Quick Start Guide
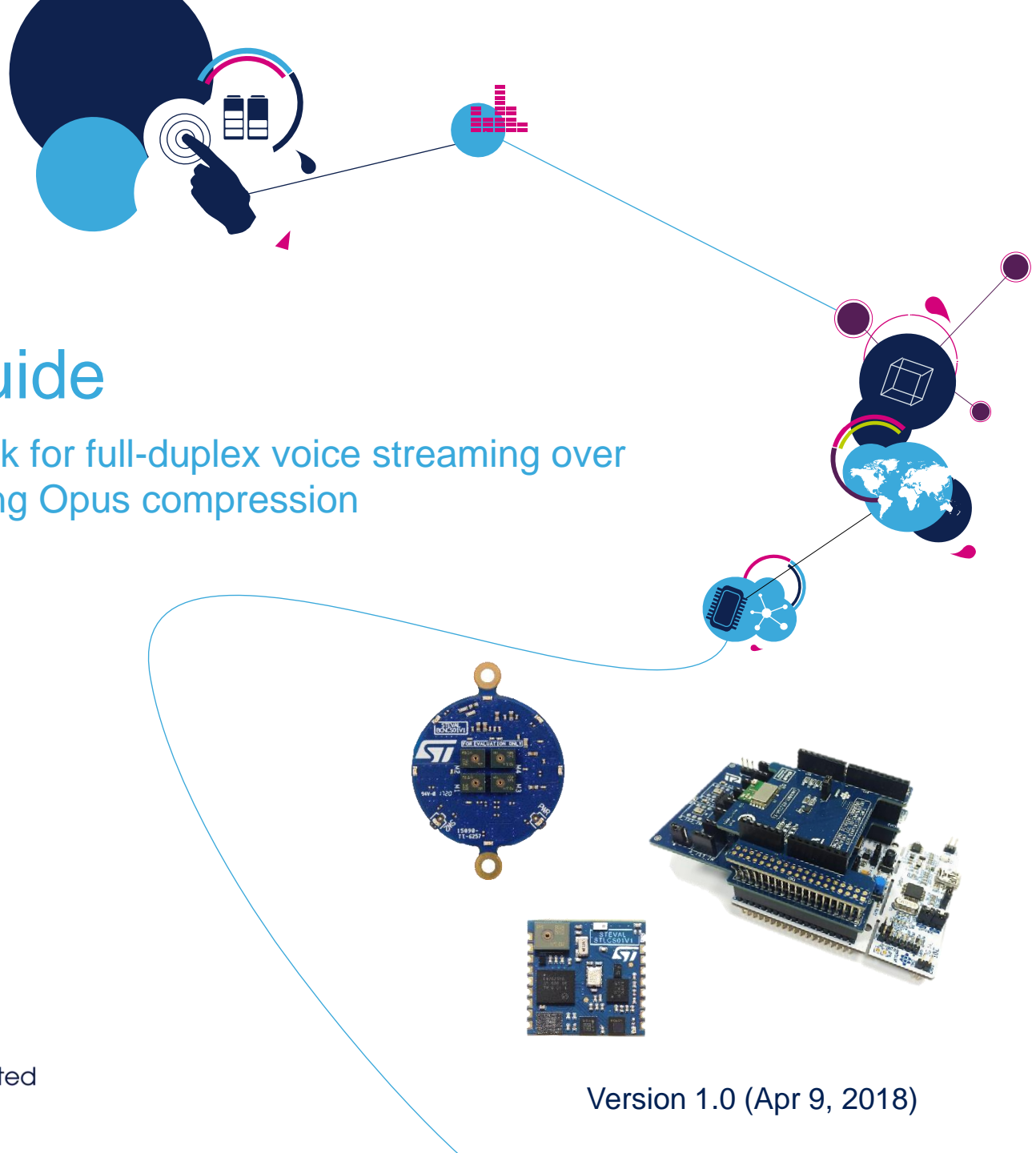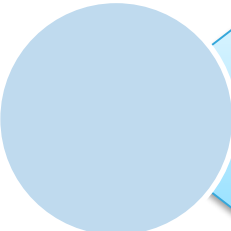
STM32Cube function pack for full-duplex voice streaming over Bluetooth low energy using Opus compression (FP-AUD-BVLINK2)
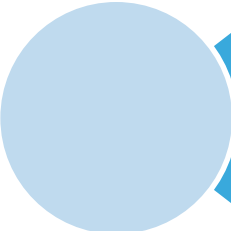
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Version 1.0 (Apr 9, 2018)

Quick Start Guide Contents

FP-AUD-BVLINK2: STM32Cube function pack for full-duplex voice streaming over Bluetooth low energy using Opus compression Hardware and Software overview

Setup & Demo Examples

Documents & Related Resources

STM32 Open Development Environment: Overview

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Bluetooth Low Energy expansion board

Hardware Overview
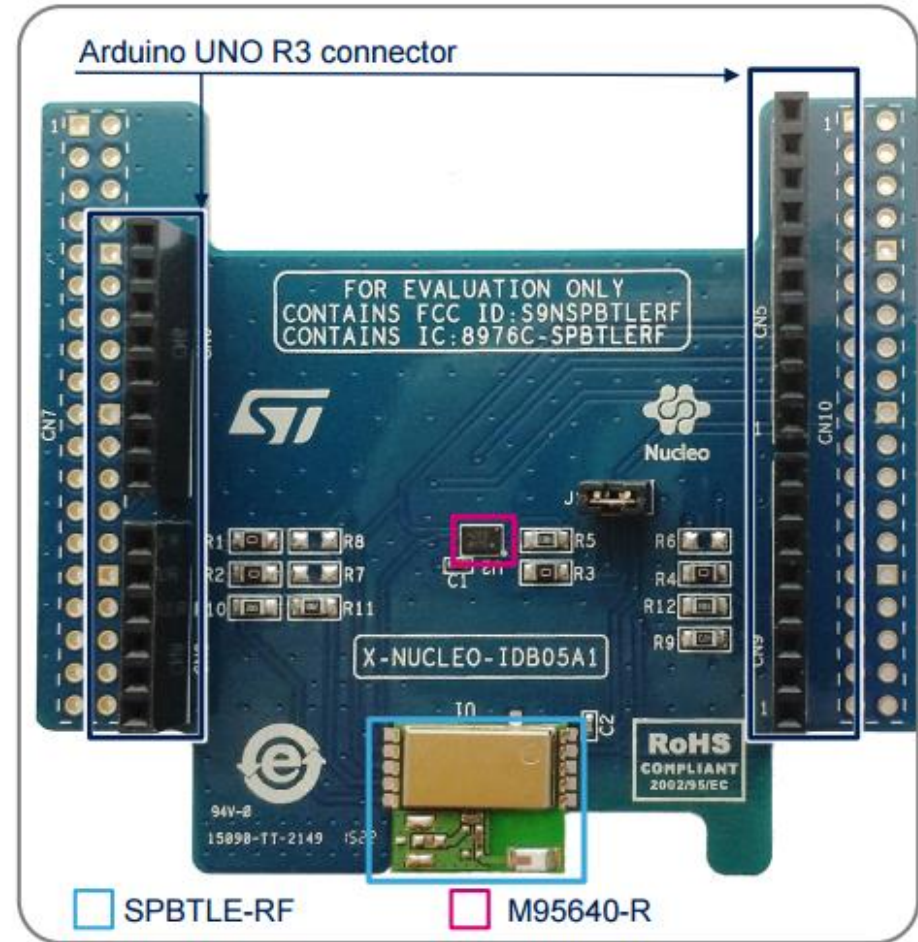
X-NUCLEO-IDB05A1 Hardware Description

- The X-NUCLEO-IDB05A1 is a Bluetooth Low Energy (BLE) evaluation and development board system, designed around ST's SPBTLE-RF Bluetooth Low Energy module based on BlueNRG-MS.

- The BlueNRG-MS processor hosted in the SPBTLE-RF module communicates with the STM32 Nucleo developer board host microcontroller though an SPI link available on the Arduino UNO R3 connector.

Key Products on board

SPBTLE-RF Bluetooth Low Energy, FCC and IC certified, module based on Bluetooth® Low Energy wireless network processor BlueNRG-MS, BLE4.1 compliant.

SPBTLE-RF integrates a BALF-NRG-01D3 balun and a chip antenna. It embeds 32 MHz and 32.768 kHz crystal oscillators for the BlueNRG-MS.

M95640-R 64-Kbit serial SPI bus EEPROM with high-speed clock interface

Latest info available at www.st.com
X-NUCLEO-IDB05A1

# Digital MEMS microphones expansion board
Hardware Overview

X-NUCLEO-CCA02M1 Hardware Description

- The X-NUCLEO-CCA02M1 is an evaluation board based on digital MEMS microphones. It has two MP34DT01 – M microphones soldered on board and it offers the possibility to plug additional microphones using MP34DT01 based coupon evaluation boards (STEVAL-MKI129V* or STEVAL-MKI155V*).

- The X-NUCLEO-CCA02M1 enables the acquisition and streaming of up 4 microphones using both I^2S and SPI bus available on ST morpho connector.

Key Products on board

MP34DT01-M Ultra-compact, low-power, omnidirectional, digital MEMS microphone built with a capacitive sensing element and an IC interface.

