# BlueCoin SDK & Advanced Audio Applications

BlueCoin Platform

Open.Audio
Acoustic algorithms

Open.Audio
BlueVoice

BlueCoin demo
System

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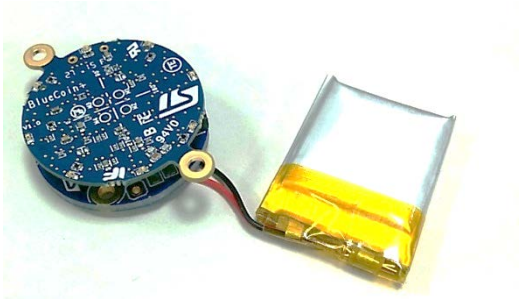
# BlueCoin Reference Platform & SDK

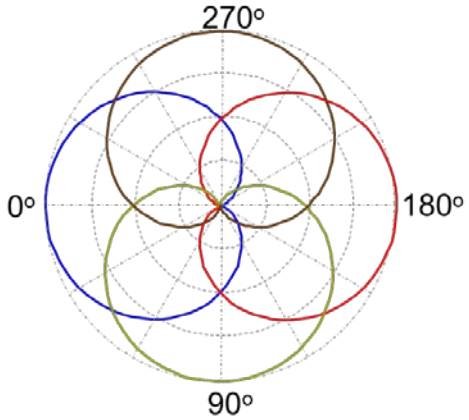
## Augmented hearing and motion sensing

Earphones Audio Out

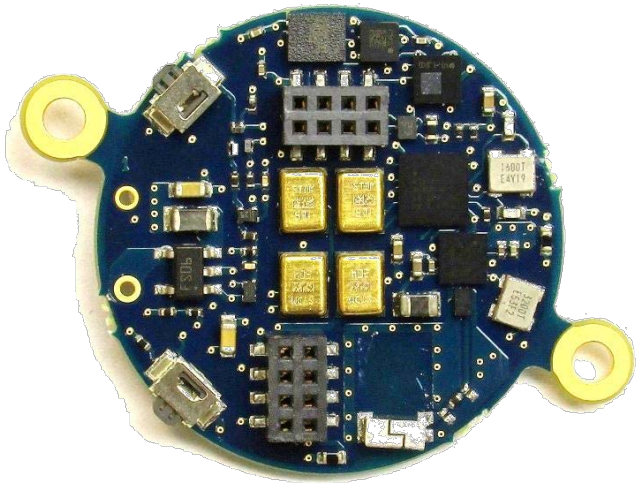
Battery powered



Directional hearing



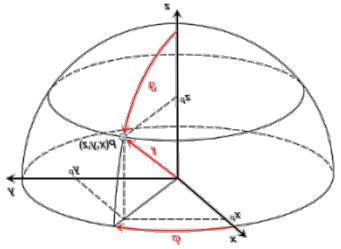

Motion, activity and balance



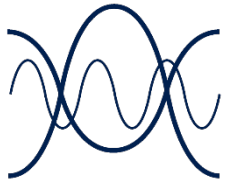
SMART

Bluetooth Low Energy

Sound Source Localization



Digital Signal Processing



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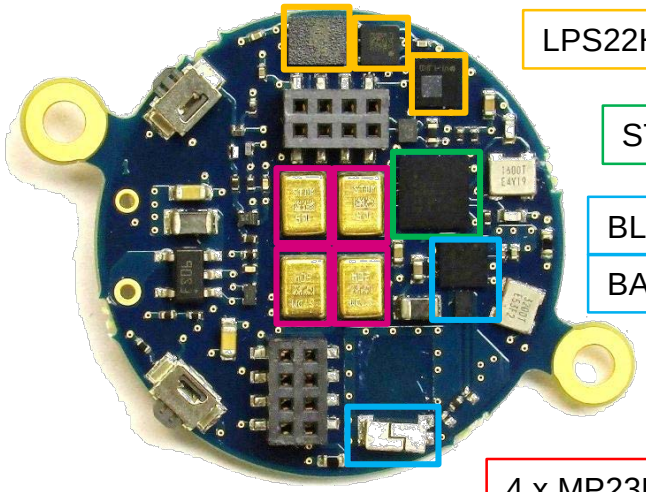
# BlueCoin Platform: a HW and SW SDK

