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Bluetooth® Low Energy Audio on STM32WBA MCUs for new listening experiences

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AURACAST™
A BLUETOOTH® TECHNOLOGY

Agenda

1 What is Bluetooth® LE Audio?

2 Advantages over classic audio

3 Architecture

4 ST and Bluetooth® LE Audio

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Evolution of Bluetooth® Audio

The Journey of Bluetooth® Audio from Classic to LE Audio

1 Initial Use Cases

- **Hands-free** calling, wireless **headsets**
- **A**dvanced **A**udio **Di**stribution **P**rofile (**A2DP**)
- Bluetooth Classic = **B**luetooth Basic **R**ate / **E**nhanced **D**ata **R**ate (**BR/EDR**)

2 New Use Cases

- Rise of **TWS** and **Hearables** : introduction of **T**rue-**W**ireless **S**tereo **earbuds** and **hearables**, shipping over 200 million units in 2021
- **Hearing Aids** and **Power Constraints**

3 LE Audio

- Overcoming Classic Limitations : addressing issues of **audio quality**, **power consumption**, and **connection limitations**
- Ensuring **compatibility** across brands
- **Auracast™** Broadcast Audio

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What is Bluetooth® LE Audio?

Discovering new user experiences

Hight quality audio with **low power**

Introduced in **2020** as part of Bluetooth® Core Specification **version 5.2**

Audio sharing (Auracast™) **:** location-based broadcast listening experience

Multi-stream service : high quality music and voice-chat simultaneously

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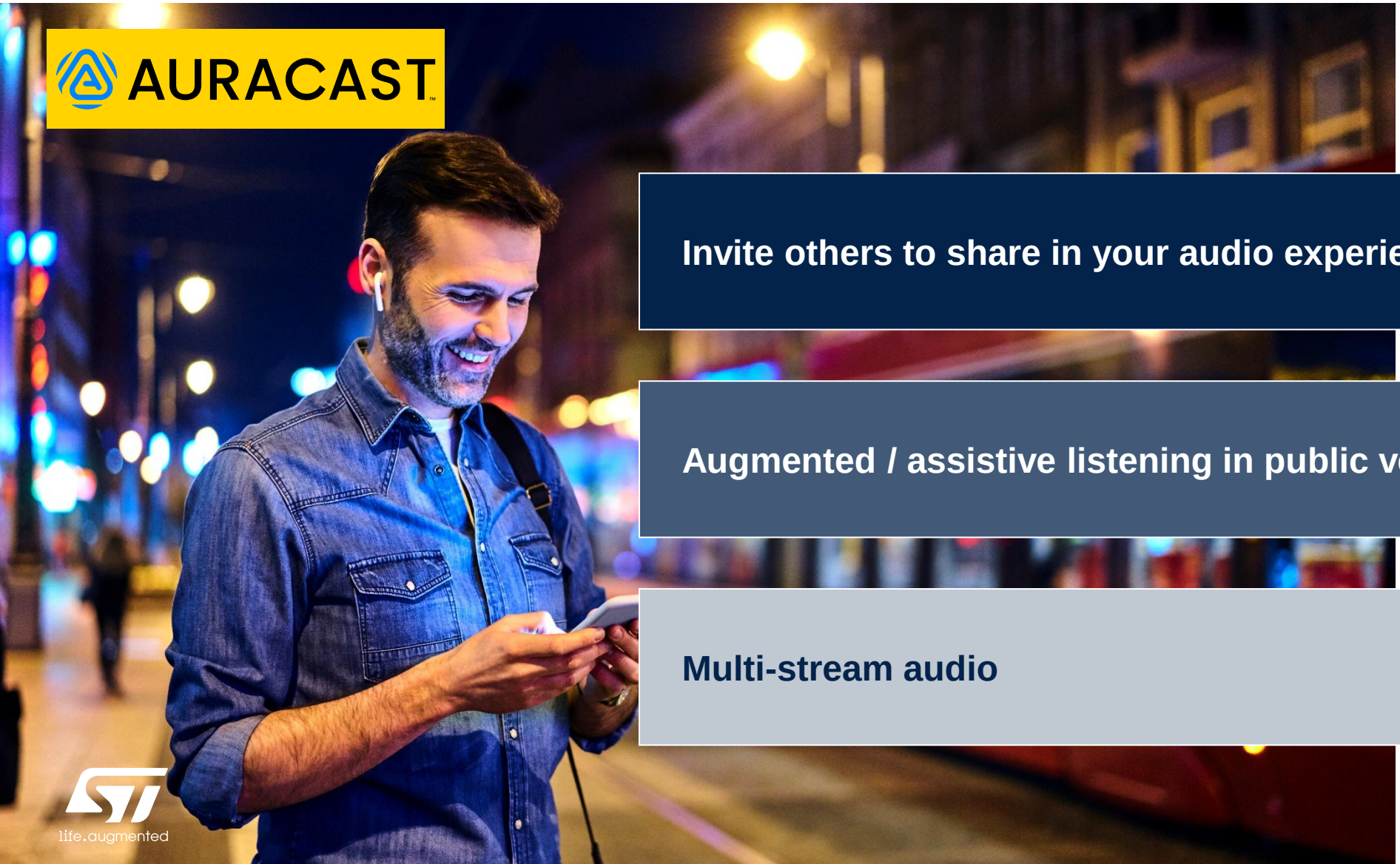
New audio experiences with Auracast™



Invite others to share in your audio experience

Augmented / assistive listening in public venues

Multi-stream audio

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Unmute your world

Silent televisions in public spaces

Multi-language support

Tour systems at museums, convention centers etc

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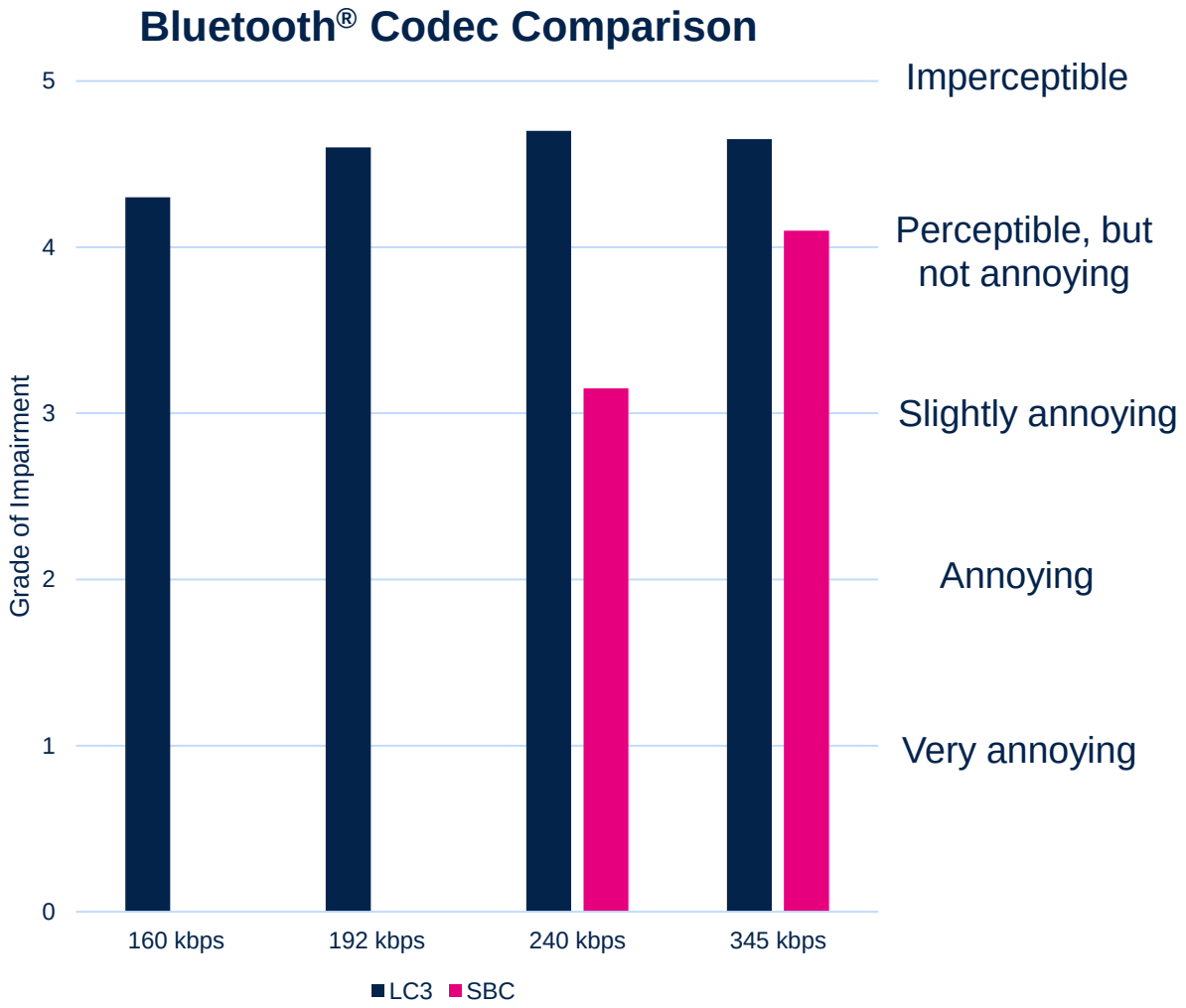
Multi-stream audio

- **True wireless earbuds**
- **Multiple sink devices**
- **Multiple audio source devices**

