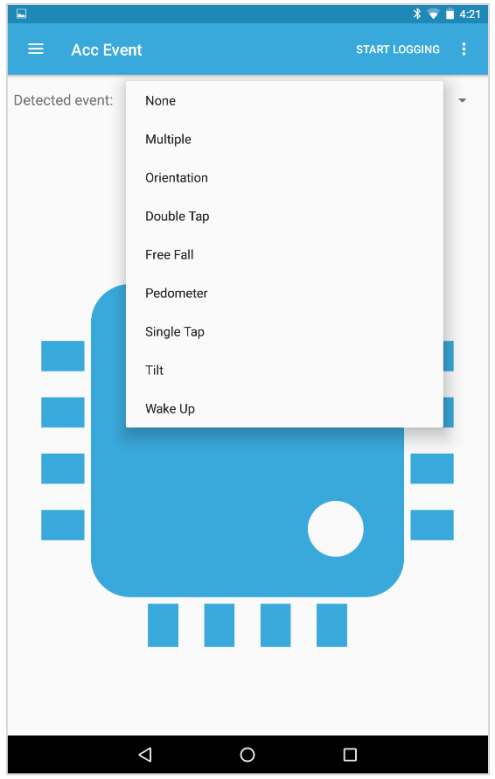
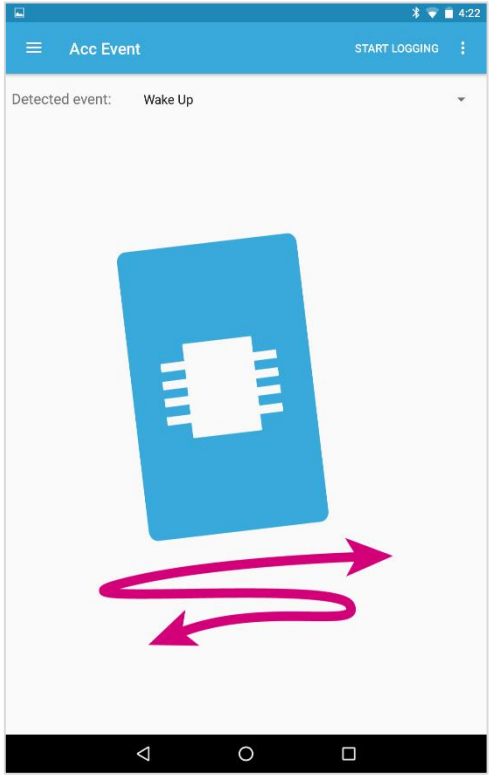
LAB4: Event Detection

The MEMS sensor hardware performs event detection recognition using a programmable interrupt logic block

Select another event



Wake Up



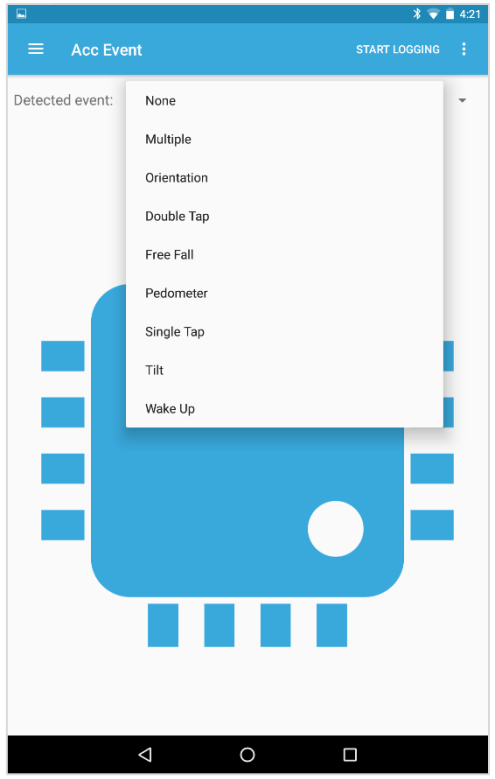
LAB

Shake the device, the acceleration will trigger an interrupt to wake up the MCU (in the meanwhile captured data can be saved to internal FIFO)