ST morpho connector
Arduino UNO R3 connector

MP34DT01-M   Microphone coupons housing   USB Connector
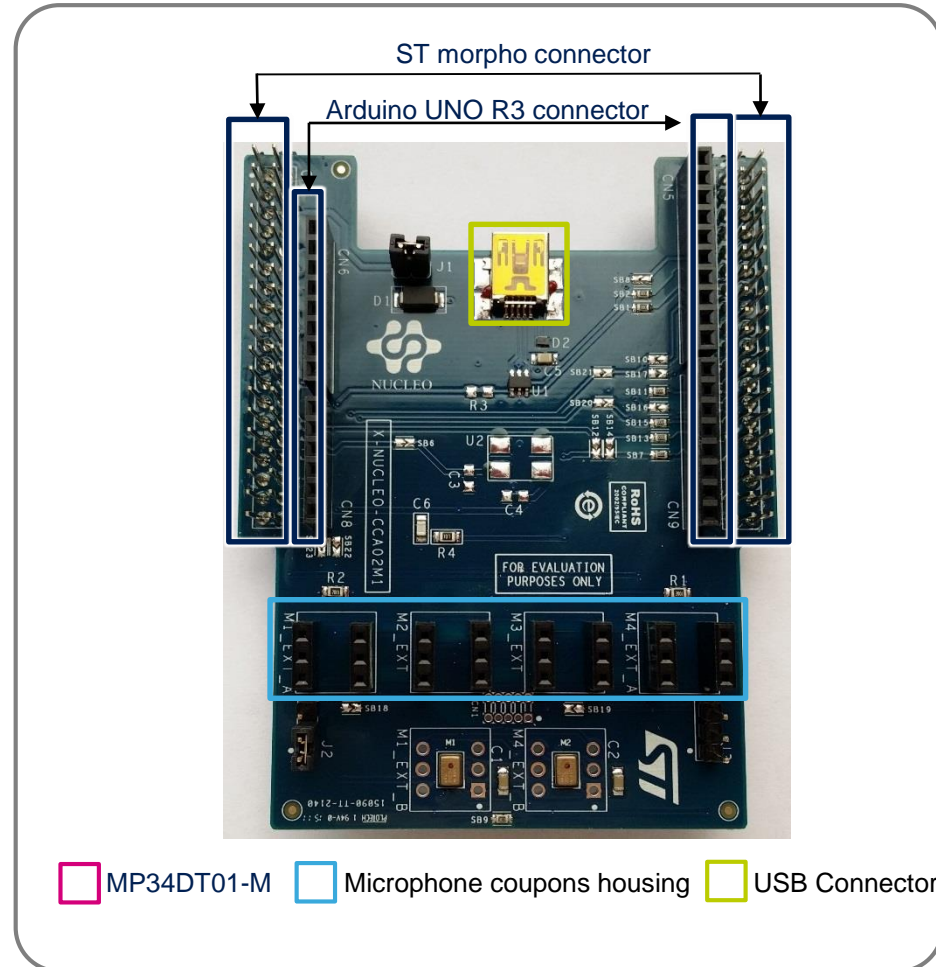
Latest info available at www.st.com
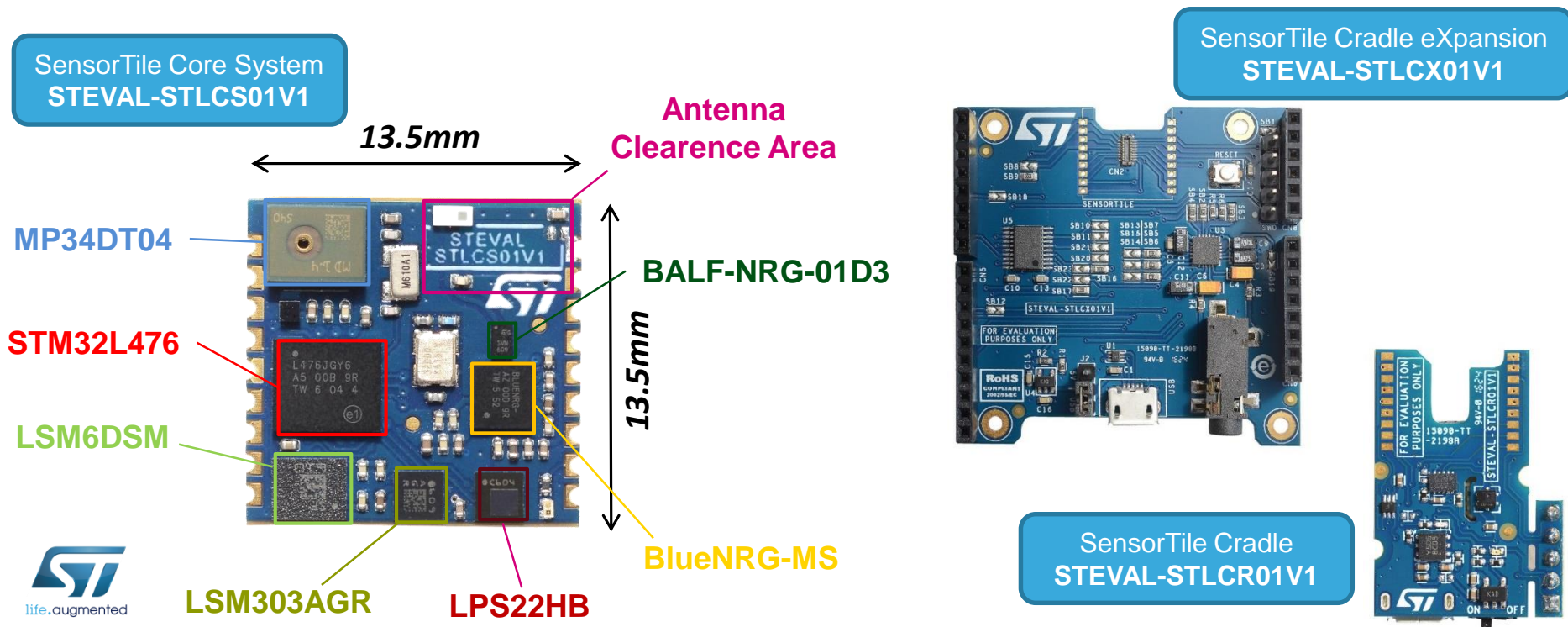**X-NUCLEO-CCA02M1**

* Is used as a wildcard character for related part number

Hardware Overview

STEVAL-STLKT01V1 Hardware Description

- STEVAL-STLKT01V1 is the development kit for the SensorTile board (STEVAL-STLCS01V1), a highly Integrated Development Platform with a broad range of functionalities aiming to improve system design cycle and accelerate delivery of results

- Two host boards are also provided as part of the kit, both featuring SWD programming interface

  - Cradle eXpansion has a plugin connection for SensorTile Core System and an Arduino interface

  - The Cradle is a small host featuring battery charger and SD card interface that supports on-the-field testing and data acquisition campaigns
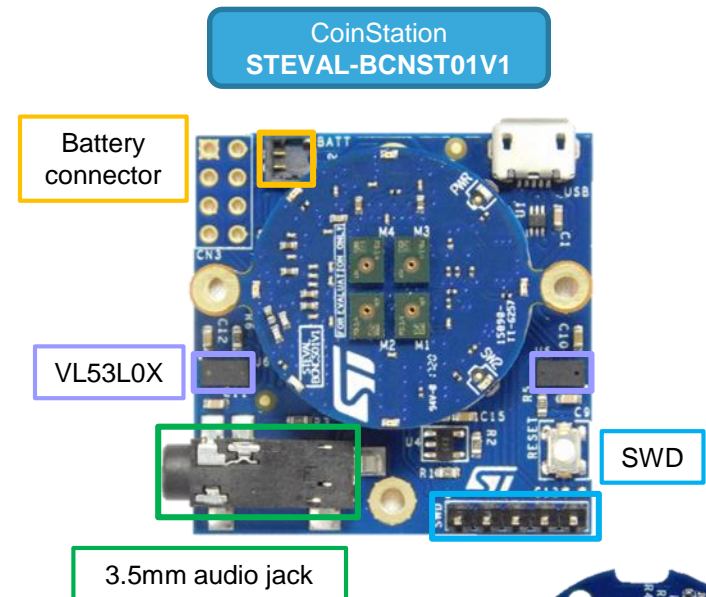
SensorTile Core System
STEVAL-STLCS01V1

13.5mm

Antenna Clearence Area

MP34DT04

STEVAL STLCS01V1

BALF-NRG-01D3

STM32L476

13.5mm

LSM6DSM

BlueNRG-MS

LSM303AGR

LPS22HB

SensorTile Cradle eXpansion
STEVAL-STLCX01V1
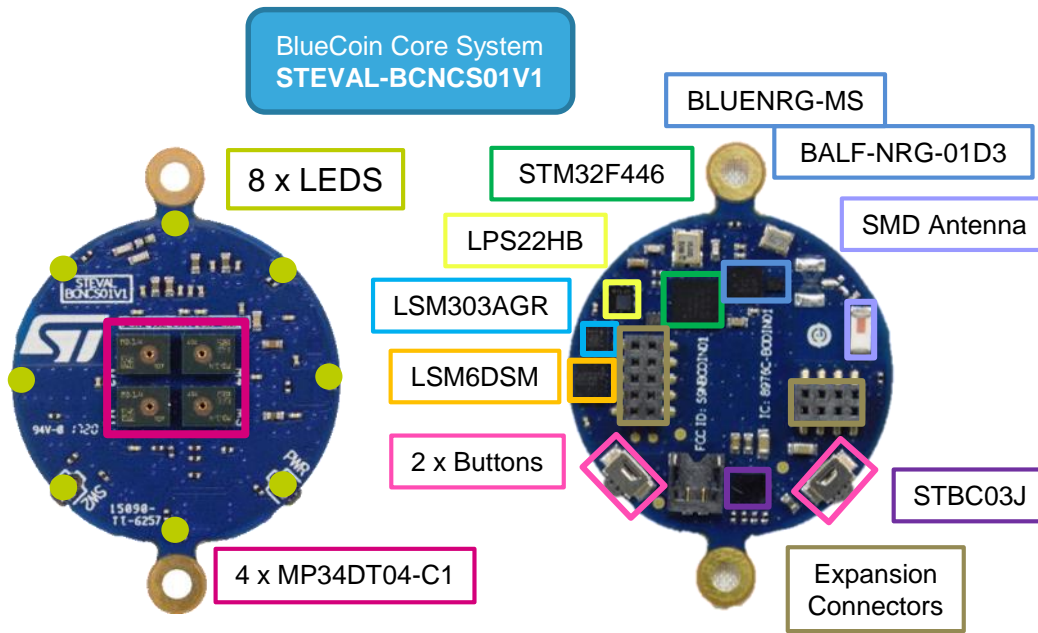
SensorTile Cradle
STEVAL-STLCR01V1

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Hardware Overview

STEVAL-BCNKT01V1 Hardware Description

- STEVAL-BCNKT01V1 is the starter kit for the BlueCoin board (STEVAL-BCNCS01V1), a highly integrated development and prototyping platform for augmented acoustic and motion sensing, aiming to improve system design cycle and accelerate delivery of results

- Two host boards are also provided as part of the kit:
  - The CoinStation provides audio output, battery management and two Time-of-flight ranging sensors.
  - The Cradle is a small host board featuring USB and SD card interfaces, it is useful for on-the-field testing and data acquisition campaigns.