LC3 Codec

- Bluetooth® LE audio based on **LC3** : **L**ow **C**omplexity **C**ommunication **C**odec
- **Mandatory and free to use** : interoperability, not depending on vendor specific codecs
- **High Quality:** better than classic Bluetooth® audio codec
- **Designed for embedded products** : low complexity and low memory footprint
- **Channel independent** : mono or stereo streams
- Suitable for both **music** and **voice**
- **Compatible with mobile codec** (reduces audio losses)
- **Low latency**



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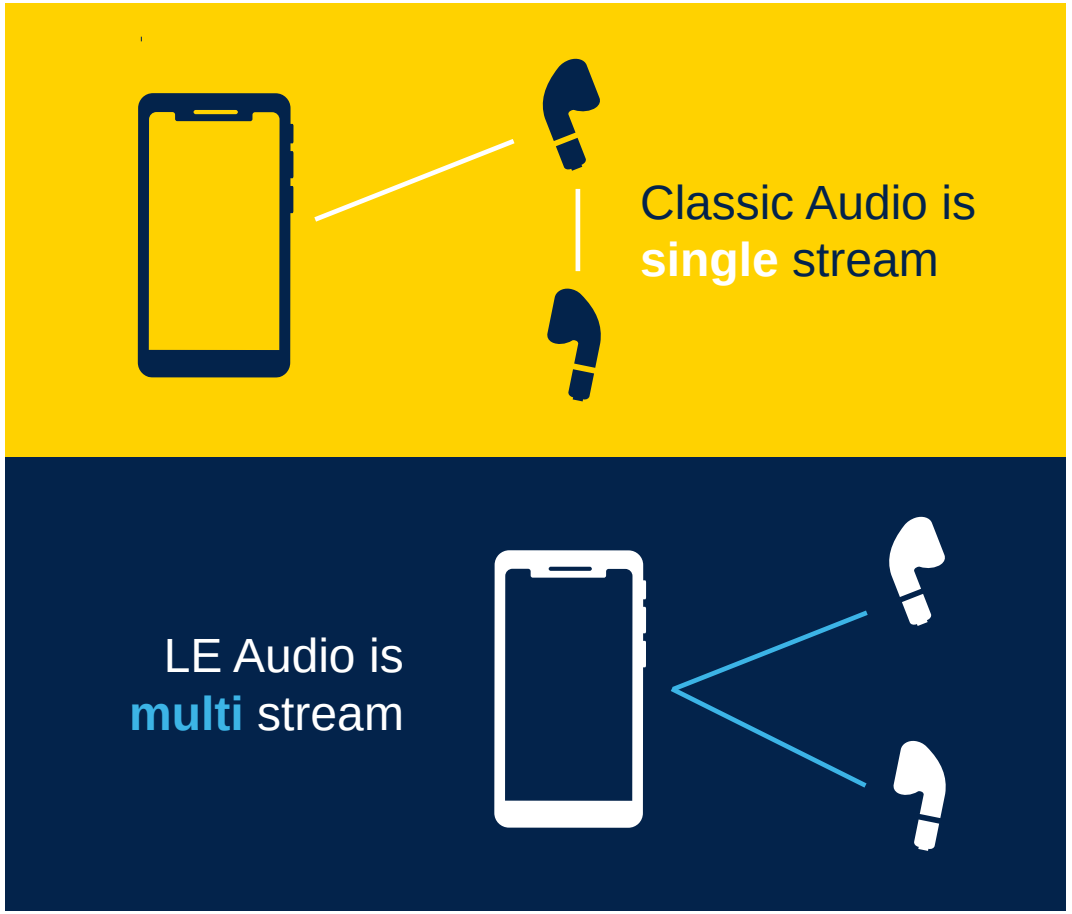
LE Isochronous Channels for Audio



- Bluetooth® 5.2 Feature
- Used to transport audio :
  - Data is synchronized with time and has a time-sensitive validity.
  - Allow retransmission to avoid data miss.
- Support multiple connected stream
- Support connectionless stream (broadcast)

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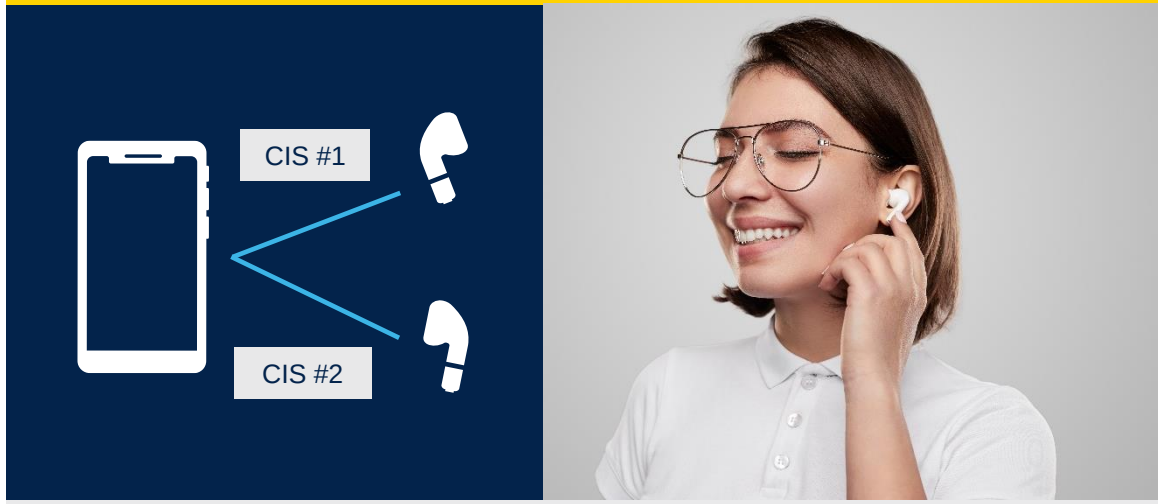
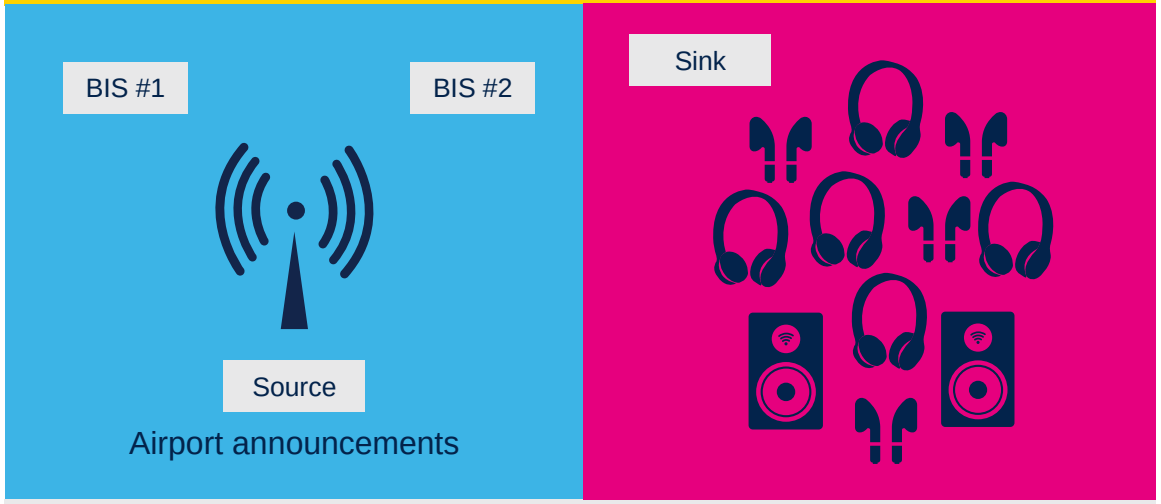
LE Isochronous Channels

Connected **I**sochronous **S**tream



- Each stream can be bidirectional
- Application example : **true wireless stereo**

Broadcast **I**sochronous **S**tream



- Allow unlimited number of audio sink devices
- Encryption can be used
- Application example : **multi language streams** (airport, conference, theaters, …)

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STM32 MCU 2.4 GHz Current portfolio

STM32WB series

- **Dual core** & security (Arm® Cortex® -M4 / -M0+)
- Up to **1 Mbyte** of flash memory / **256 Kbytes** of RAM

MCUs: STM32WB55, STM32WB35, STM32WB15, STM32WB50, STM32WB30, STM32WB10

Modules: STM32WB5M, STM32WB1M

5.4 & mesh

matter

STM32WBA series

STM32WBA54/55

STM32WBA52

5.4

matter*

AURACAST

- Arm® Cortex® -M33/TrustZone® 100 MHz
- **1 Mbyte of** flash memory / **128 Kbytes** of RAM
- Up to **+10 dBm** output power
- *Matter Thread RCP mode only
- Bluetooth® Low Energy 5.4 (long range, **AoA/AoD, isochronous channel**)

BlueNRG series

MCU's: BlueNRG-1, BlueNRG-2/2N

Module: BlueNRG-M2SP/SA

5.2,5.3 & mesh

- Arm® Cortex® -M0/M0+
- Up to **256 Kbytes** of flash memory / **64 Kbytes** of RAM

STM32WB0x series

STM32WB09

STM32WB06/07

STM32WB05/05N

5.4

- Arm® Cortex® -M0+ at 64 MHz
- **512 Kbytes** of flash memory / **64 Kbytes** of RAM
- Bluetooth® Low Energy 5.4 (long range, 2 Mbps, advertising ext, **AoA/AoD, isochronous channel, Periodic Adv w/Response, Encrypt Adv**)
- Up to **+8 dBm** of output power