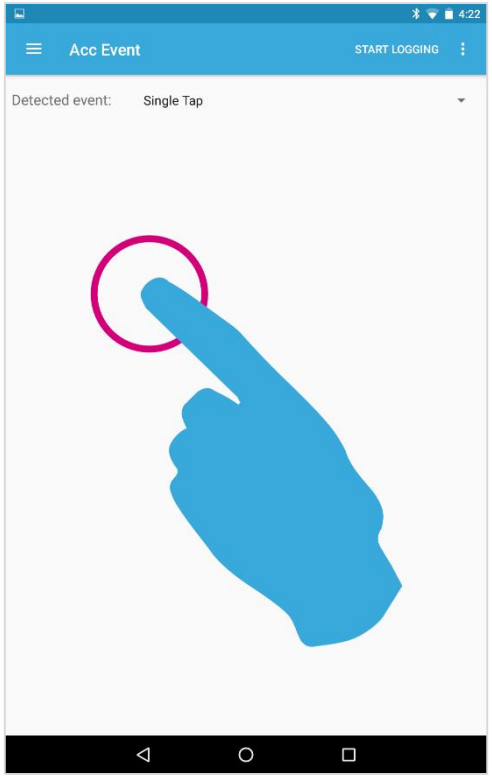
LAB4: Event Detection

The MEMS sensor hardware performs event detection recognition using a programmable interrupt logic block

Select another event



Single Tap



LAB

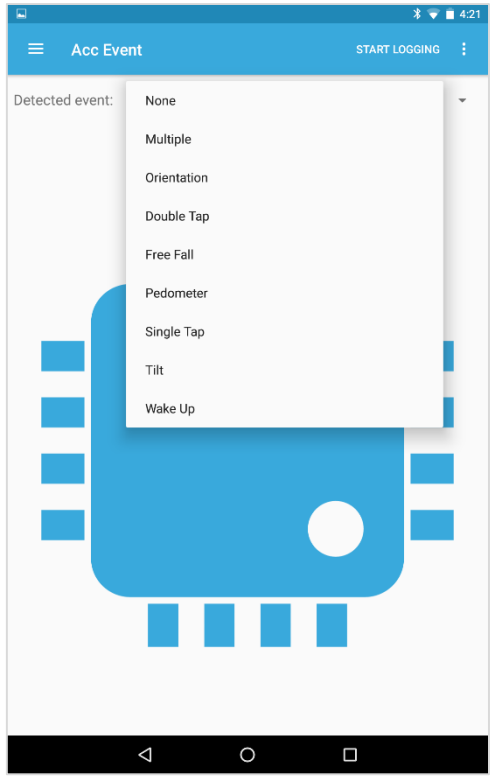
Tap the device. What happens for the double tap?

life.augmented

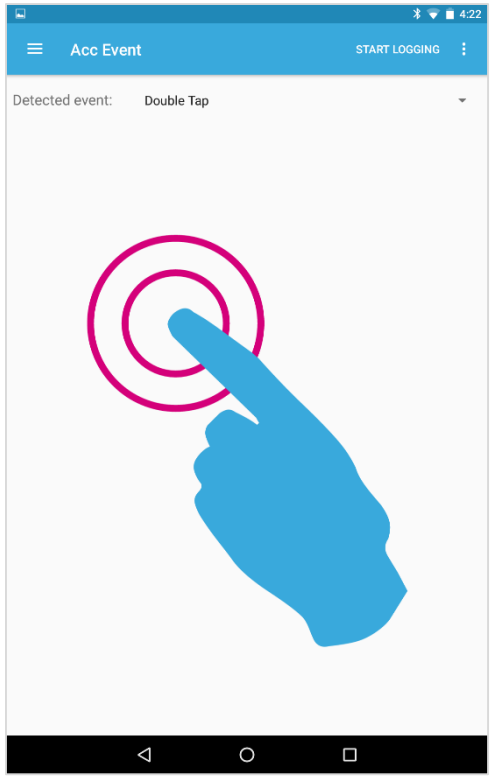
LAB4: Event Detection

The MEMS sensor hardware performs event detection recognition using a programmable interrupt logic block