OSX
OpenSoftwareX

open.AUDIO
open.MEMS
open.RF

STM32



LSM6DS3
LIS3MDL
LPS22HB
STM32F446
BLUENRG-MS
BALF-NRG-01D3
4 x MP23DB01MM

Ultra Low Power Connectivity

High-Performance MCU

Sensors

Motion MEMS
Environmental Sensors
MEMS microphones
Low-power brain
Sensor fusion
Bluetooth Smart

open.AUDIO
4 x MP23DB01MM

open.MEMS
LSM6DS3
LIS3MDL
LPS22HB

open.RF
BLUENRG-MS
BALF-NRG-01D3

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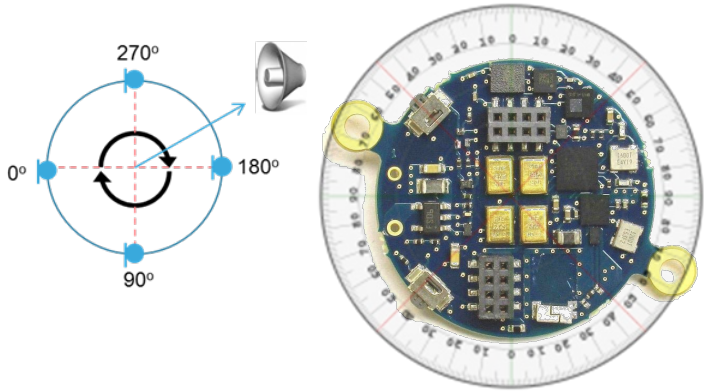
# Open.Audio Acoustic libraries

## Open.Audio testing and prototyping with BlueCoin platform SDK

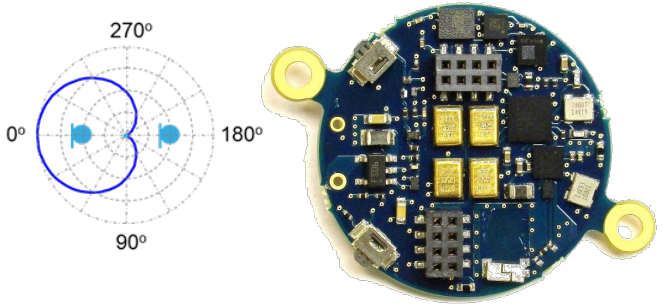
### osxAcousticSL
Sound Source Localization

Estimates the angle of arrival of audio signal using a MEMS microphone array



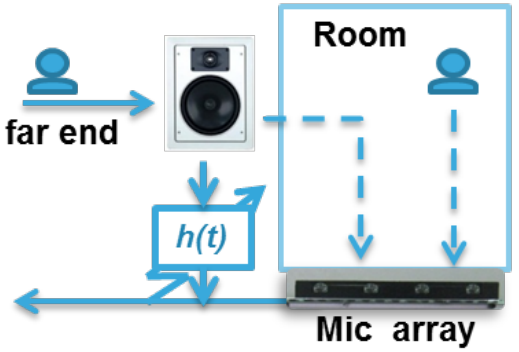

### osxAcousticBF
Beamforming

Small and compact directional virtual microphone based on ST MEMS microphone array




### osxAcousticEC
Acoustic Echo Cancellation

Based on the *Speex.org* Open Source libraries




**µ4** (micro-4) architecture : The smallest microphone array architecture ever!
Microphone's sound inlets are just 3mm away from each other

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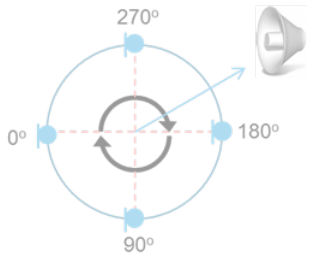
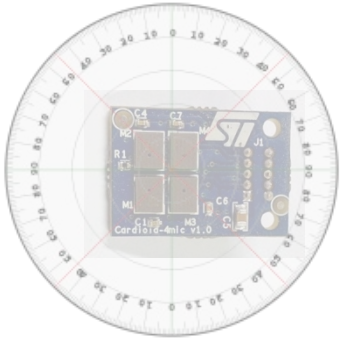
# Acoustic Processing with MEMS Microphones

## Open.Audio acoustic libraries for STM32

**osxAcousticSL**
Sound Source Localization

using a MEMS microphone array, it estimates the angle of arrival of audio signal



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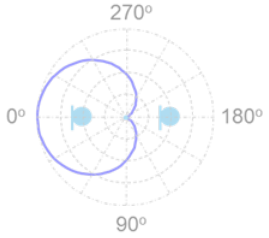