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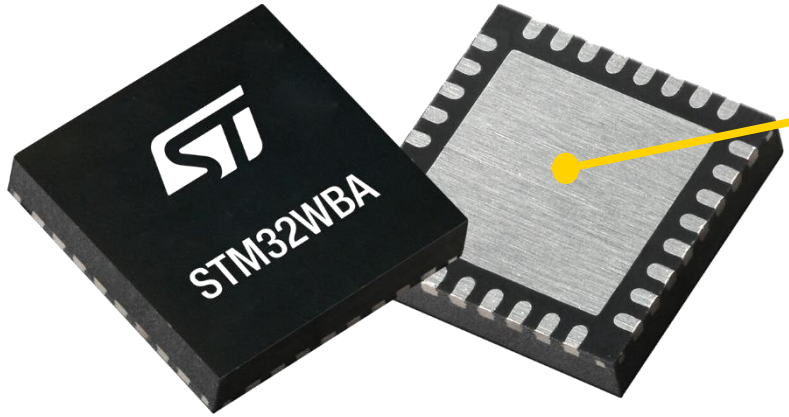
STM32WBA series enables faster time to market and higher wireless performance

matter



Built using **40 nm process technology**

SESIP™

Enhanced wireless performance for a greater user experience

- Arm® Cortex®-M33 at 100MHz. CoreMark score at 407.
- Multiprotocol support: Bluetooth® Low Energy 5.4, Zigbee, OpenThread, Matter
- +10 dBm output power with low power consumption
- Ultra-low-power radio performance (only 30 µA/MHz when running at 100MHz)
- Switched-mode power supplies (SMPS) for low power applications

Reliable and compliant with the latest regulations

- SESIP Level 3 target certification: compliance with the US Cyber Trust Mark and the EU Radio Equipment Directive (RED) regulations due to become mandatory in 2025
- 10-year rolling longevity commitment for continuous supply

Simpler and faster development thanks to proven STM32 ecosystem

- Rich ecosystem offering hardware, embedded software & tools, documentation

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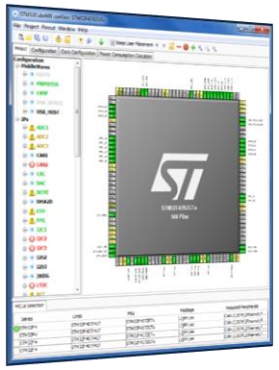
STM32WBA ecosystem simplifies your design journey

STM32WBA



STM32 Cube

Hardware

Nucleo board & discovery kit

Software

STM32CubeWBA
(connectivity + examples + peripherals)
STM32CubeMX
(code generation + power calculation)
STM32CubeMonRF
STM32CubeProg

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Discovery Kit

Jack Input/Output

New concept: daughter boards hosting the **STM32WBA55**

USB C

LCD

Joystick

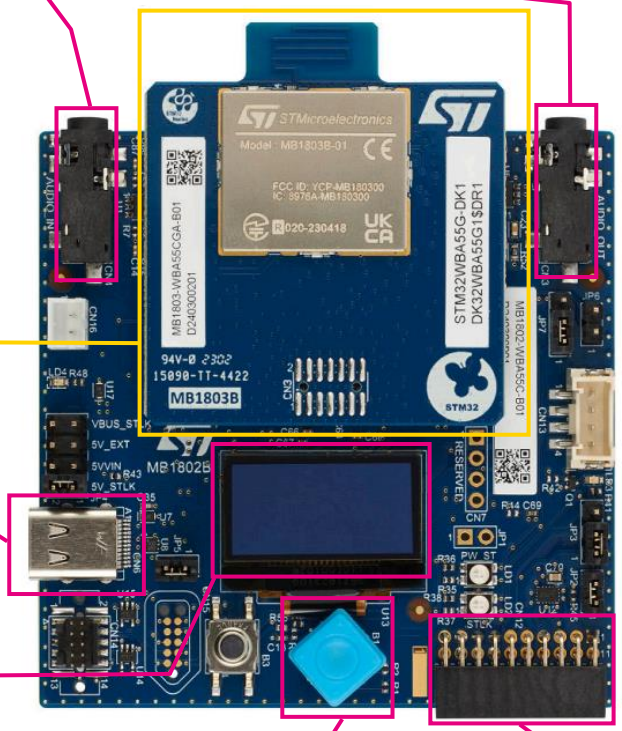
Stereo codec with headphone amplifier

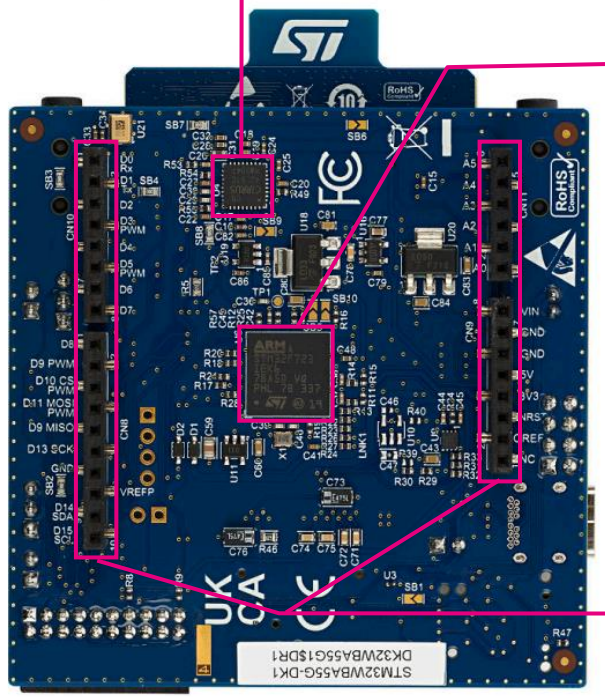
ST link

RF certified

Arduino Connector

STMod+ Connector





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Bluetooth® LE Audio stack

Use Case Profile management

- **T**elephony & **M**edia **A**udio
- **H**earing **A**ccess
- **P**ublic **B**roadcast
- **G**a**M**ing **A**udio

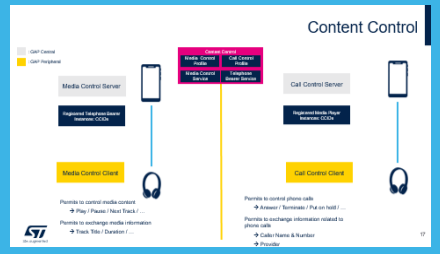
Common Audio Profile

- **M**edia **C**ontrol
- **C**all **C**ontrol
- **B**asic **A**udio
- **C**oordinated **S**et **I**dentification
- **MI**crophone **C**ontrol
- **V**olume **C**ontrol

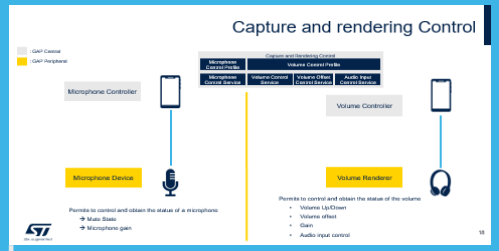
Use Case Profiles

TMAP
TMAS
HAP
HAS
PBP
GMAP

Generic Audio Framework



Starting, updating, and stopping unicast and broadcast Audio Streams



Control of audio input and volume.

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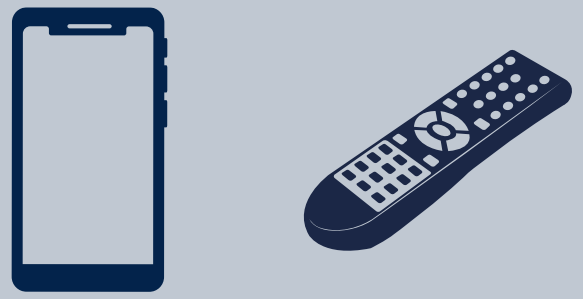
Common Audio Profile - Roles

Initiator	Acceptor	Commander
		
Transmit/Receive Audio Stream	Receive/Transmit Audio Stream Receive request from commander	Scan, start and end Broadcast Audio Stream on behalf of Acceptor