Select another event



Double Tap



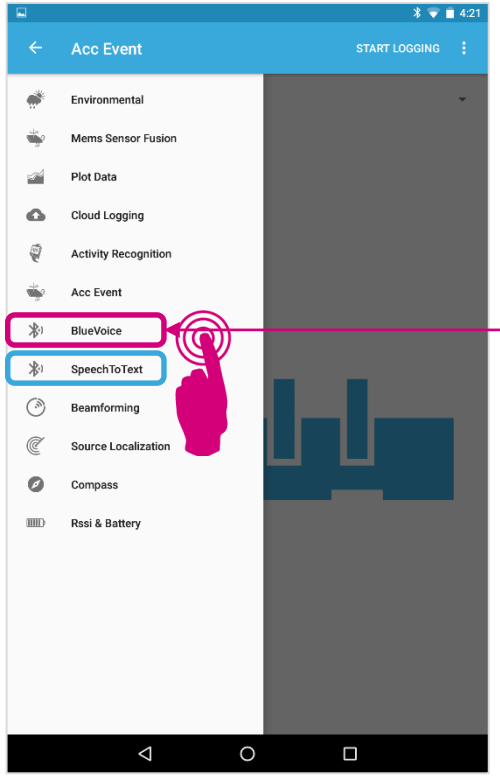
LAB

Double tap the device. What happens now for the single tap?

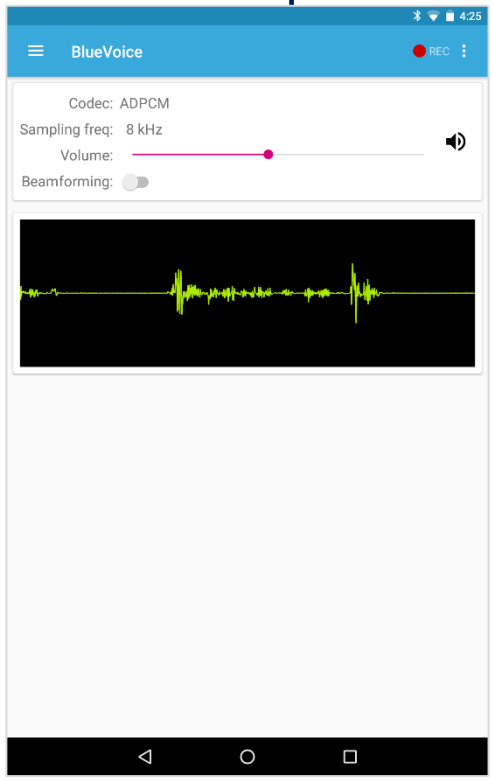
life.augmented

LAB5: Voice over Bluetooth LE

Select “more”
Select “BlueVoice”



Speak to device,
hear on phone



Do not silence your phone,
must not be vibration only!

LAB

Speak into the BlueCoin mic and listen to your phone

(if the mic captures the audio from the phone speaker, a very high pitch sound can happen!)

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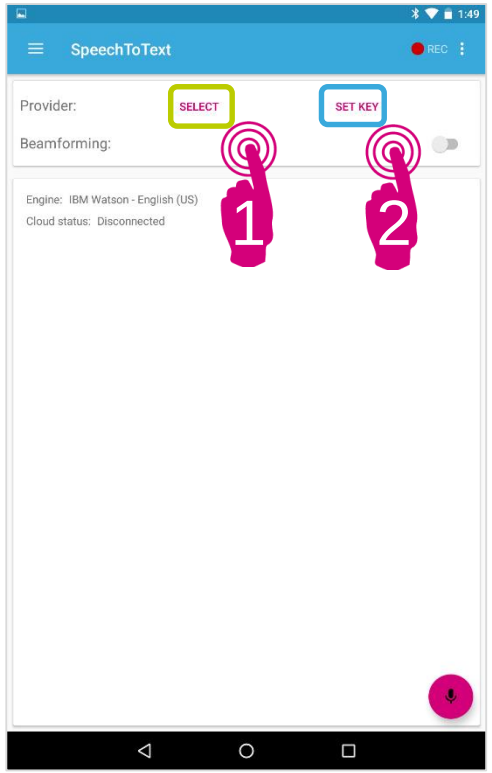
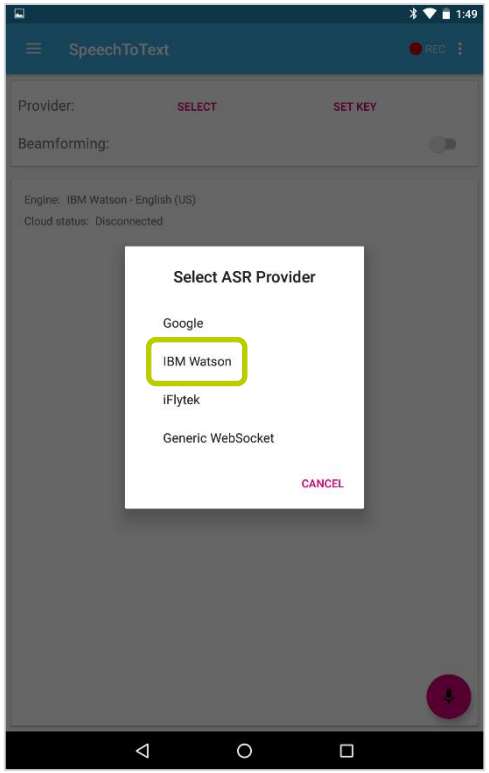
BlueVoice
(voice over Bluetooth LE)