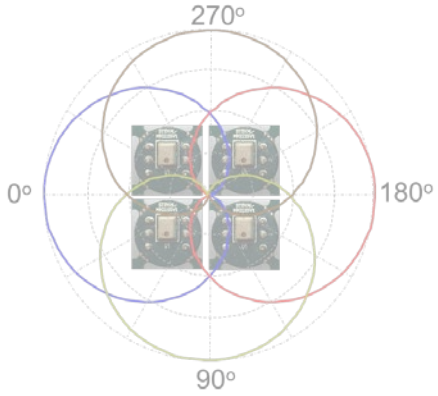


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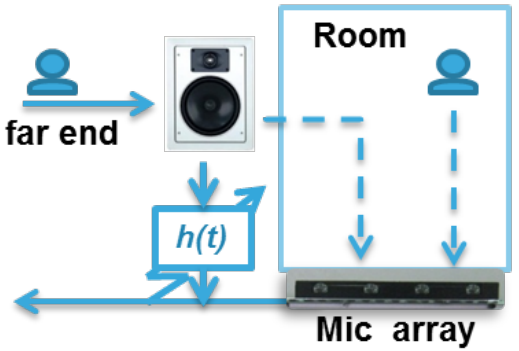


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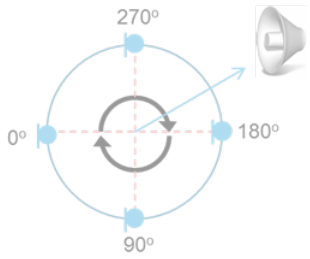


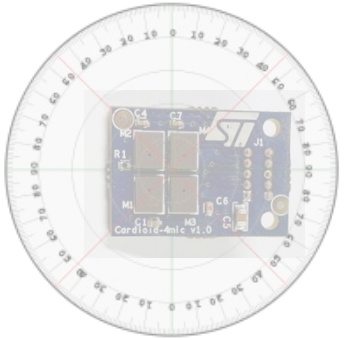

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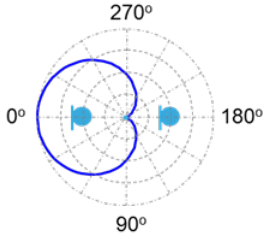


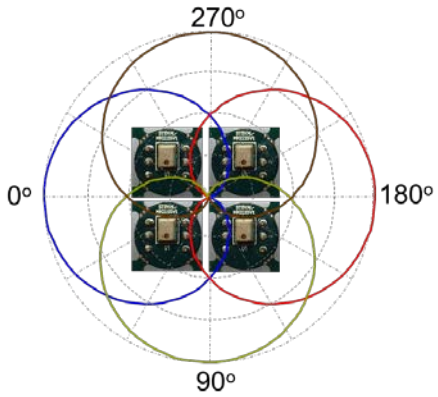


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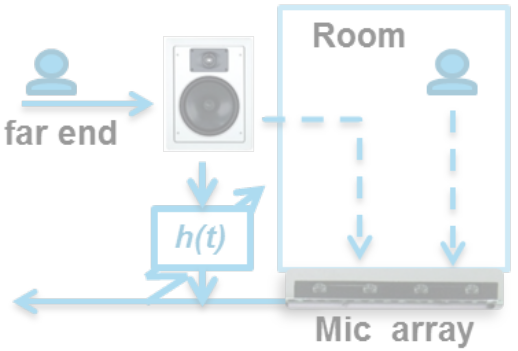


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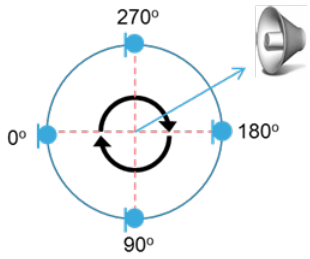


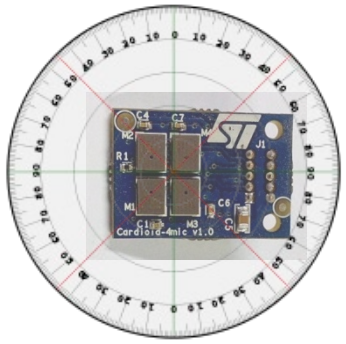

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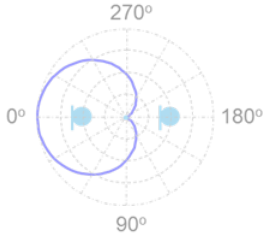