Content Control

: GAP Central

: GAP Peripheral

Media Control Server

Registered Telephone Bearer Instances: CCIDs

Media Control Client

Permits to control media content

→ Play / Pause / Next Track / …

Permits to exchange media information

→ Track Title / Duration / …

Content Control

Media Control Profile

Call Control Profile

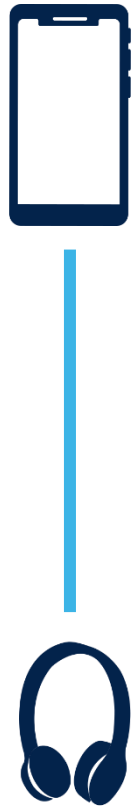
Media Control Service

Telephone Bearer Service

Call Control Server

Registered Media Player Instances: CCIDs

Call Control Client



Permits to control phone calls

→ Answer / Terminate / Put on hold / …

Permits to exchange information related to phone calls

→ Caller Name & Number

→ Provider

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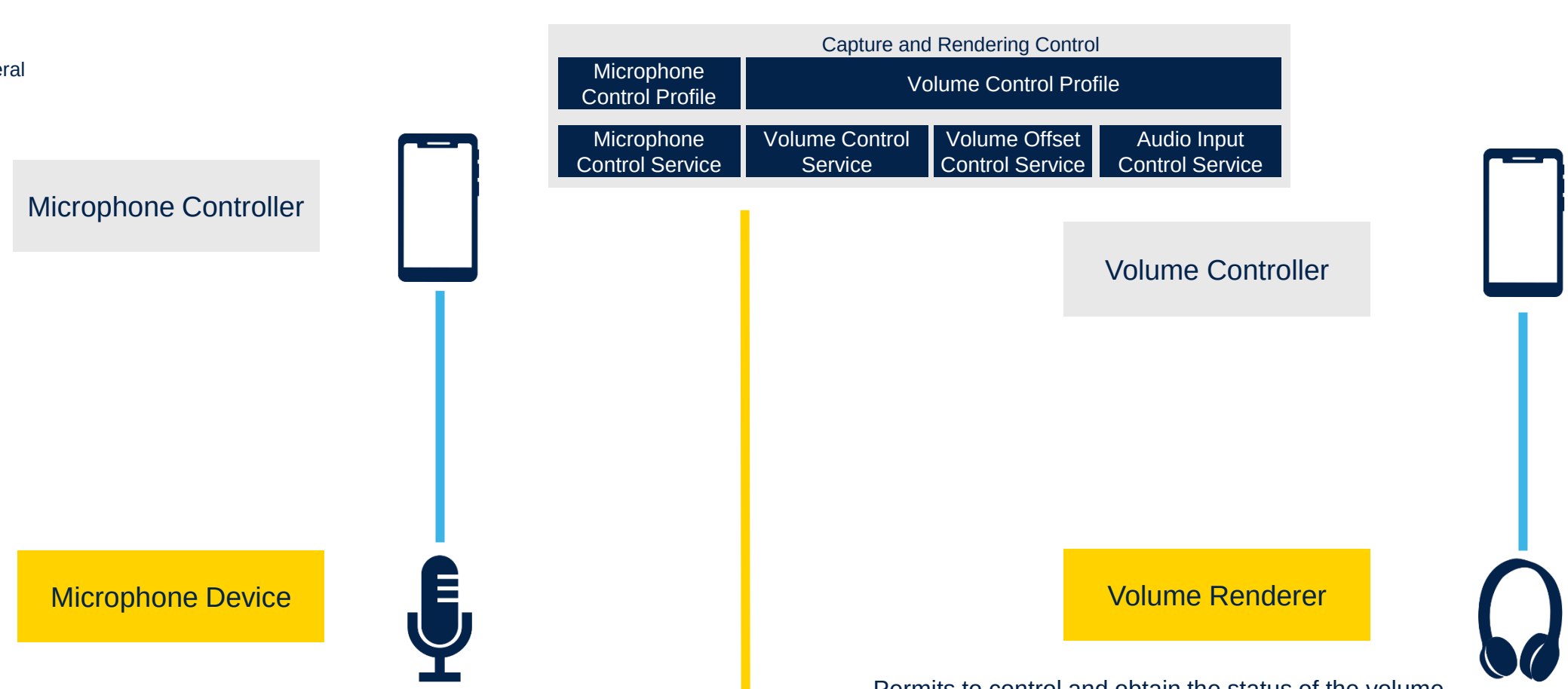
Capture and rendering Control

: GAP Central

: GAP Peripheral



Permits to control and obtain the status of a microphone

- → Mute State
- → Microphone gain

Permits to control and obtain the status of the volume

- Volume Up/Down
- Volume offset
- Gain
- Audio input control

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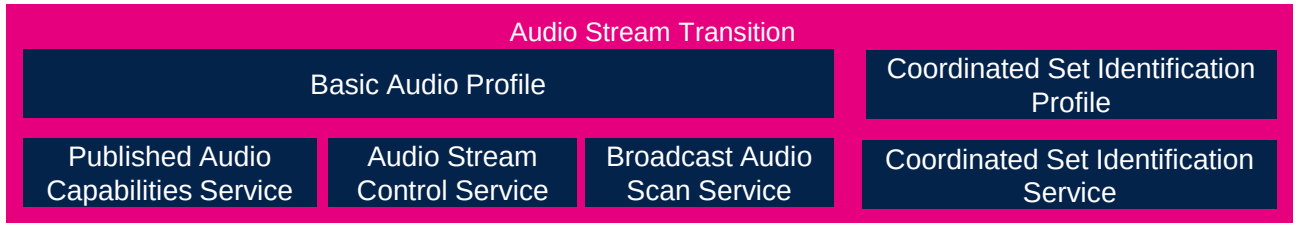
: GAP Central

: GAP Peripheral

: GAP Observer

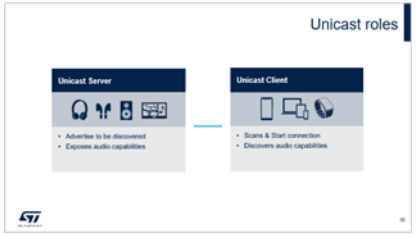
: GAP Broadcaster

Audio Stream Management

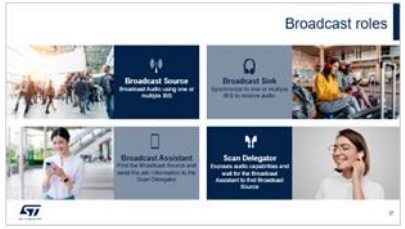


- Defines the capabilities of the devices :
  - Codec
  - Audio location & contexts
- Store the Audio configuration for each devices :
  - Max latency
  - PHY
  - Coding format
  - Retransmission number
- Defines 6 roles divided in two sections :

Unicast



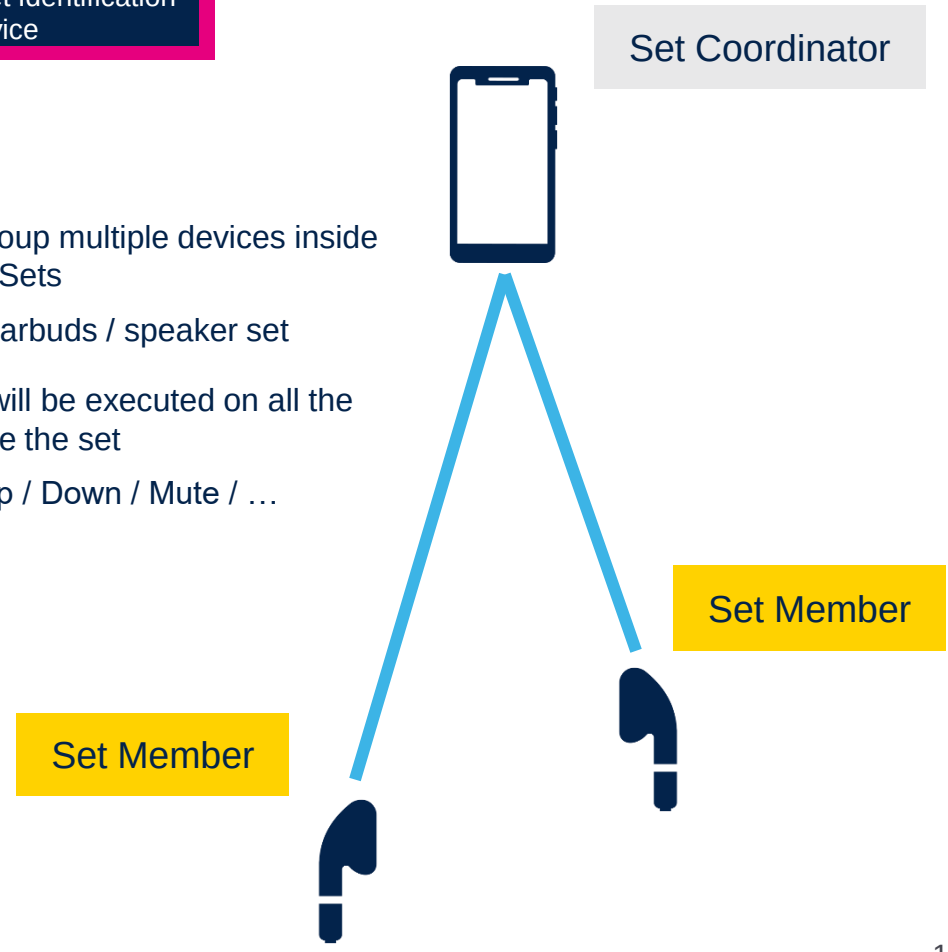
Broadcast



- Permits to group multiple devices inside Coordinated Sets

  → A pair of earbuds / speaker set
- Procedures will be executed on all the devices inside the set

  → Volume Up / Down / Mute / …



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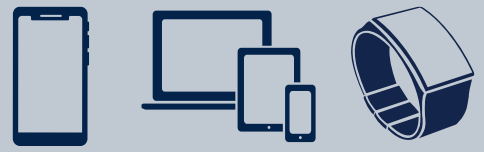
Unicast roles