LAB6: SpeechToText

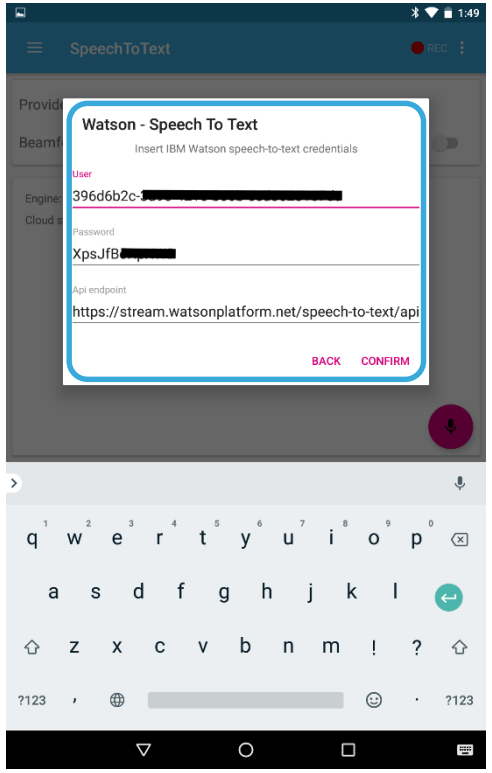
Select ASR Engine

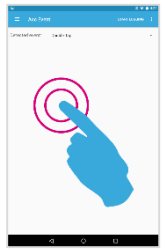


IBM Watson

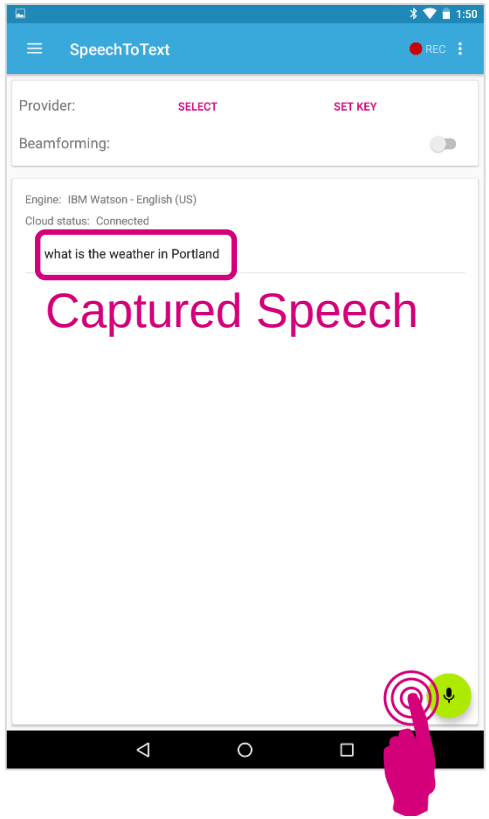


Add credentials



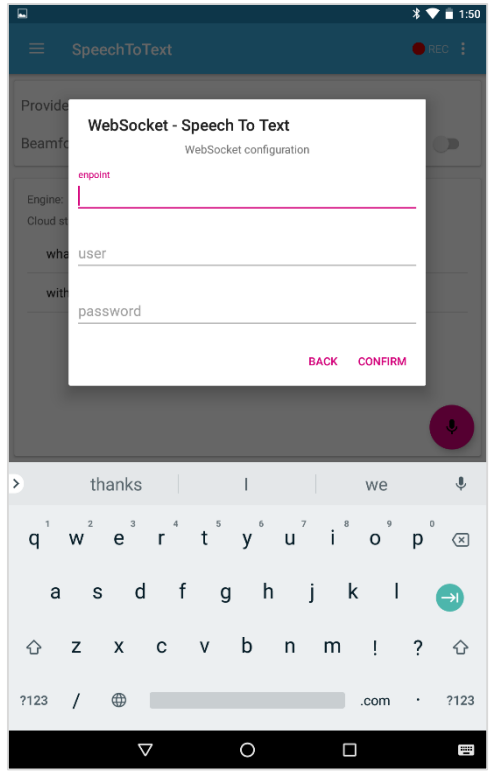