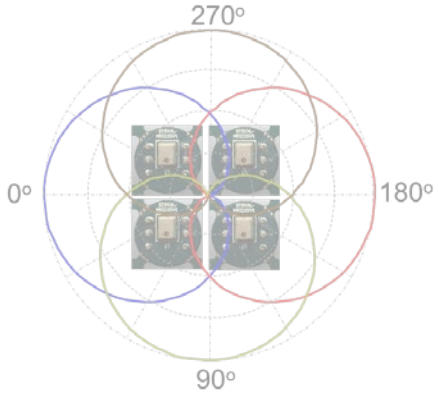


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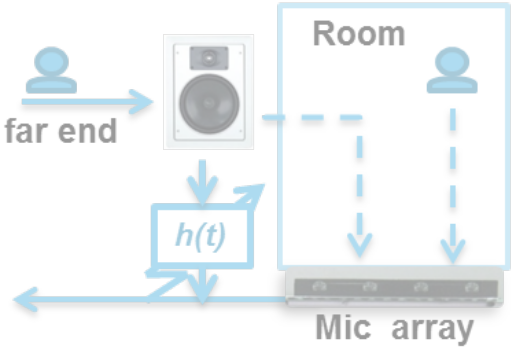


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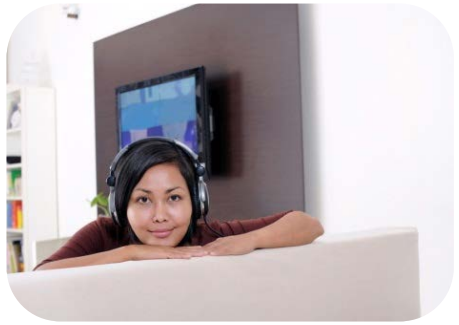
# Voice and Music Over Bluetooth Smart

**Audio Entertainment & Gaming**



Voice

Low power

Music

**Voice controlled TV remote**

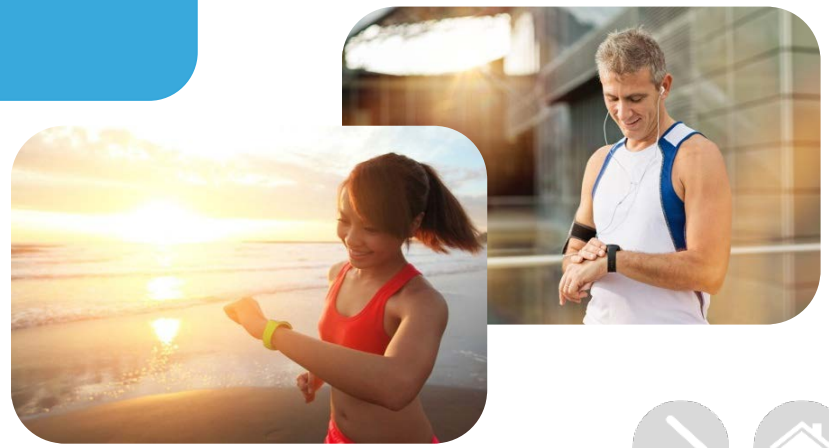
The ST hardware and software solution for ultra-low-power voice & music streaming over Bluetooth Low-Energy

**Smart Home**

Full duplex

Full band

**Wearables**



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# BlueVoiceLink SDK

OSX OpenSoftwareX

open.AUDIO

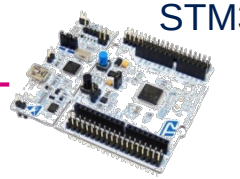
## Central Unit

Microphone

BLE

X-NUCLEO-IDB04A1
X-NUCLEO-CCA02M1

STM32 Nucleo



USB

USB out
@16kHz

***Half-duplex*** Voice
ADPCM @ 64 kbps

Bluetooth SMART

**www.st.com/bluevoicelink**

## Peripheral Unit

BLE

Microphone

X-NUCLEO-IDB04A1
X-NUCLEO-CCA02M1

STM32 Nucleo

USB

USB out
@16kHz

## STM32 Signal Processing and Application Firmware

| Part Number | Status | Description |
|---|---|---|
| BLUEVOICELINK1 | Active | Bluetooth Low Energy and microphones software expansion for STM32Cube |
| OSXBLUEVOICE | Active | Voice-over-Bluetooth Low Energy vendor-specific profile library for STM32 and BlueNRG |