BlueCoin Core System
STEVAL-BCNCS01V1

8 x LEDS

BLUENRG-MS

STM32F446

BALF-NRG-01D3

LPS22HB

SMD Antenna

LSM303AGR

LSM6DSM

2 x Buttons

STBC03J

4 x MP34DT04-C1

Expansion Connectors

CoinStation
STEVAL-BCNST01V1

Battery connector

VL53L0X

SWD

3.5mm audio jack

BlueCoin Cradle
STEVAL-BCNCR01V1

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FP-AUD-BVLINK2 Software

- FP-AUD-BVLINK2 is an STM32Cube function pack that performs voice streaming over BLE in a full-duplex configuration using the advanced Opus compression algorithm. The application runs on the STM32 Nucleo and includes drivers and middleware for BLE (BlueNRG-MS) and digital MEMS microphones.

- Sample implementation available for X-NUCLEO-IDB05A1 plus X-NUCLEO-CCA02M1 connected to a NUCLEO-F446RE or NUCLEO-L476RG, for SensorTile (STEVAL-STLKT01V1) and BlueCoin (STEVAL-BCNKT01V1)
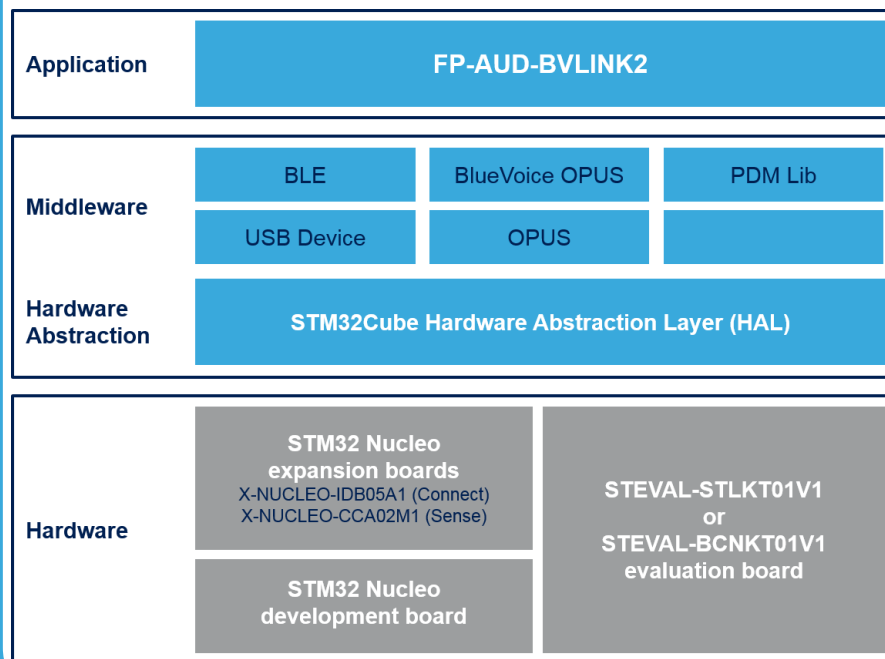
Key features

- Complete firmware to implement full-duplex speech communication over Bluetooth low energy (BLE) using Opus compression

- BlueVoiceOPUS customized profile for audio over BLE, including an easy-to-use set of APIs to exploit advanced Opus functionality (source code available)

- Third-party Opus v1.2.1 (downloadable from http://opus-codec.org/) middleware: an open, royalty-free and highly versatile audio codec that is standardized by the Internet Engineering Task Force (IETF) as RFC 6716

- Digital audio signal acquisition and processing and Audio out playback through USB or jack connector

Overall Software Architecture

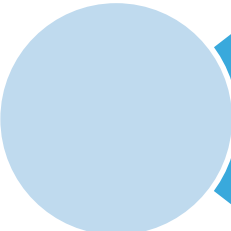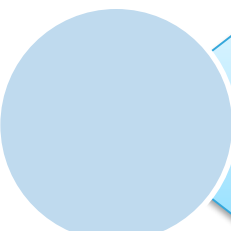| Application	FP-AUD-BVLINK2		
Middleware	BLE	BlueVoice OPUS	PDM Lib
	USB Device	OPUS	
Hardware Abstraction	STM32Cube Hardware Abstraction Layer (HAL)		

Hardware

STM32 Nucleo expansion boards
X-NUCLEO-IDB05A1 (Connect)
X-NUCLEO-CCA02M1 (Sense)

STM32 Nucleo development board

STEVAL-STLKT01V1 or STEVAL-BCNKT01V1 evaluation board

Latest info available at www.st.com
FP-AUD-BVLINK2

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Quick Start Guide Contents

FP-AUD-BVLINK2: STM32Cube function pack for full-duplex voice streaming over Bluetooth low energy using Opus compression
Hardware and Software overview

Setup & Demo Examples

Documents & Related Resources

STM32 Open Development Environment: Overview

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Setup & Demo Examples
SW prerequisites

- **STSW-LINK004**:
  - STM32 ST-LINK Utility is a full-featured software interface for programming STM32 microcontrollers. You can use this utility to flash your STM32 Nucleo, SensorTile or BlueCoin board, for a fast demo setup.
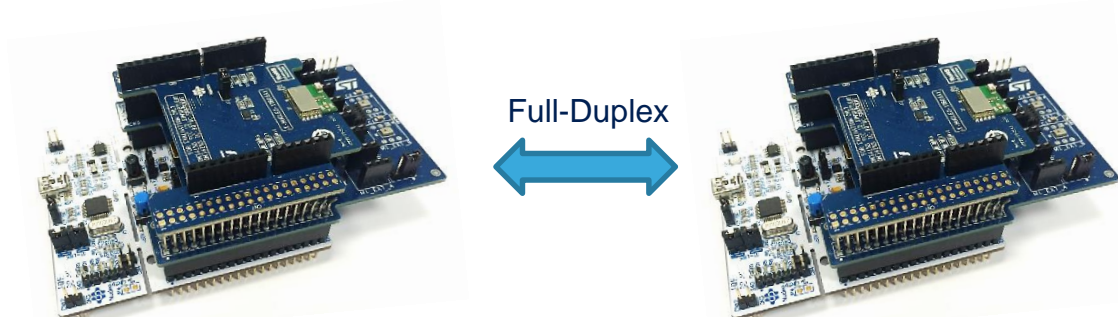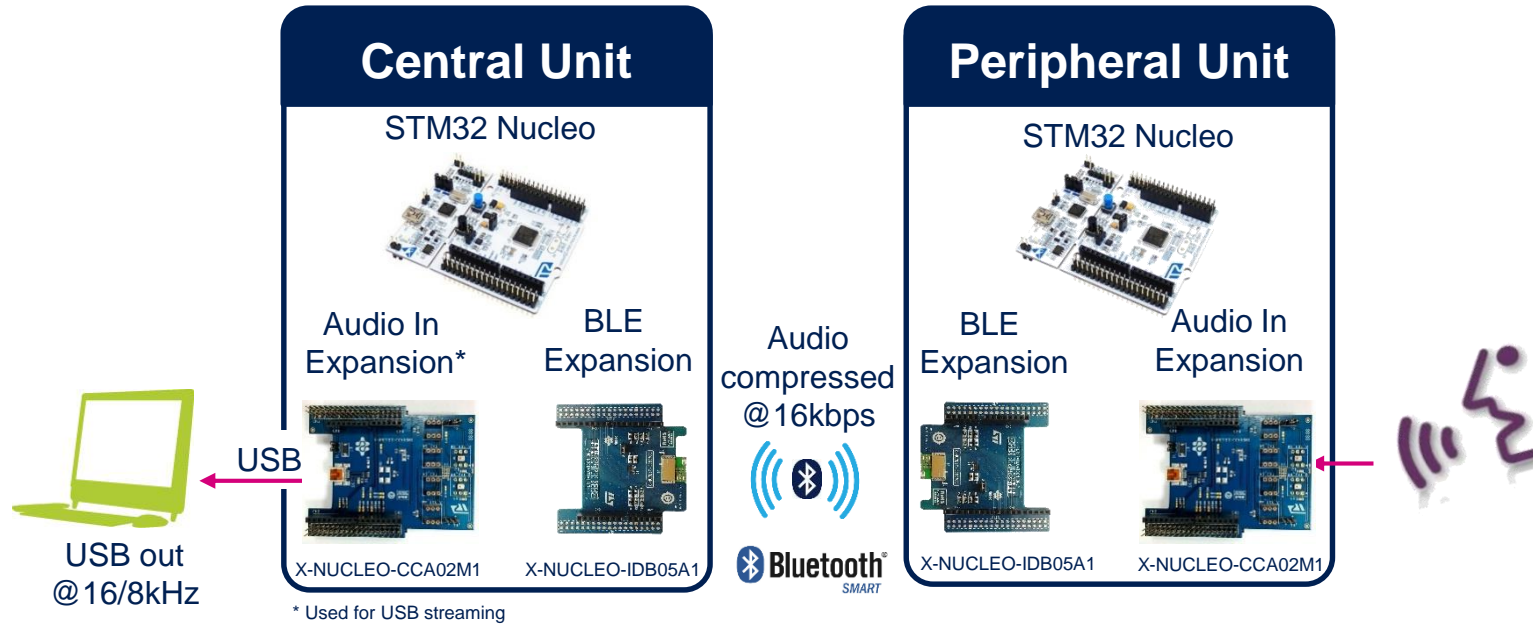
- **FP-AUD-BVLINK2**
  - Copy the .zip file content into a folder on your PC. The package contains source code example (Keil, IAR, System Workbench) based on **NUCLEO-F446RE**, **NUCLEO-L476RG, SensorTile or BlueCoin.**