Start/Stop recognition and speak

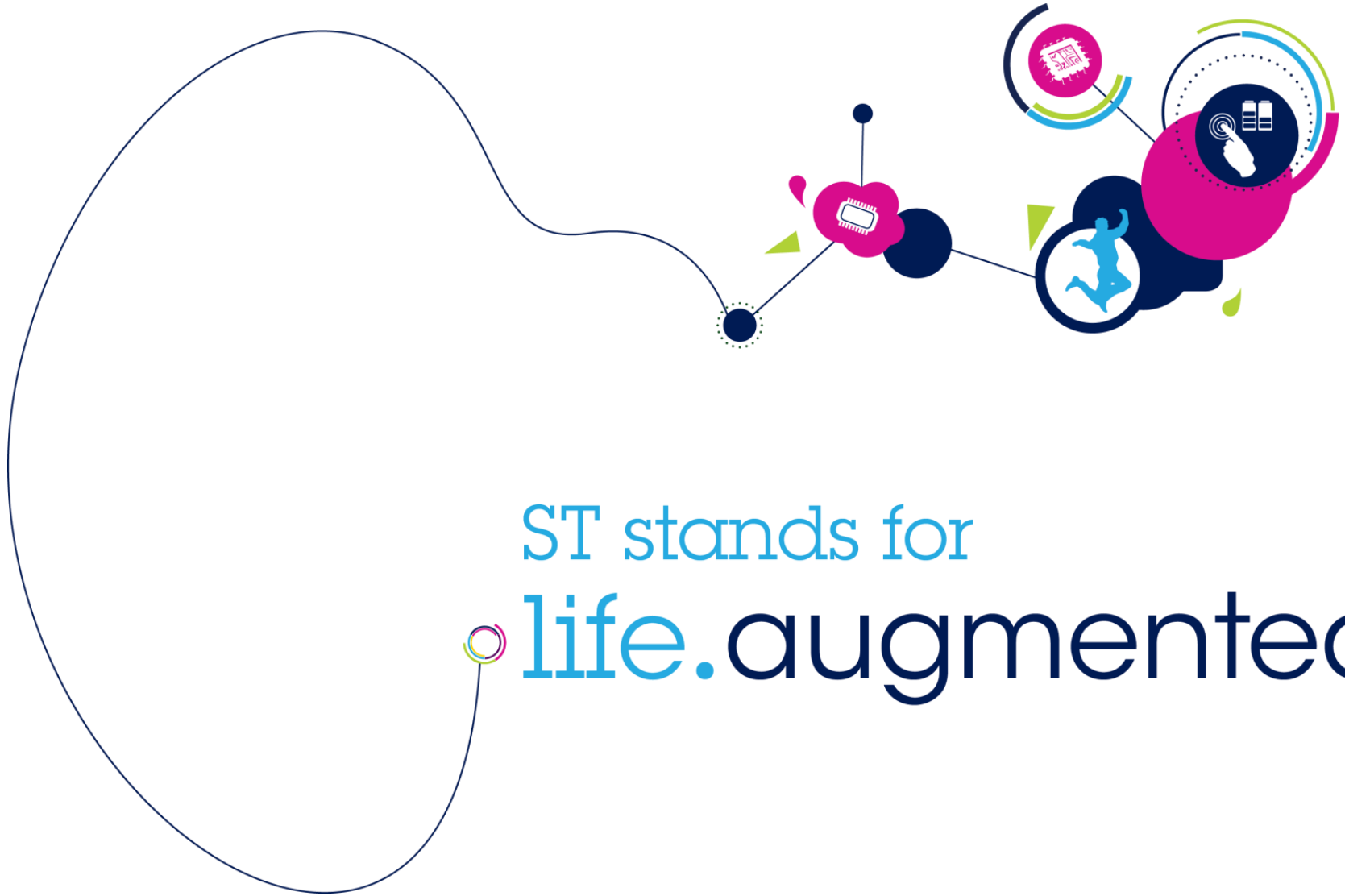


- **Double Tap on BlueCoin**
- Or Tap on Screen

Alternatively Use WebSocket



life.augmented



ST stands for

life.augmented