Unicast Server

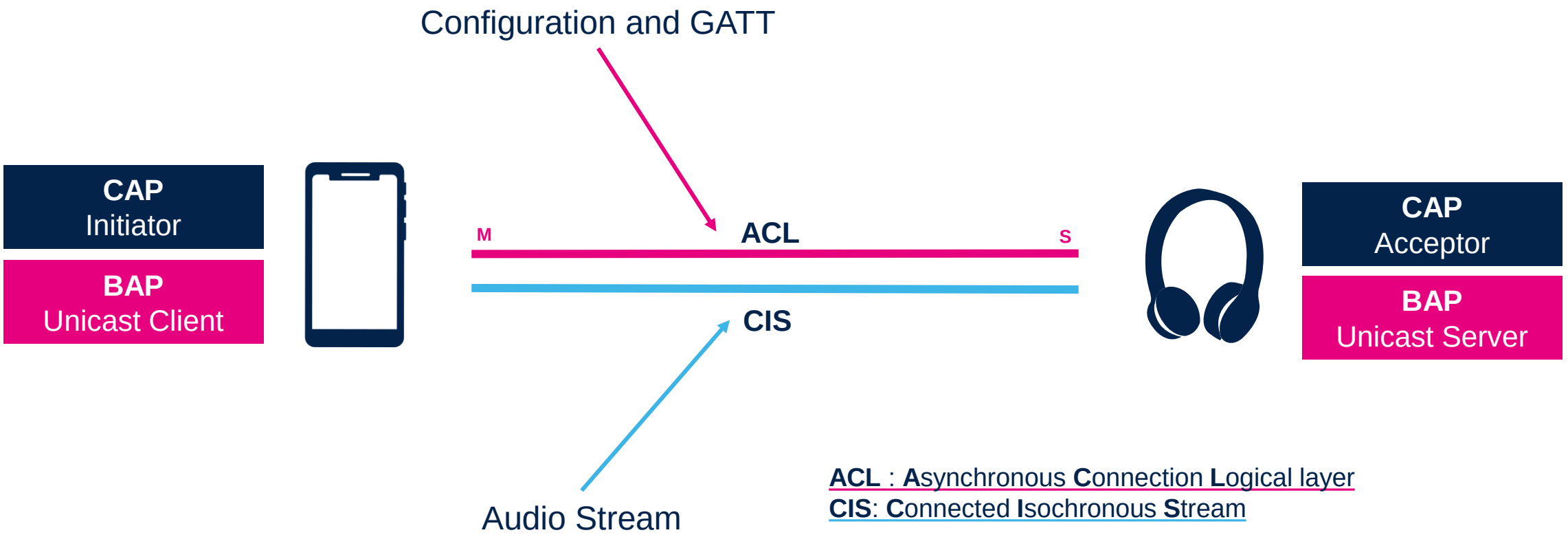
- Advertise to be discovered
- Exposes audio capabilities

Unicast Client



- Scans & Start connection
- Discovers audio capabilities

Example of Unicast use-case



ACL : **A**synchronous **C**onnection **L**ogical layer
CIS: **C**onnected **I**sochronous **S**tream

Broadcast roles

Broadcast Source

Broadcast Audio using one or multiple BIS

Broadcast Sink

Synchronize to one or multiple BIS to receive audio

Broadcast Assistant

Find the Broadcast Source and send the adv information to the Scan Delegator

Scan Delegator

Exposes audio capabilities and wait for the Broadcast Assistant to find Broadcast Source

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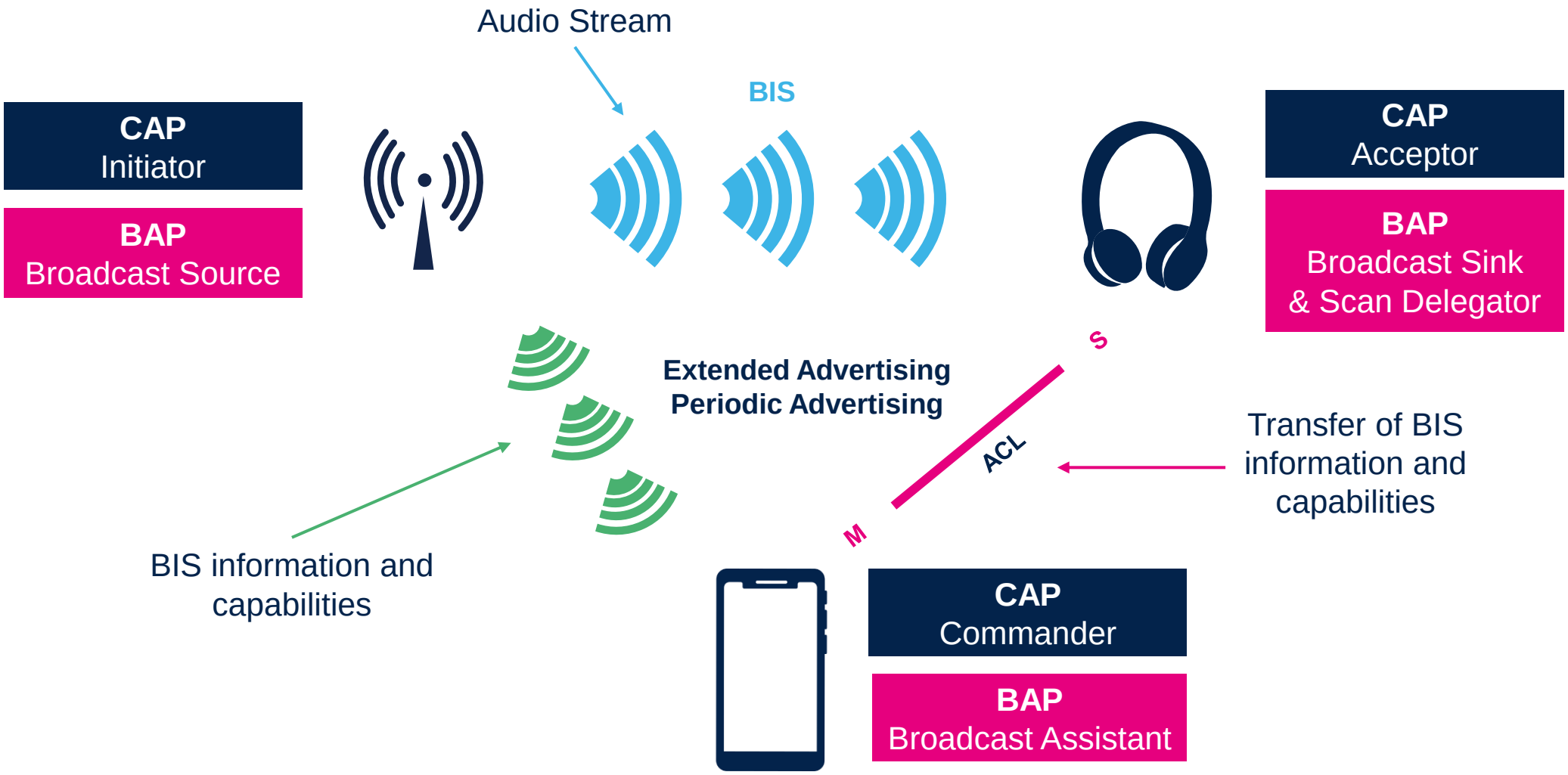
Example of Broadcast Use Case



Common Audio Profile - Roles

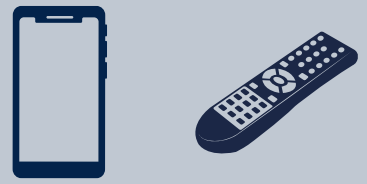
Initiator

- **BAP** Broadcast Source
- **BAP** Unicast Client
- **CCP** Call Control Server
- **MCP** Media Control Server

Acceptor

- **BAP** Broadcast Sink
- **BAP** Unicast Server
- **BAP** Scan Delegator
- **CCP** Call Control Client
- **MICP** Micro-phone Device
- **MCP** Media Control Client
- **VCP** Volume Renderer
- **CSIP** Set Member

Commander



- **BAP** Broadcast Assistant
- **MICP** Micro-phone Controller
- **VCP** Volume Controller
- **CSIP** Set Coordinator