- Third party software for audio acquisition (if you are using STM32Nucleo board)
  - Audacity® is free, open source, cross-platform software for recording and editing sounds.
  - It is available for Windows®, Mac®, GNU/Linux®; and other operating systems.
  - Link: http://audacity.sourceforge.net

Central Unit

STM32 Nucleo

Audio In Expansion*

BLE Expansion

X-NUCLEO-CCA02M1

X-NUCLEO-IDB05A1

USB

USB out @16/8kHz

* Used for USB streaming

Audio compressed @16kbps

Bluetooth
SMART

Peripheral Unit

STM32 Nucleo

BLE Expansion

Audio In Expansion

X-NUCLEO-IDB05A1

X-NUCLEO-CCA02M1

Full-Duplex

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Setup & Demo Examples
STM32Nucleo - HW prerequisites

- 2x STM32 Nucleo Bluetooth Low Energy expansion board (**X-NUCLEO-IBD05A1**)

- 2x STM32 Nucleo Digital MEMS microphones expansion board (**X-NUCLEO-CCA02M1**)

- 2x STM32 Nucleo development board (**NUCLEO-F446RE**, **NUCLEO-L476RG**), for Full-Duplex communication.

- PC with Windows® 7 or above
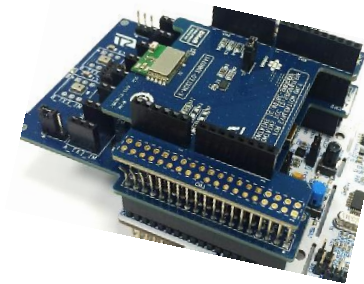
- 2x USB type A to Mini-B USB cable

NUCLEO-F401RE
or NUCLEO-L152RE

X-NUCLEO-CCA02M1

X-NUCLEO-IDB05A1

2x kits needed
(for central and peripheral roles
In full-duplex communication)

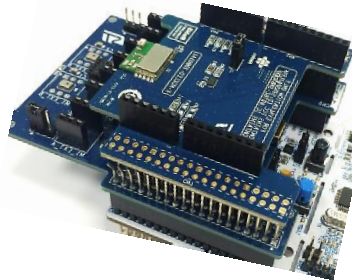# Voice over BLE software

1 www.st.com/stm32ode-fp

www.st.com

2 Select
FP-AUD-BVLINK2

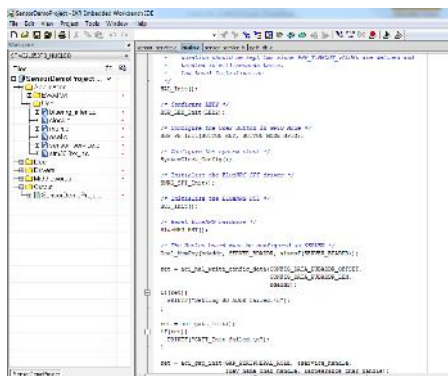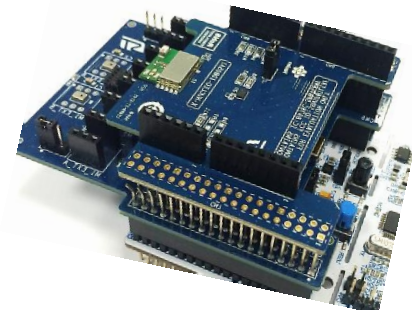**3** Download & unpack

FP-AUD-BVLINK2 package structure

Name

_htmresc

Documentation ← Docs

Drivers ← BSP, HAL and drivers

Middlewares ← BlueNRG, BlueVoice

Projects ← Application example

Utilities

package.xml

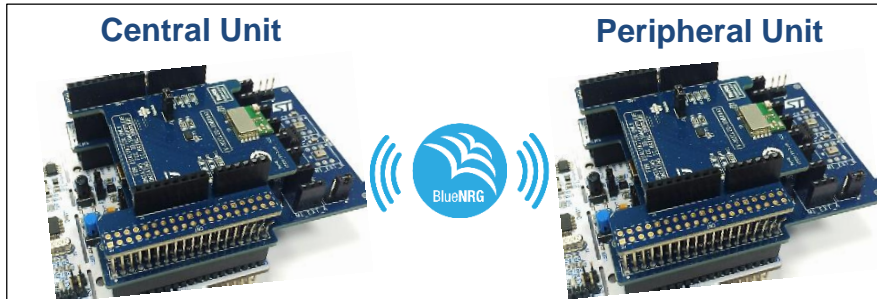Release_Notes.html

4

5 Build the application

KEIL Tools by ARM

IAR SYSTEMS

Open project example
"BVLCen" or "BVLPer"

Setup & Demo Examples
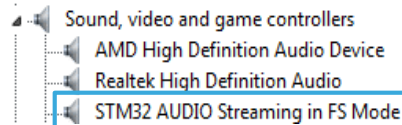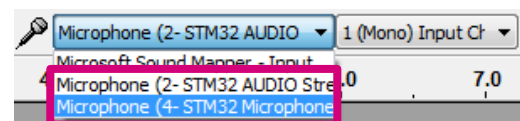
STM32Nucleo - Demo setup

Central Unit   **Peripheral Unit**

BlueNRG

1. Compile and download BVLCen application on one unit and BVLPer application on the other (see previous slide)

IAR SYSTEMS   **KEIL Tools by ARM**   **ac6** Anastasor Cemral Systems

2. Unplug USB cable from STM32 Nucleo board
   Move STM32 Nucleo jumper JP5 to E5V USV ■ ●● E5V
   Plug mini USB cable into X-NUCLEO-CCA02M1

3. Both units are recognized as USB Microphone.

   Sound, video and game controllers
   - AMD High Definition Audio Device
   - Realtek High Definition Audio
   - STM32 AUDIO Streaming in FS Mode

4. Open Audacity, select the peripheral or central unit and click record.

   Microphone (2- STM32 AUDIO ▼)   1 (Mono) Input Ch ▼
   Microsoft Sound Mapper - Input
   Microphone (2- STM32 AUDIO Stre
   Microphone (4- STM32 Microphone

5. Press STM32Nucleo user button to START streaming, press again to STOP it. Both units can stream at the same time.

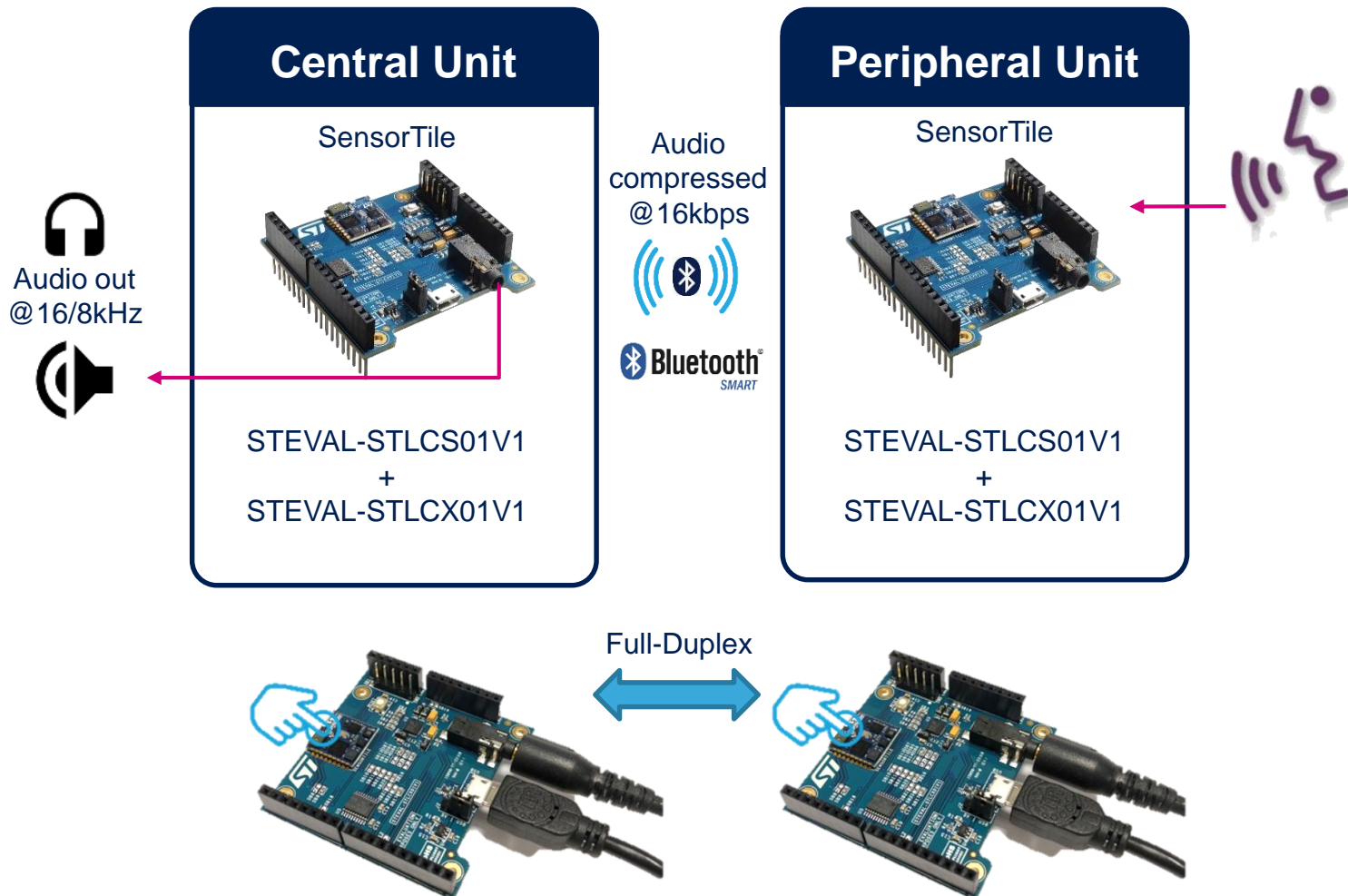6. Audacity records audio coming from the selected microphone.