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# BlueVoice Full Band Music over BLE

## Open.Audio demo on BlueCoin platform


- Central Tx
  - Stereo wav files @ 48 kHz from USB key
  - Opus compression
  - BLE encoding and transmission
- BlueCoin Peripheral Rx
  - BlueVoice Opus decoding
  - Voice recognition
  - Beamforming

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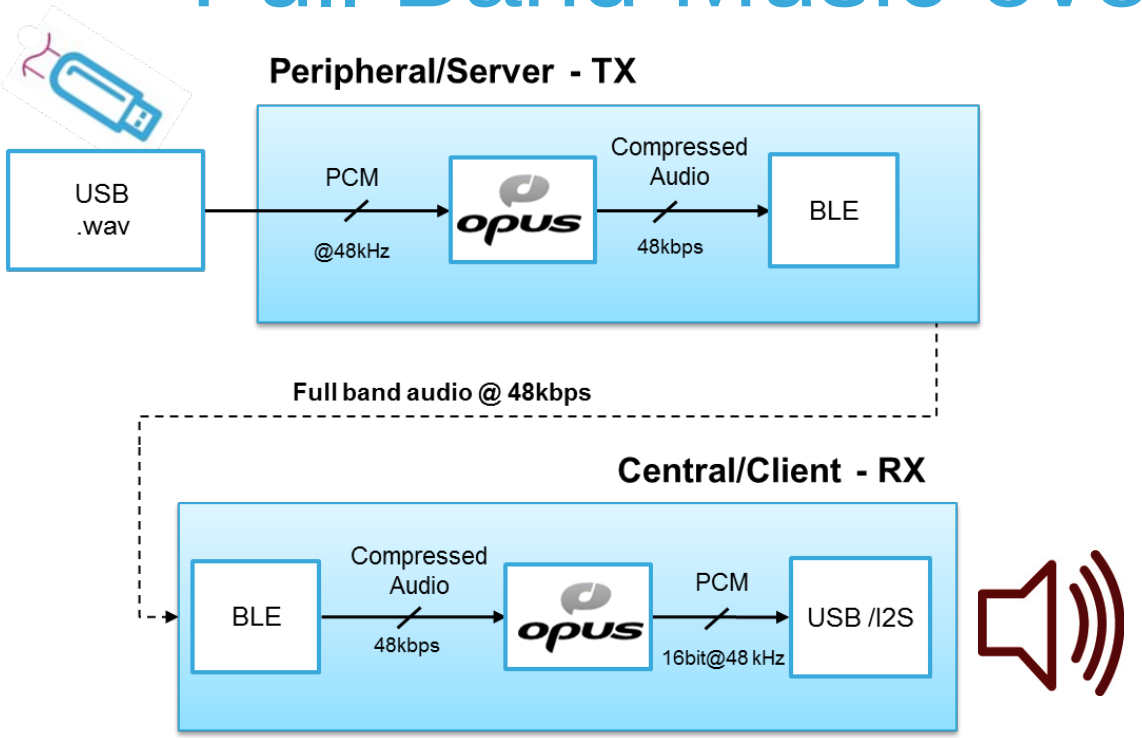
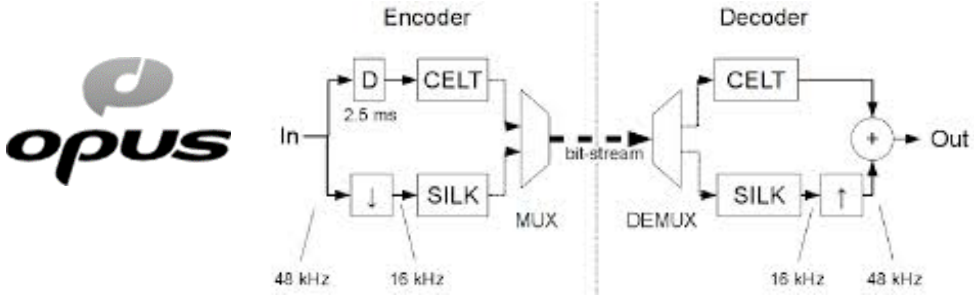
# Full Band Music over BLE: Audio processing