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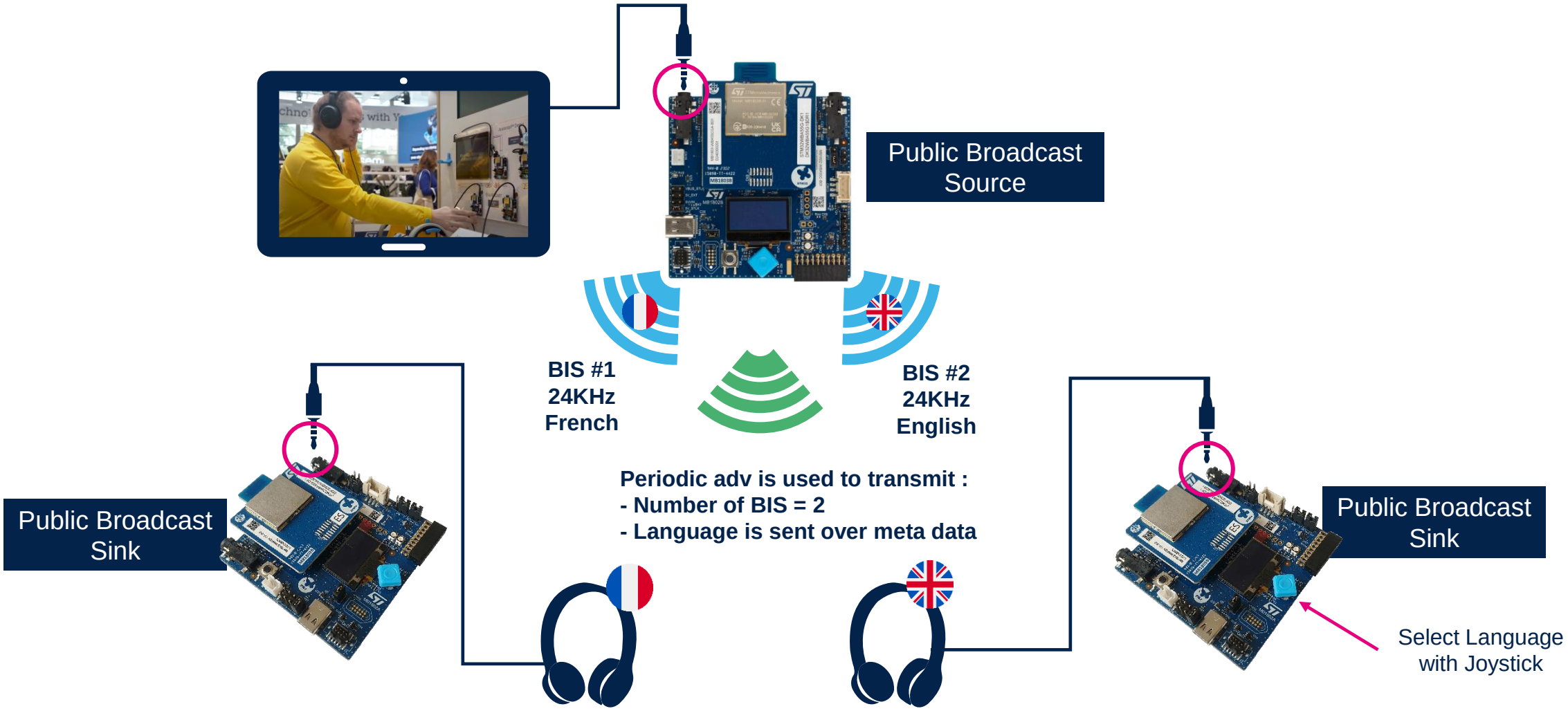
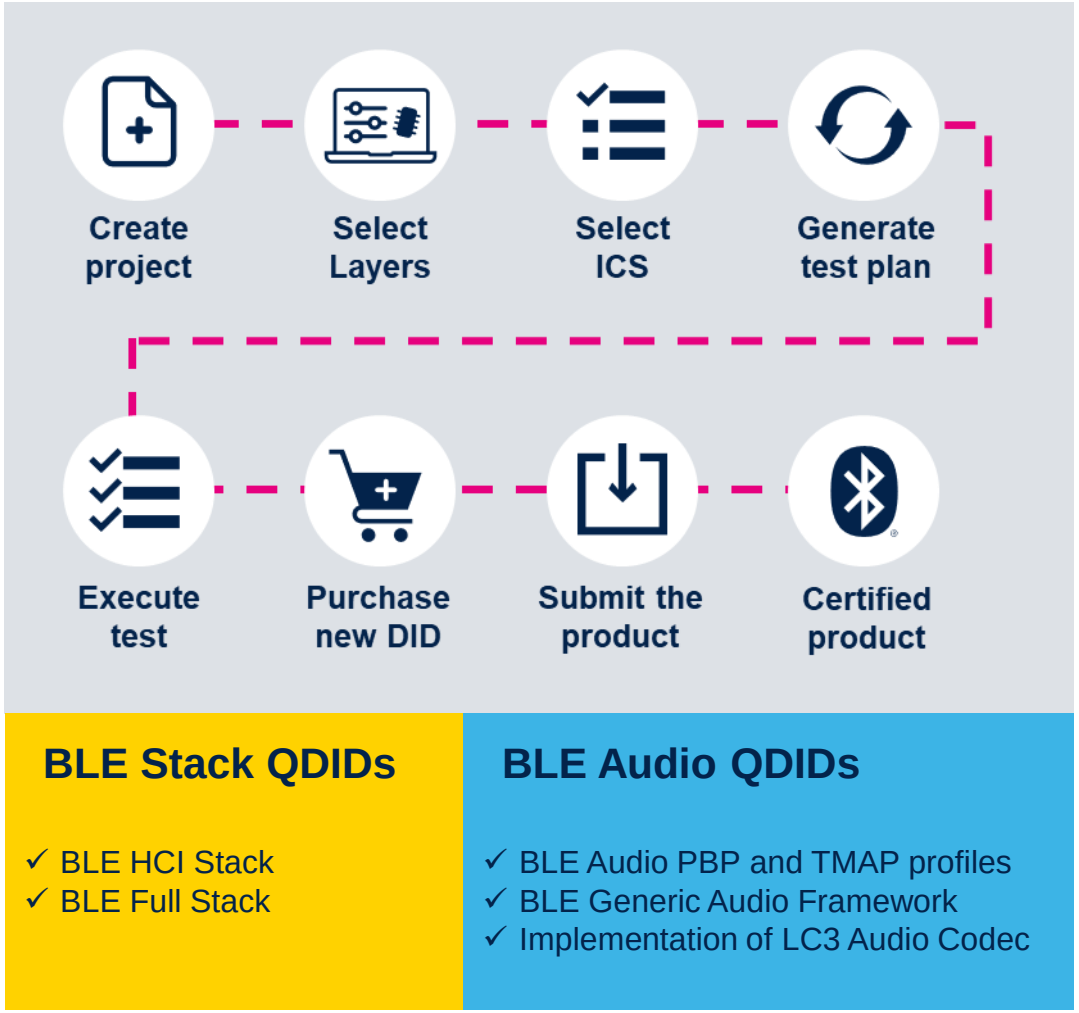
Public Broadcast Profile use case



Bluetooth® LE Audio Qualification Process



- **ALL** Bluetooth® products must be qualified
- Two paths : **with** or **without testing**
- Product **qualified with testing** receives a Declaration ID (**DID**) and a list of referenced Qualification Device ID (**QDID**)
- **STM32WBA** Series already qualified : QDIDs for **BLE 5.4 full stack** and for **BLE Audio** framework
- **Pre-qualified** design allows you to **speed up** your product's qualification process by **omitting a testing phase**.
- **Lower** development **cost** and a **shorter** time-to-market

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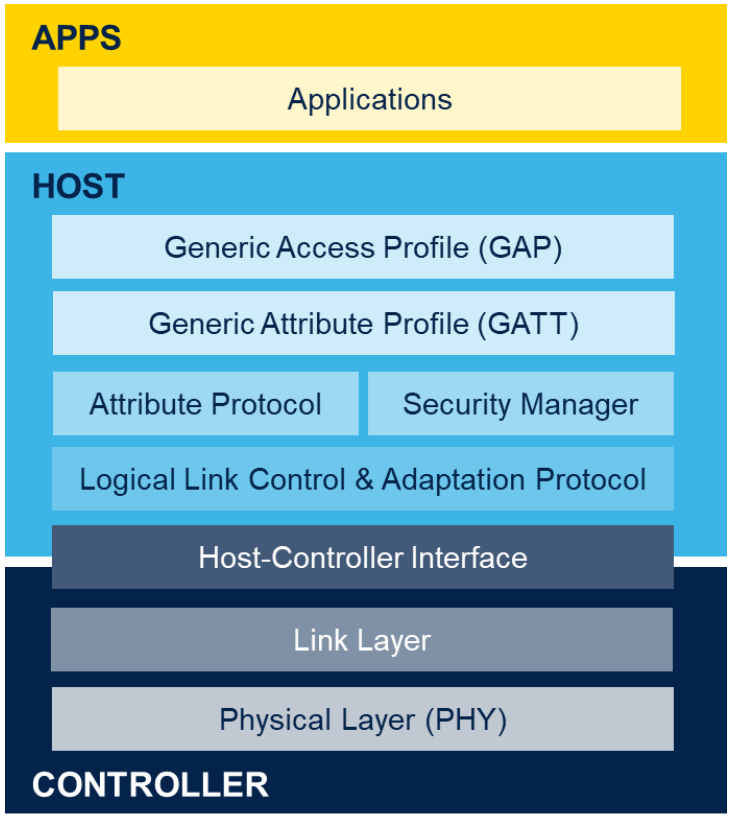
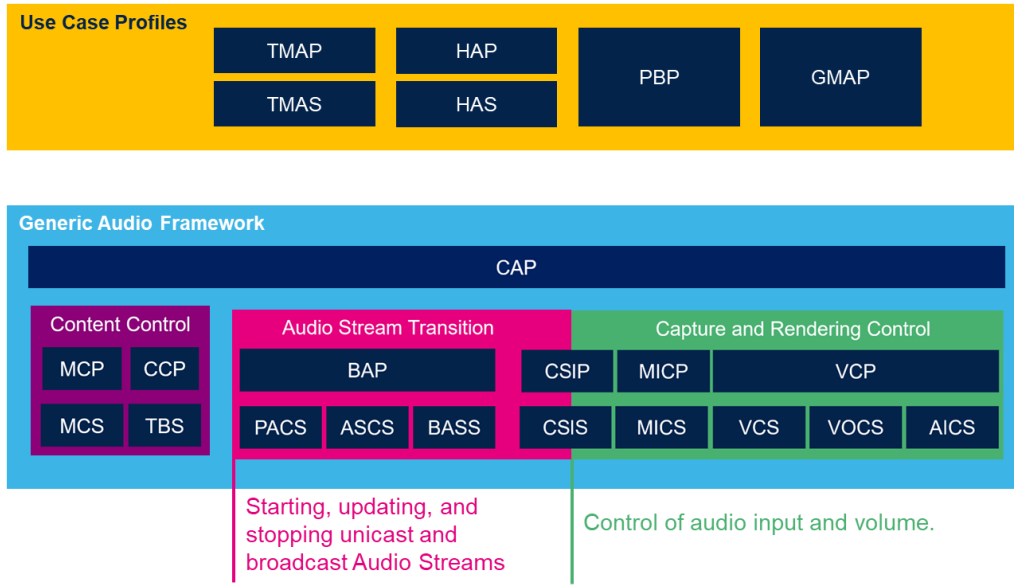
Bluetooth® LE Audio qualification process