   Audio Track ▼
   Mono, 16000Hz
   16-bit PCM
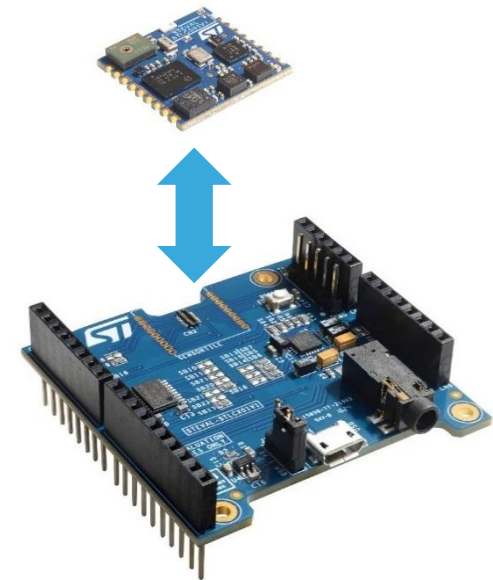   Mute | Solo

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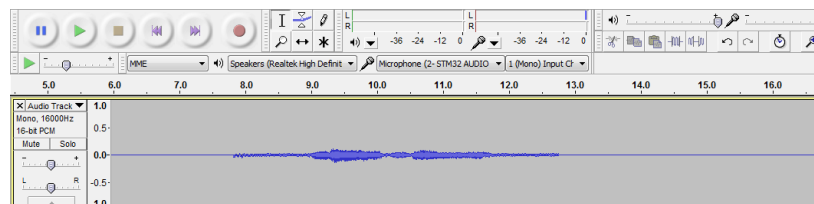
Setup & Demo Examples
SensorTile - HW prerequisites

- 2x STEVAL-STLKT01V1: STEVAL-STLCS01V1 connected to the STEVAL-STLCX01V1 for Full-Duplex communication.

- 2x Passive speaker output: loudspeaker or headset.

2x kits needed
(for central and peripheral roles)

Setup & Demo Examples
SensorTile - HW setup

- In order to program the board you need to connect an external ST-Link to the SWD connector on the cradles, a 5pin flat cable is provided within the SensorTile Kit package.

- The easiest way is to get an STM32-Nucleo board which includes an ST-Link V2.1 programmer.

- Be sure that CN2 Jumpers are OFF and connect your STM32 Nucleo board to the SensorTile Cradle through the provided cable paying attention to the polarity of the connectors. Pin 1 can be identified by a little circle on the PCB silkscreen (STM32 Nucleo board and SensorTile Cradle Expansion).

Cradle eXpansion SWD connection

CN2

Remove Jumpers

SWD

(Pin1)

SWD

(Pin1)
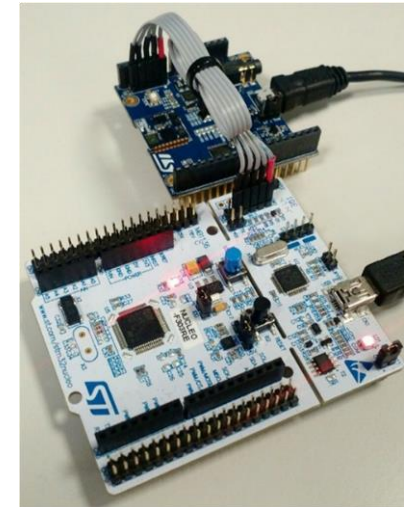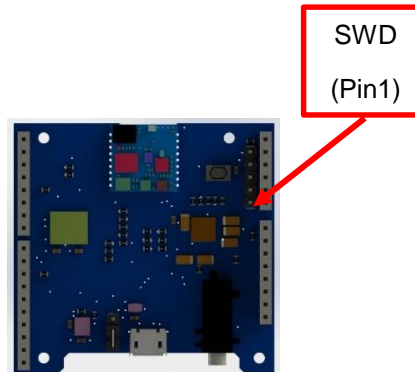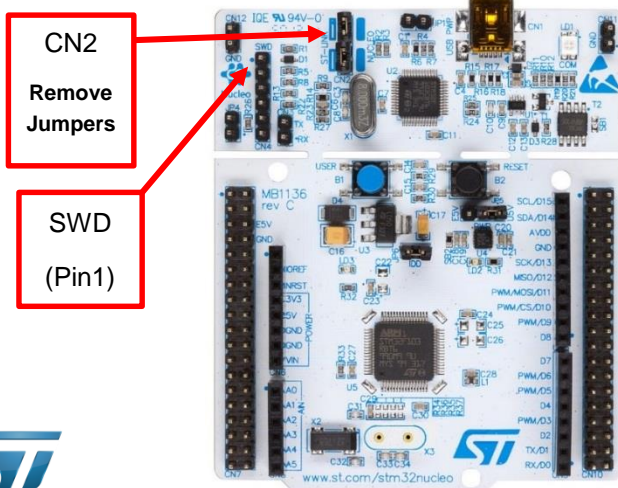
Setup & Demo Examples

SensorTile - Demo setup

Central Unit   BlueNRG   **Peripheral Unit**
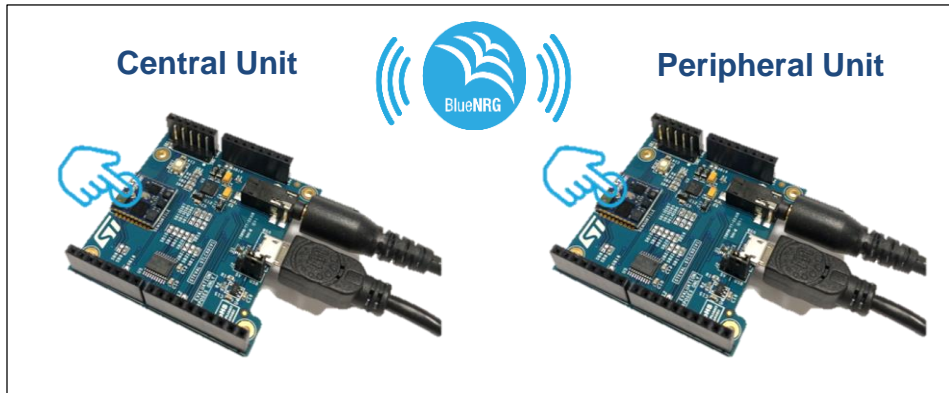
1 Compile and download BVLCen application on one SensorTile and BVLPer application on the other.

2 Connect to the jack connector on the Expansion cradle board a loudspeaker or a headset.

3 Double tap on the SensorTile that must act as transmitter, the audio streaming will start.

4 Double tap again on the same unit to stop the streaming.

5 Both units can stream at the same time.
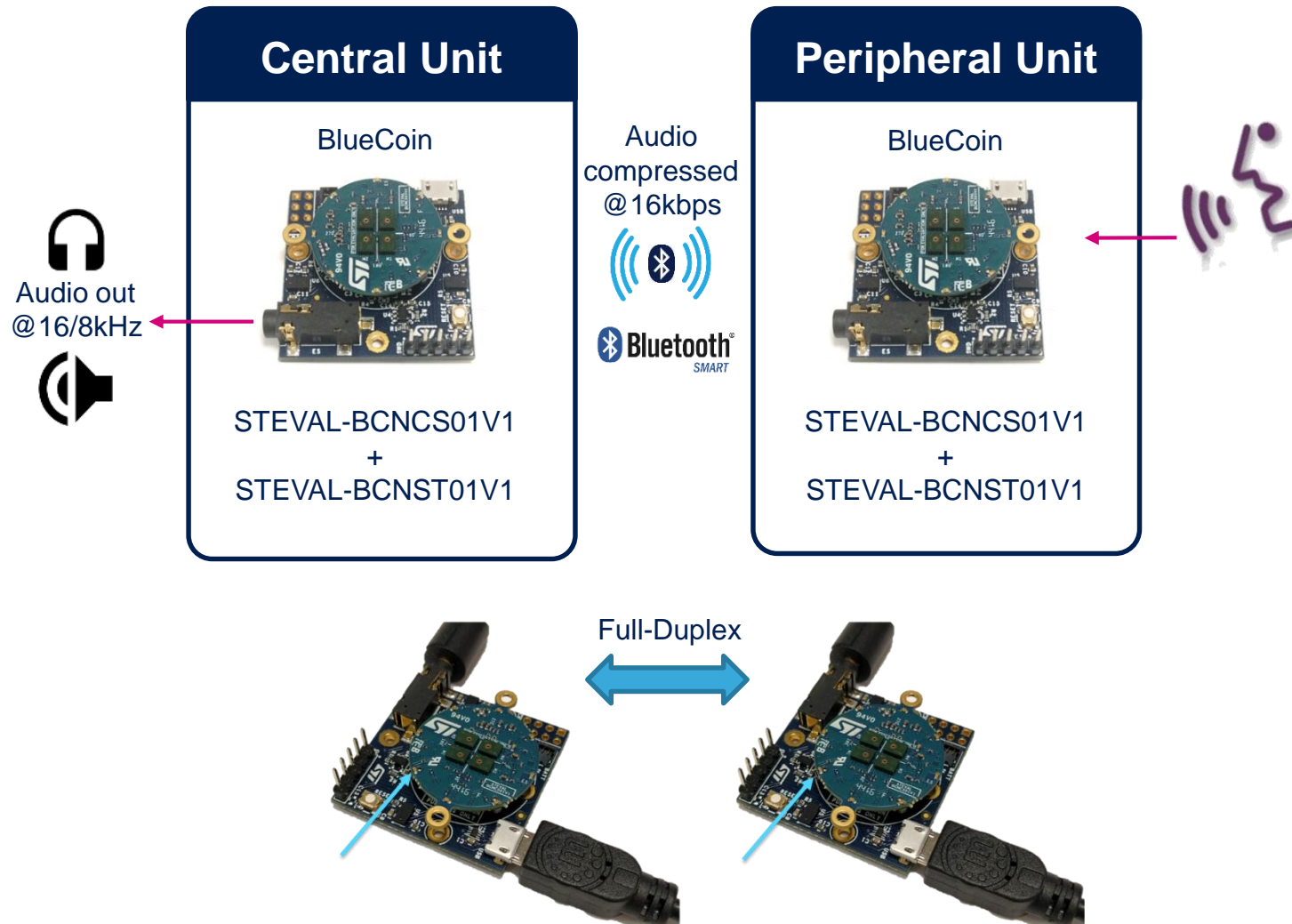
Setup & Demo Examples
BlueCoin - HW prerequisites