## **STM32** Audio Compression




**Full Band Audio Stereo** Streaming

- BlueNRG-MS
- STM32F446, STM32F7
- Audio Format: **PCM** @ **48 kHz** (.wav)
- Opus Compression @ **48kbps**

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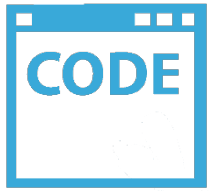
# BlueCoin SDK: Open.Audio  Demo System

## BlueCoin SDK: Hardware features

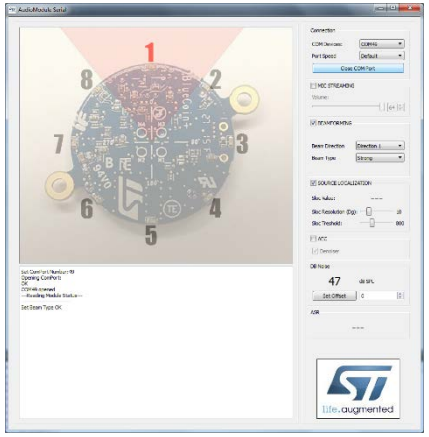
- STM32 Nucleo board powered by STM32F4 MCU
- Digital MEMS microphone STM32 Nucleo expansion board X-NUCLEO-CCA02M1
- µ-4 array hosting 4x MP34DT01 digital MEMS microphones

## BlueCoin SDK: Firmware




- Microphone acquisition
- Embedded running algorithms
  - Beamforming
  - Source Localization
- USB output:
  - Audio class for audio streaming
  - Virtual COM Port for array configuration

## Software




PC control software to configure:

- Optimizations
- Beam direction
- Source localization

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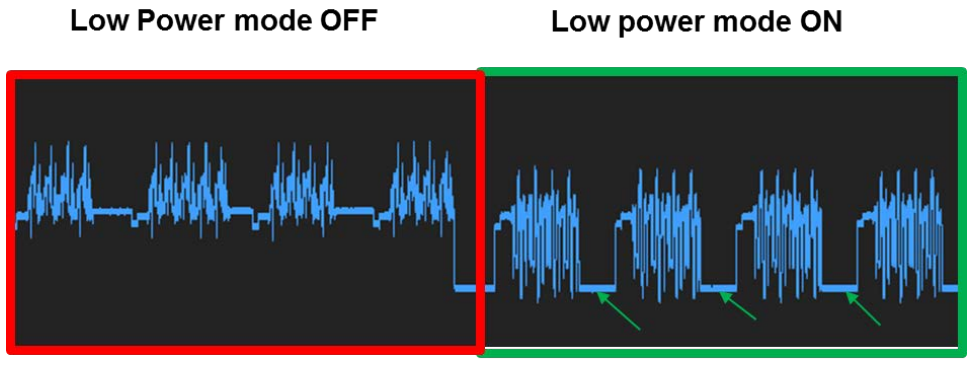
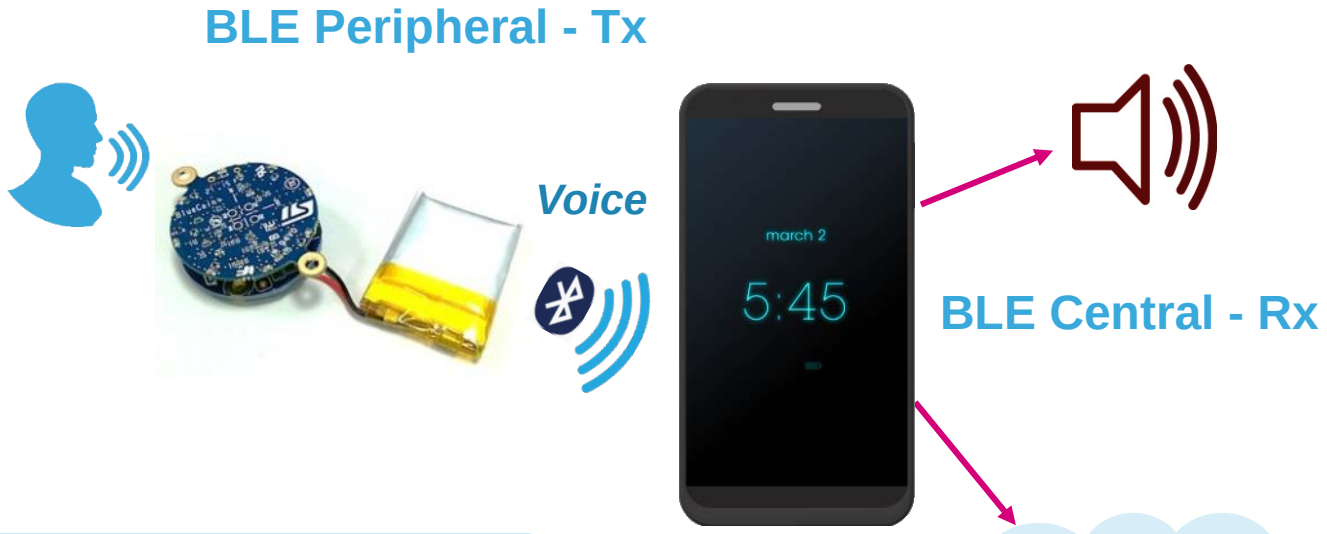
# Android BlueVoice for Wearable Systems