BLE Stack



BLE Audio framework

✓ **Already qualified !**

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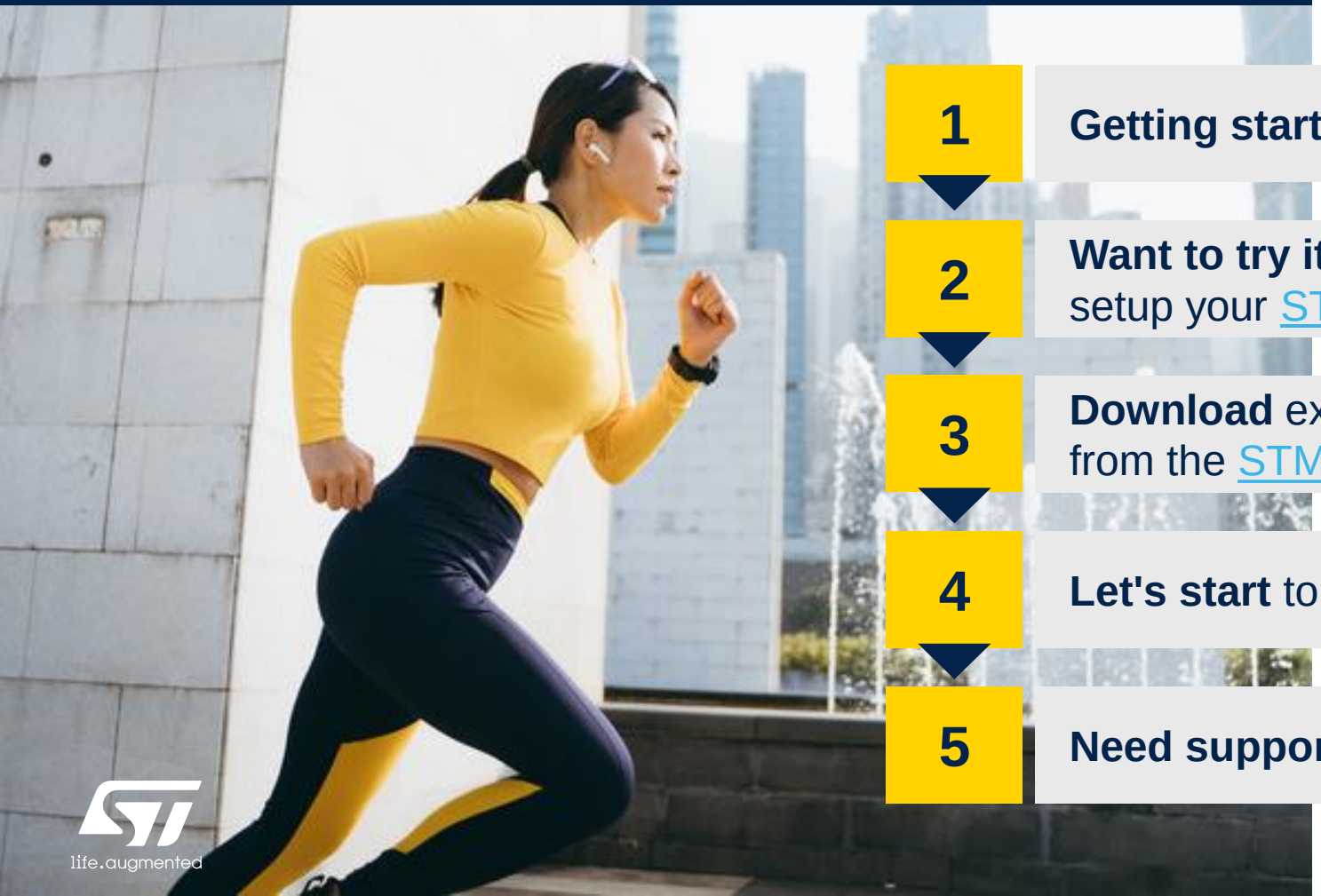
Start developing now !

STM32 ecosystem supporting Bluetooth® LE Audio



1. **Getting started !** Go to the Bluetooth ® LE Audio Wiki page
2. **Want to try it ?** Get your board, and learn how to quickly setup your STM32WBA
3. **Download** examples from STM32CubeWBA packages or from the STM32 Hotspot GitHub
4. **Let's start** to play with one of BLE Audio projects
5. **Need support ?** You are not alone ! Join ST Community

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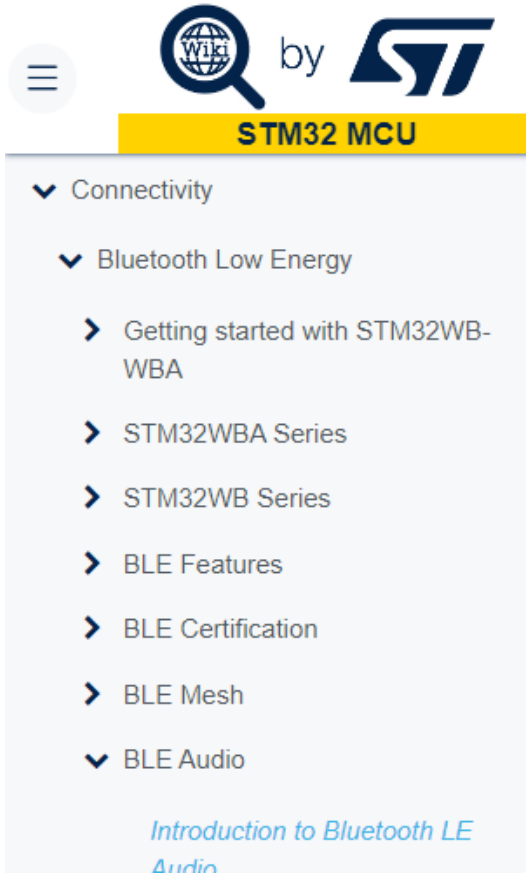
STM32 Wiki Page



1 **Getting started !** Go to the [Bluetooth ® LE Audio Wiki]page

BLE Audio

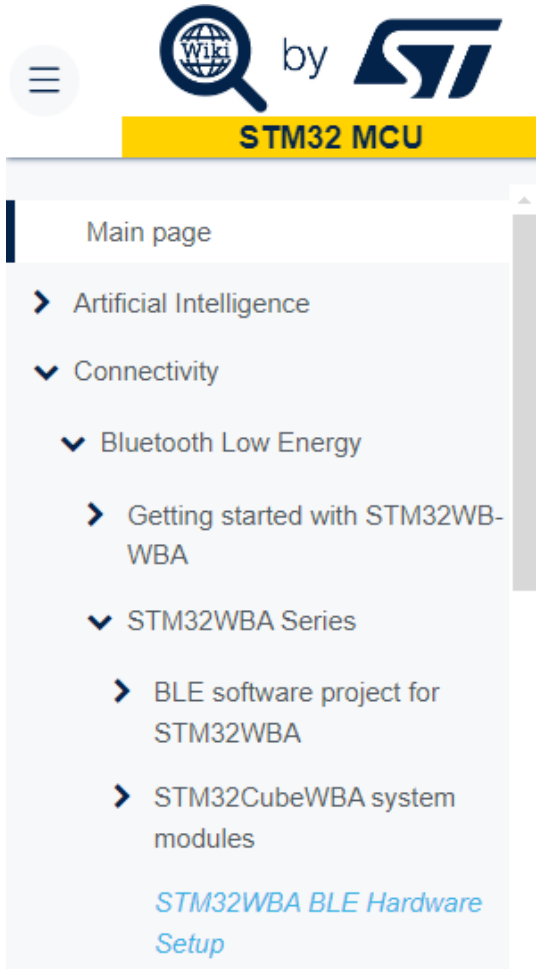
In this category you can find all articles related to STM32 Bluetooth® LE audio features.

Pages in category "BLE Audio"↑

The following 5 pages are in this category, out of 5 total.

- Connectivity:Introduction to Bluetooth LE Audio
- Connectivity:Bluetooth LE Audio - STM32WBA LC3 Codec
- Connectivity:Bluetooth LE Audio - STM32WBA Telephony & Media Audio Profile
- Connectivity:Bluetooth LE Audio - STM32WBA Public Broadcast Profile
- Connectivity:Bluetooth LE Audio - STM32WBA Architecture and Integration

STM32WBA Setup



2 **Want to try it ?** Get your board, and learn how to quickly setup your STM32WBA

STM32WBA Bluetooth® LE hardware setup

Click here for Bluetooth® LE overview.

Contents [hide]

1 STM32WBA boards
- 1.1 NUCLEO-WBA55CG board
- 1.2 STM32WBA55G-DK1 board

2 Hardware platform configuration
- 2.1 Debug log via UART interface
- 2.2 How to connect external debuggers
  - 2.2.1 Setup using ST-LINK
  - 2.2.2 Setup using J-LINK

3 Going further

4 References

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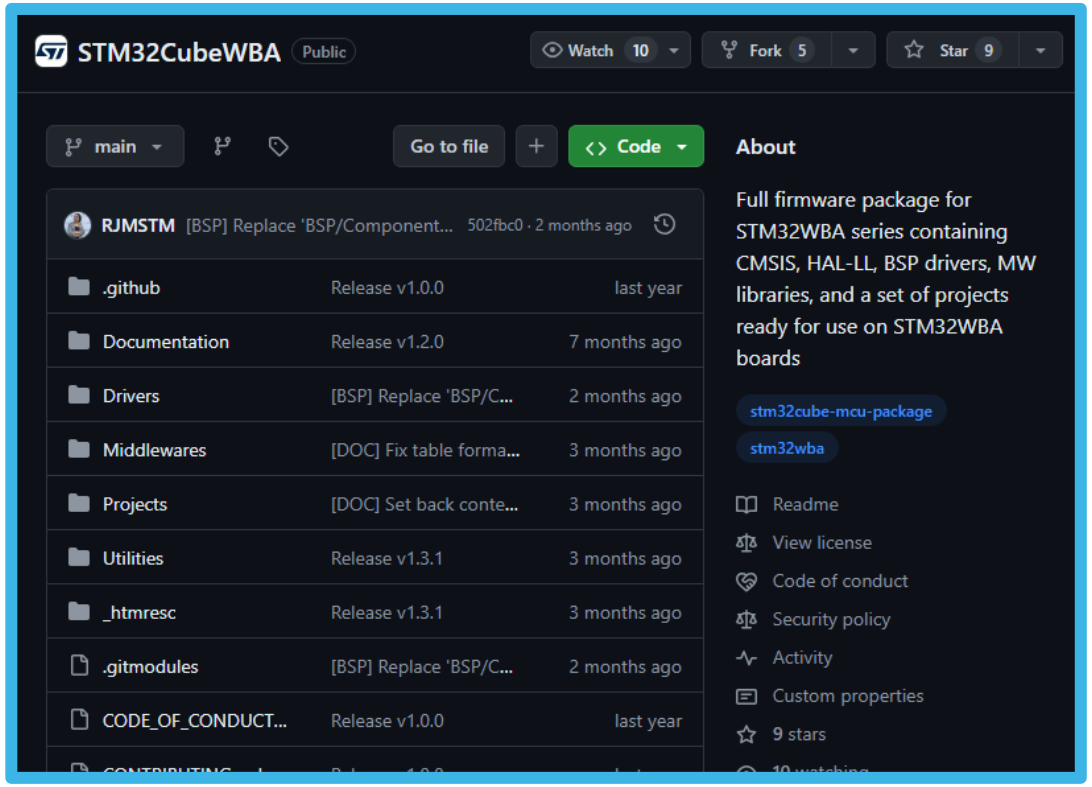
STM32CubeWBA Firmware