- 2x STEVAL-BCNKT01V1: STEVAL-BCNCS01V1 connected to the STEVAL-BCNST01V1 for Full-Duplex communication.

- Passive speaker output: loudspeaker or headset.


2x kits needed
(for central and peripheral roles)

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Setup & Demo Examples
BlueCoin - HW setup

- In order to program the board you need to connect an external ST-Link to the SWD connector on the BlueCoin Station, a 5pin flat cable is provided within the BlueCoin Kit package.

- The easiest way is to get an STM32-Nucleo board which includes an ST-Link V2.1 programmer.

- Be sure that CN2 Jumpers are OFF and connect your STM32 Nucleo board to the BlueCoin Station through the provided cable paying attention to the polarity of the connectors. Pin 1 can be identified by a little circle on the PCB silkscreen (STM32 Nucleo board and BlueCoin Station).

BlueCoin Station SWD connection

CN2

Remove Jumpers

SWD

(Pin1)

SWD

(Pin1)
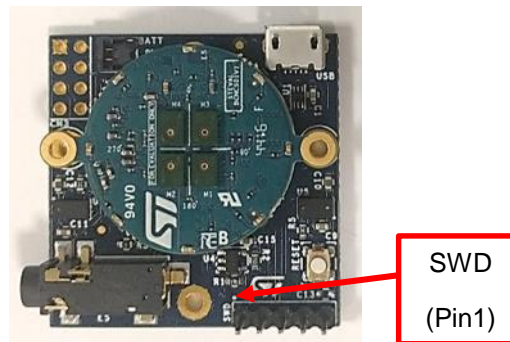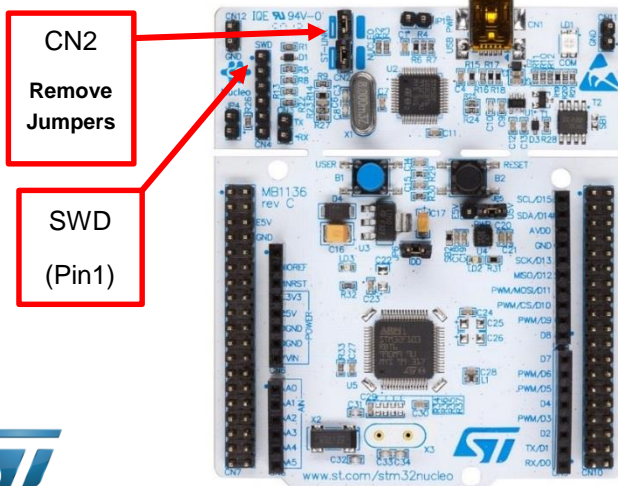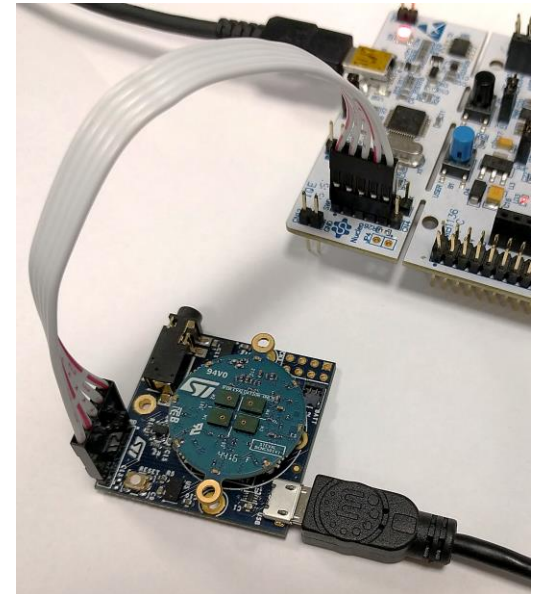
Setup & Demo Examples

## BlueCoin - Demo setup

Central Unit   **Peripheral Unit**
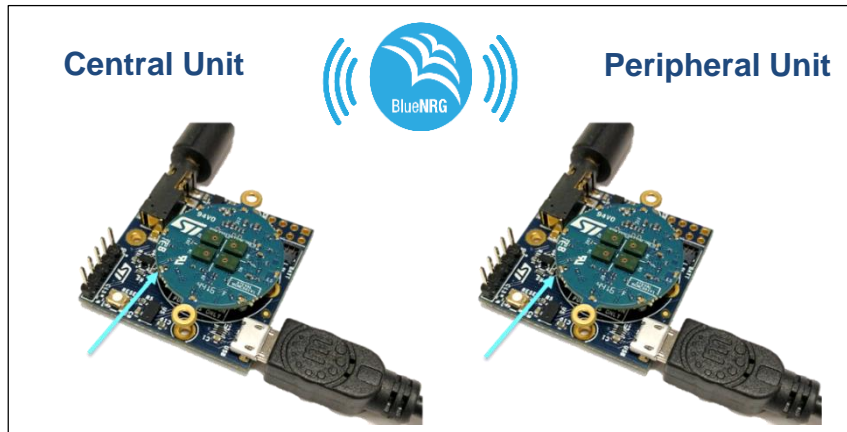
1 Compile and download BVLCen application on one BlueCoin and BVLPer application on the other.

2 Connect to the jack connector on the BlueCoin Station a loudspeaker or a headset.

3 Press the button indicated in the picture above to start the audio streaming from the BlueCoin acting as transmitter.

4 Press again the same button to stop the streaming.

5 Both units can stream at the same time.

Documents & Related Resources (1/2)

All documents are available in the DESIGN tab of the related products webpage

FP-AUD-BVLINK2:

- **DB3552**: STM32Cube function pack for full-duplex voice streaming over Bluetooth low energy using Opus compression – **Data Brief**
- **UM2382:** Getting started with the STM32Cube function pack for full-duplex voice streaming over Bluetooth low energy using Opus compression – **User Manual**
- Software setup file

X-NUCLEO-CCA02M1

- Gerber files, BOM, Schematics
- **DB2593:** Digital MEMS microphones expansion board based on MP34DT01-M for STM32 Nucleo **– Data Brief**
- **UM1900:** Getting started with the digital MEMS microphones expansion board based on MP34DT01-M for STM32 Nucleo – **User Manual**

X-NUCLEO-IDB05A1

- Gerber files, BOM, Schematic
- **DB2592:** Bluetooth Low Energy expansion board based on SPBTLE-RF module for STM32 Nucleo **– Data Brief**
- **UM1912:** Getting started with X-NUCLEO-IDB05A1 Bluetooth low energy expansion board based on SPBTLE-RF module for STM32 Nucleo **– User Manual**

Consult www.st.com for the complete list

Documents & Related Resources (2/2)

All documents are available in the DESIGN tab of the related products webpage

STEVAL-STLKT01V1
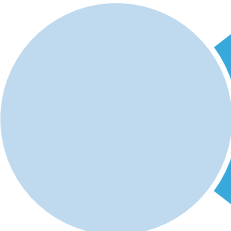
- Gerber files, BOM, Schematic
- **DB2956:** SensorTile development kit **– Data Brief**
- **UM2101**: Getting started with the STEVAL-STLKT01V1 SensorTile integrated development platform **– User Manual**

STEVAL-BCNKT01V1
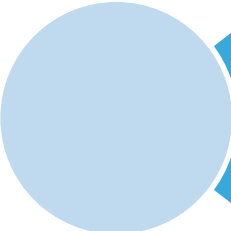
- Gerber files, BOM, Schematic
- **DB3258:** BlueCoin Starter kit **– Data Brief**
- **UM2240**: Getting started with the STEVAL-BCNKT01V1 BlueCoin kit: augmented acoustics and motion sensing development platform **– User Manual**

Consult www.st.com for the complete list

Quick Start Guide Contents

FP-AUD-BVLINK2: STM32Cube function pack for full-duplex voice streaming over Bluetooth low energy using Opus compression
Hardware and Software overview

Setup & Demo Examples

Documents & Related Resources

STM32 Open Development Environment: Overview

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STM32 Open Development Environment
Fast, affordable Prototyping and Development

- The STM32 Open Development Environment (ODE) consists of a set of stackable boards and a modular open SW environment designed around the STM32 microcontroller family.