## Low Power Architecture




STM32 current consumption profile on STM32L4




BlueVoice system streaming ADPCM voice@8KHz

Overall* power consumption: **5.1mA @ 2.1V**

**Less than 10 mW**

*STM32 + BlueNRG + MEMS microphone

**Google**
**Speech 2 Text API**
(create your own service!)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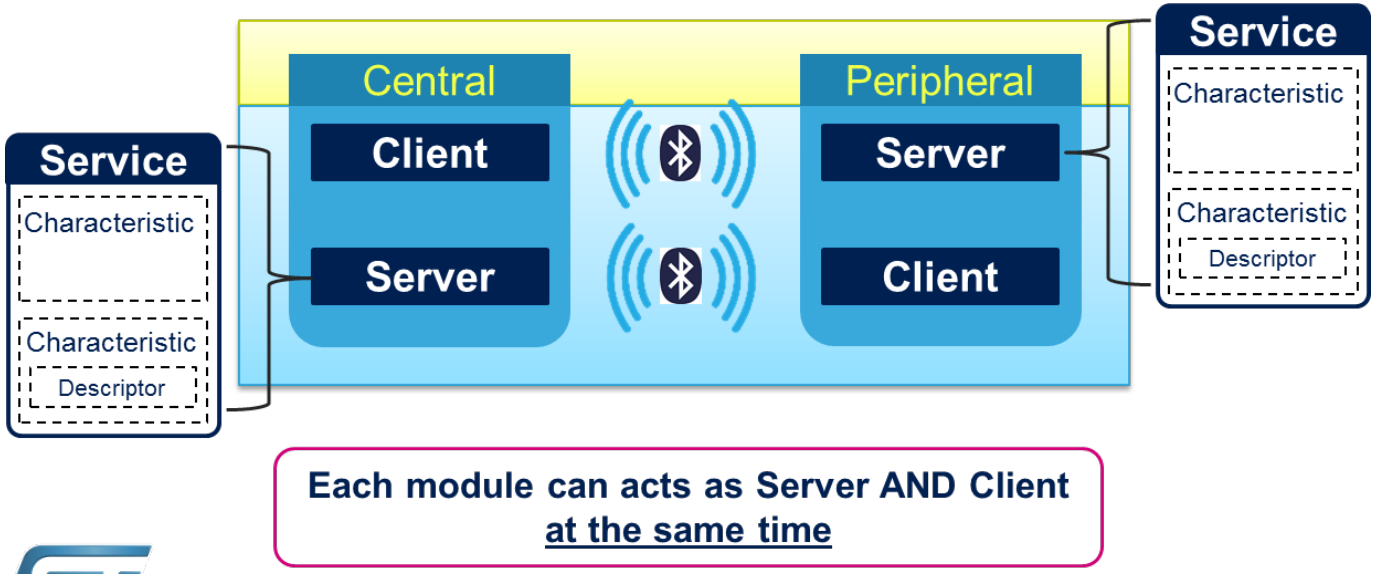
# BlueVoice Full Duplex

**Central**



**Peripheral**




**Each module can acts as Server AND Client at the same time**

## Advanced audio compression

- Opus codec
  - SILK algorithm optimized for speech
  - Sample frequency: 16kHz
  - Bitrate: ~ 10 kbps

## Bluetooth LE audio streaming

- Synchronized transmission

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