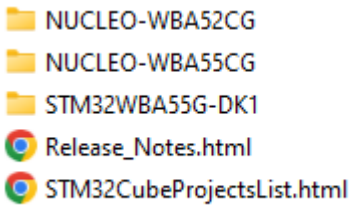
3 **Download** examples from STM32CubeWBA packages or from the STM32 Hotspot GitHub



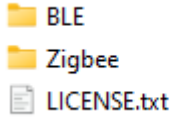
STM32CubeWBA Firmware

4 **Let's start** to play with one of BLE Audio projects

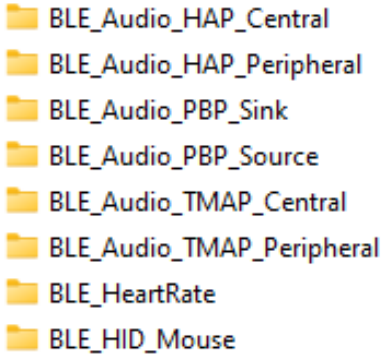
Select the Appropriate Board/Device



Select the Technology Application



Numerous CubeWBA BLE Audio projects



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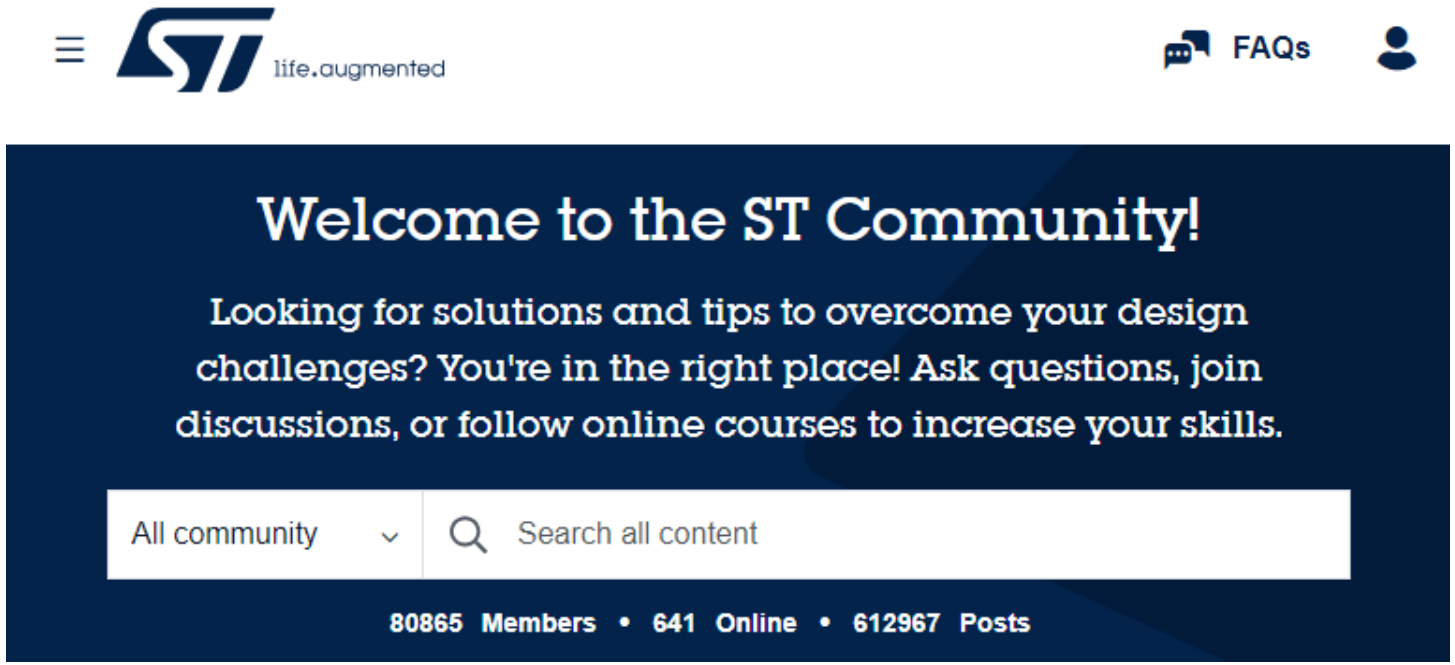
Online Support and ST Community

5 **Need support ?** You are not alone ! Join [ST Community]



Auracast™ demo video

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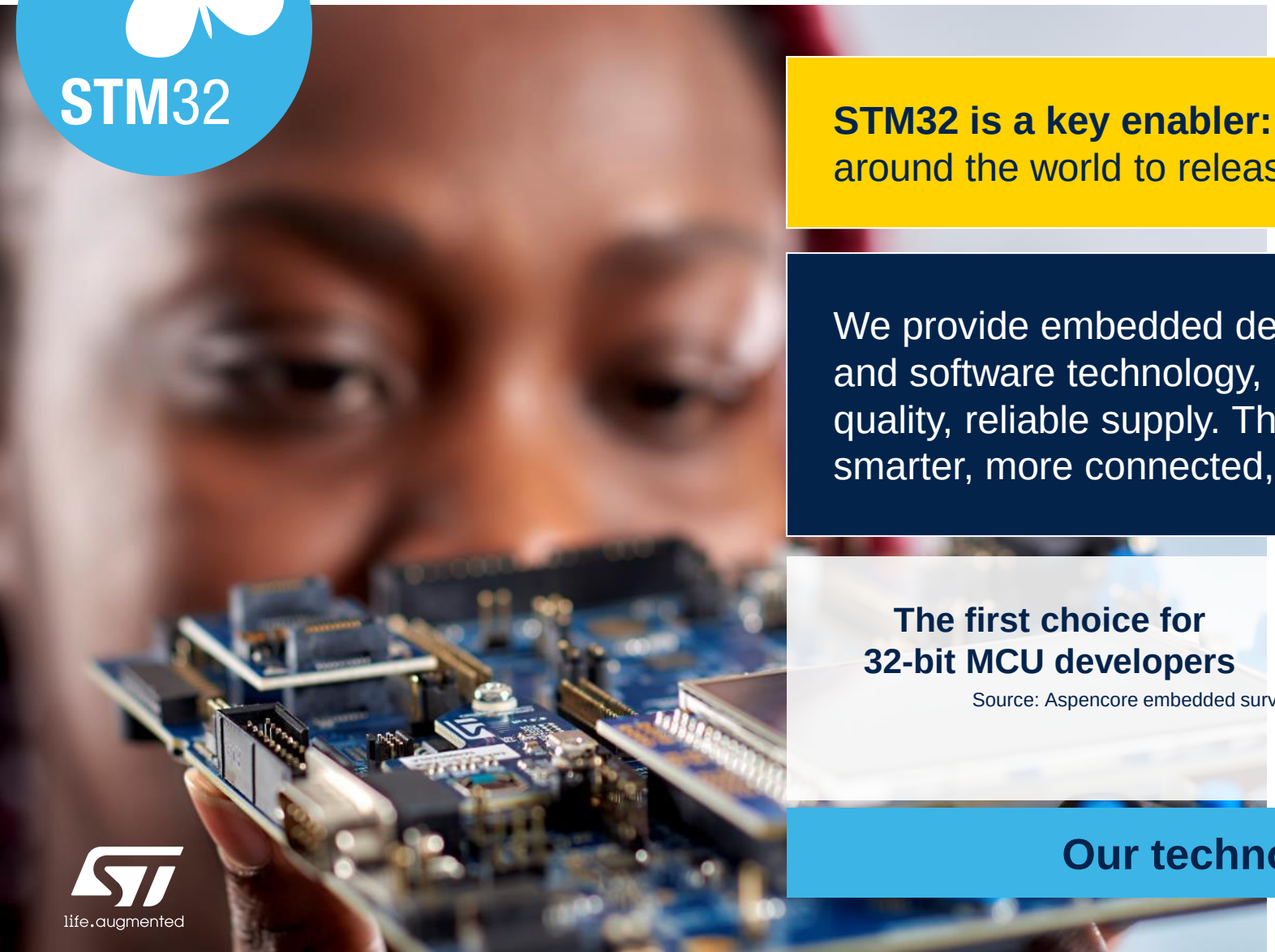
STM32: a developer-first strategy since 2007



STM32 is a key enabler: empowering embedded developers around the world to release their creativity.

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Source: Aspencore embedded survey, 2022

#1 GP MCU Worldwide

Source: OMDIA CLT, 2022, 2023

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