STM32Cube development software

STM32 Nucleo expansion boards (X-NUCLEO)

STM32 Nucleo development boards

STM32Cube expansion software (X-CUBE)

Function Packs (FP)

www.st.com/stm32ode
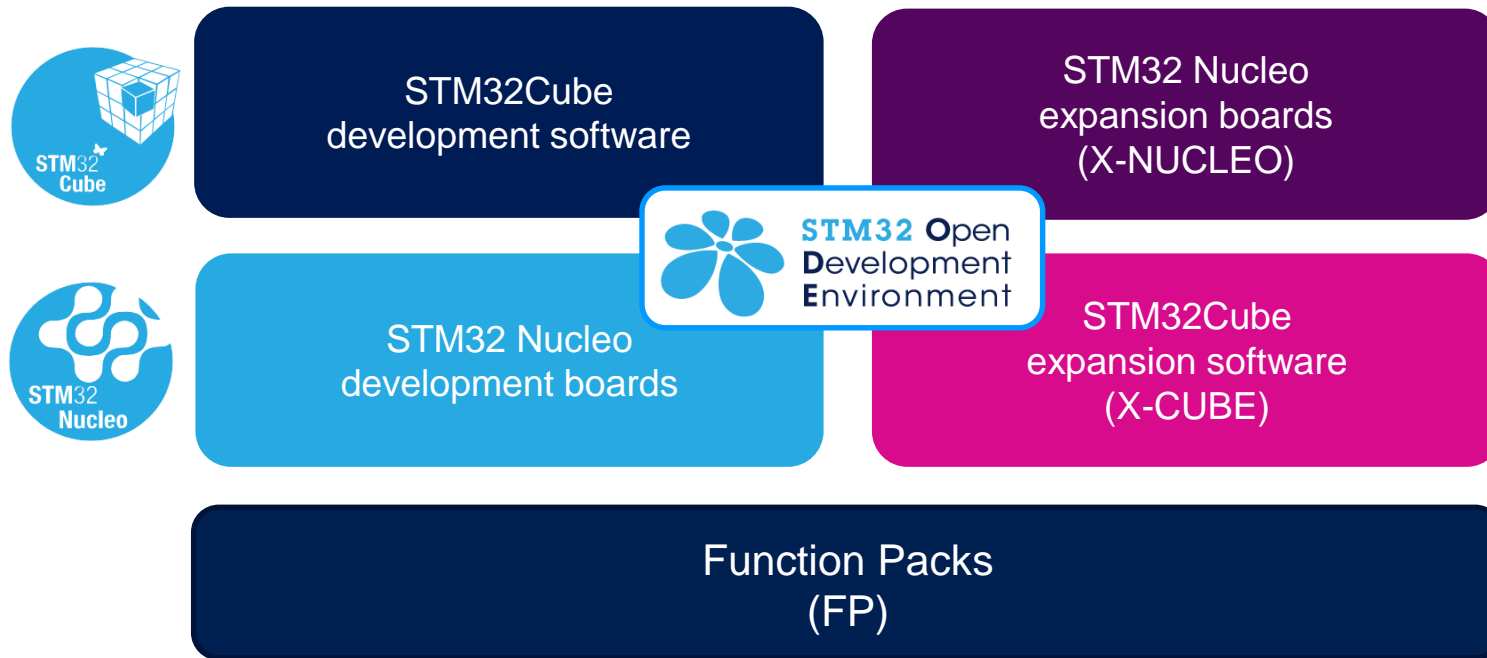
STM32 Nucleo
Development Boards (NUCLEO)

- A comprehensive range of affordable development boards for all the STM32 microcontroller series, with unlimited unified expansion capabilities and integrated debugger/programmer functionality.

Power supply through USB or external source

STM32 microcontroller

Integrated debugging and programming ST-LINK probe

Complete product range from ultra-low power to high-performance

ST morpho extension header

Arduino™ UNO R3 extension headers

www.st.com/stm32nucleo
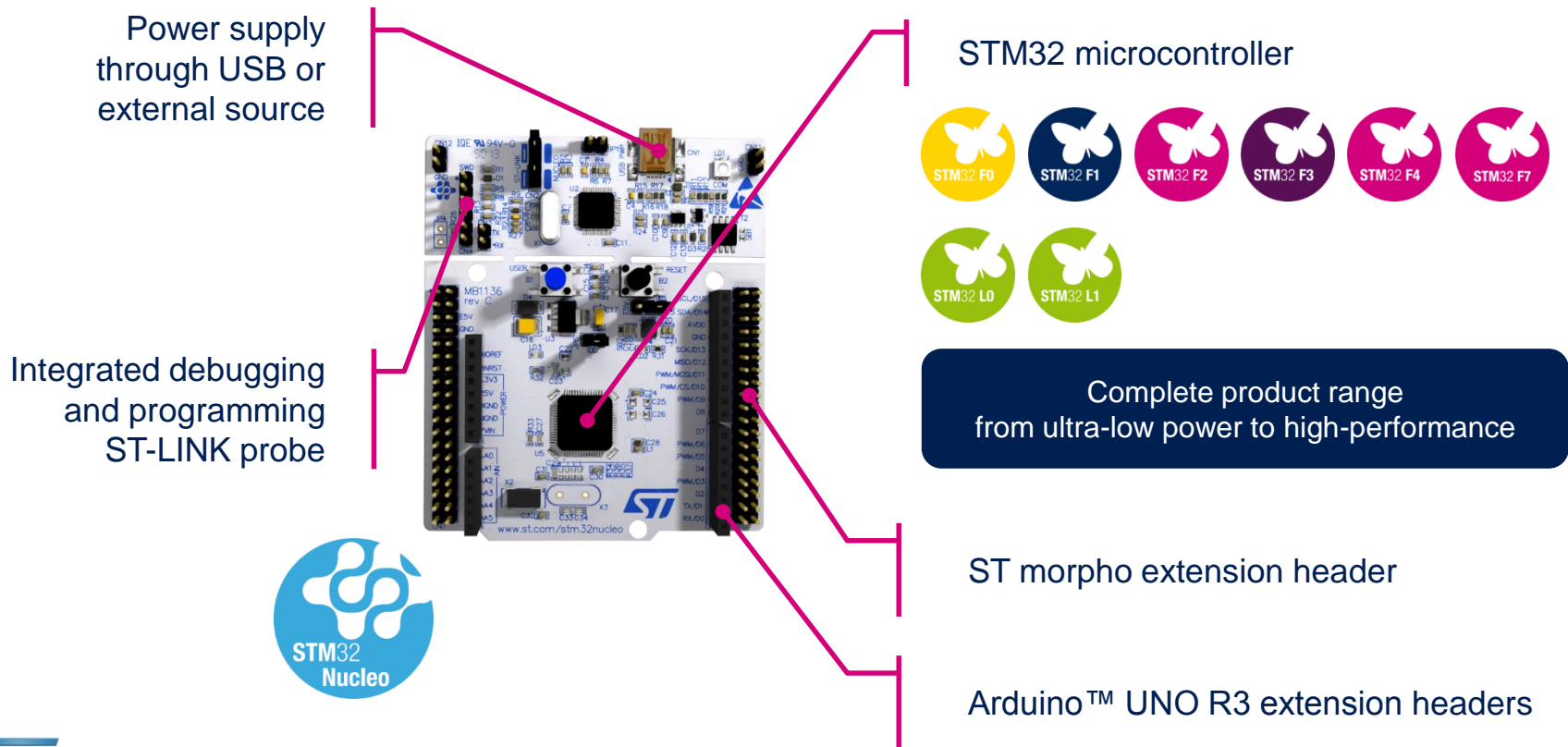
Expansion Boards (X-NUCLEO)

- Boards with additional functionality that can be plugged directly on top of the STM32 Nucleo development board directly or stacked on another expansion board.

Connect

Power

Move/Actuate

Interact

Sense

Motion MEMS sensors

Environmental sensors

DIL24 support for new devices

Example of STM32 expansion board (X-NUCLEO-IKS01A1)

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www.st.com/x-nucleo

STM32 Open Development Environment
Software components

- **STM32Cube software (CUBE)** - A set of free tools and embedded software bricks to enable fast and easy development on the STM32, including a Hardware Abstraction Layer and middleware bricks.

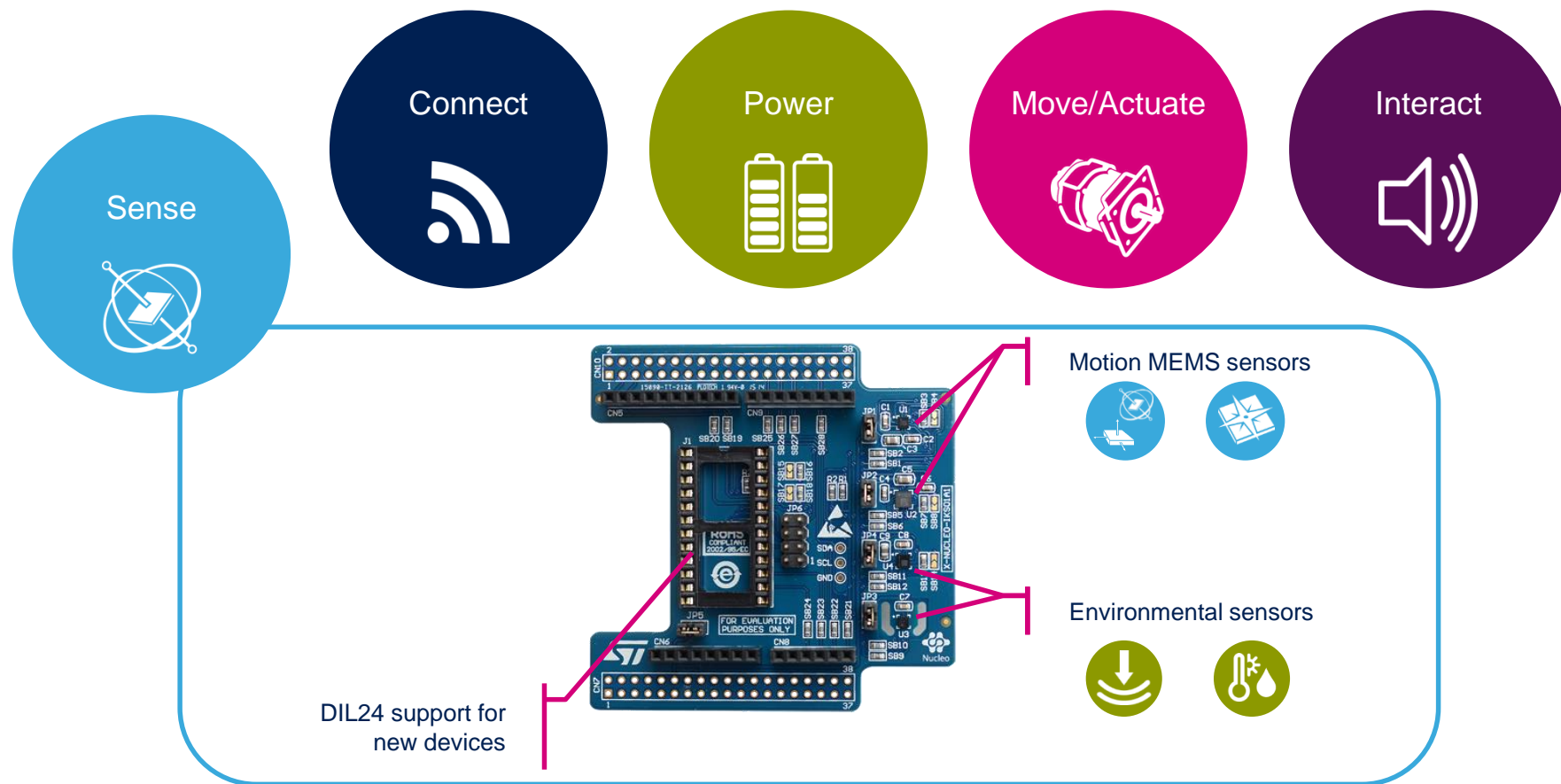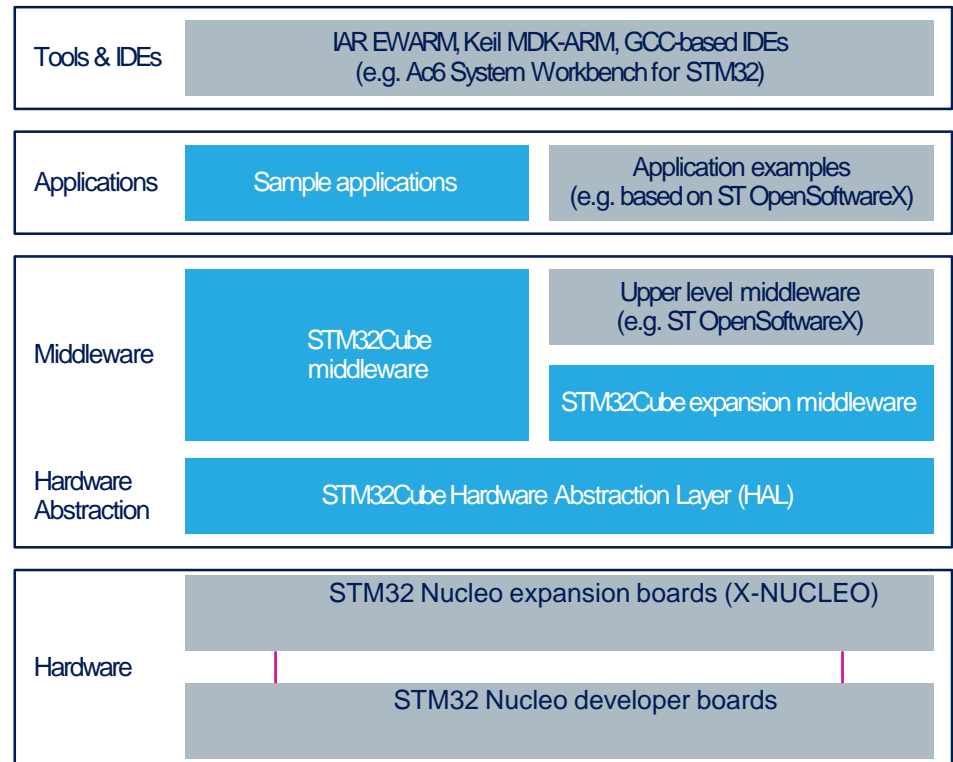- **STM32Cube expansion software (X-CUBE)** - Expansion software provided free for use with the STM32 Nucleo expansion board and fully compatible with the STM32Cube software framework. It provides abstracted access to expansion board functionality through high-level APIs and sample applications.

Tools & IDEs	IAR EWARM, Keil MDK-ARM, GCC-based IDEs (e.g. Ac6 System Workbench for STM32)	
Applications	Sample applications	Application examples (e.g. based on ST OpenSoftwareX)
Middleware	STM32Cube middleware	Upper level middleware (e.g. ST OpenSoftwareX)
		STM32Cube expansion middleware
Hardware Abstraction	STM32Cube Hardware Abstraction Layer (HAL)	
Hardware	STM32 Nucleo expansion boards (X-NUCLEO)	
	STM32 Nucleo developer boards	

- **Compatibility with multiple Development Environments -** The STM32 Open Development Environment is compatible with a number of IDEs including IAR EWARM, Keil MDK, and GCC-based environments. Users can choose from three IDEs from leading vendors, which are free of charge and deployed in close cooperation with ST. These include Eclipse-based IDEs such as Ac6 System Workbench for STM32 and the MDK-ARM environment.
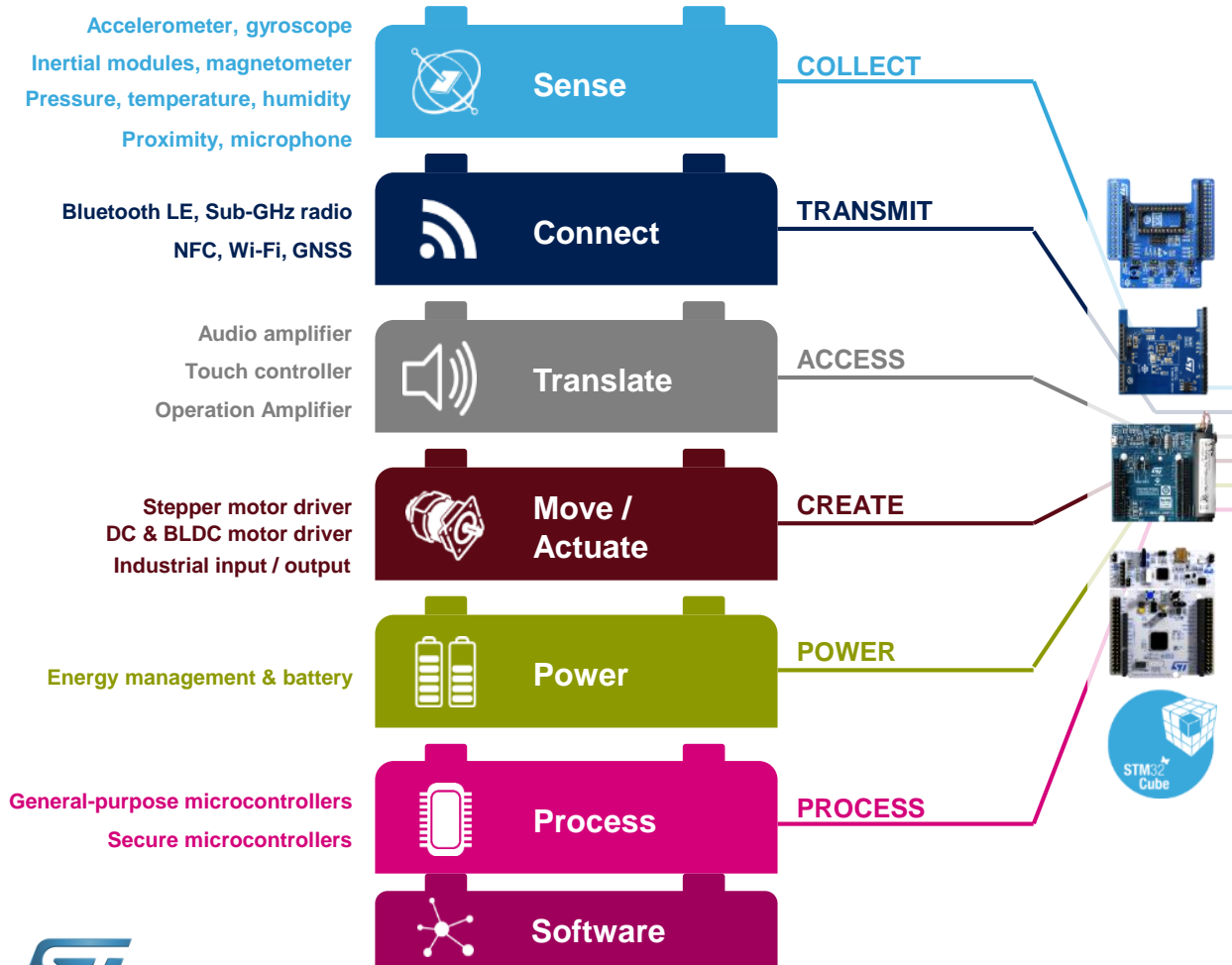
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STM32 Open Development Environment
Building block approach

The building blocks ▶ **Your need** ▶ **Our answer**

Accelerometer, gyroscope
Inertial modules, magnetometer
Pressure, temperature, humidity
Proximity, microphone

Sense — COLLECT

Bluetooth LE, Sub-GHz radio
NFC, Wi-Fi, GNSS

Connect — TRANSMIT

Audio amplifier
Touch controller
Operation Amplifier

Translate — ACCESS

Stepper motor driver
DC & BLDC motor driver
Industrial input / output

Move / Actuate — CREATE

Energy management & battery

Power — POWER

General-purpose microcontrollers
Secure microcontrollers

Process — PROCESS

Software

STM32 **O**pen **D**evelopment **E**nvironment

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