BlueCoin, the Robotic Ear

Audio and Sensor Platforms R&D

AST – Central Labs

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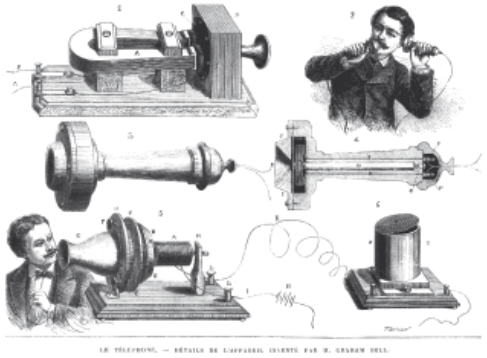
Voice Communication

a key driver of innovation since 1800's



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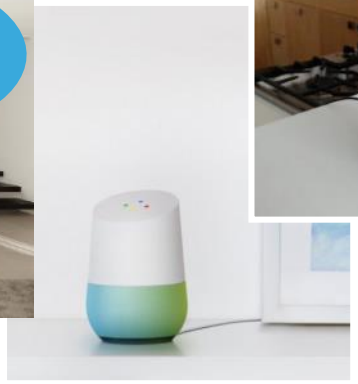
IoT evolution of Voice Automation:

the IoT voice assistant

…to Smart Mobiles



…to “Anything Connectable”

From professional PC applications

…to Home / Office Terminals

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MEMS microphones and Audio Quality at system level

Voice & data Gateway

Seamless connectivity

Cloud

- Natural Language Processing
- Dialogue Management
- Services

Play Music

Control Lighting, heating, …

News, sport, traffic, weather, …

Answer questions, create to-do lists, shopping lists, …

Place orders online, use other online services: taxi, pizza, …

Voice Terminal

- Audio capture & render
- Signal processing
- Low power
- Constained geometry

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BlueCoin

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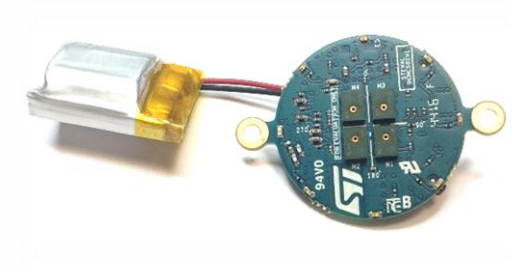
Coming in June 2017

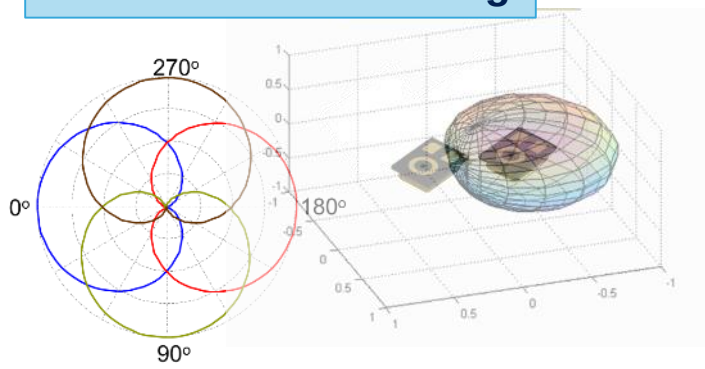
BlueCoin: the Robotic Ear

Augmented hearing plus range, environmental and motion sensing

Motion, Activity and Balance

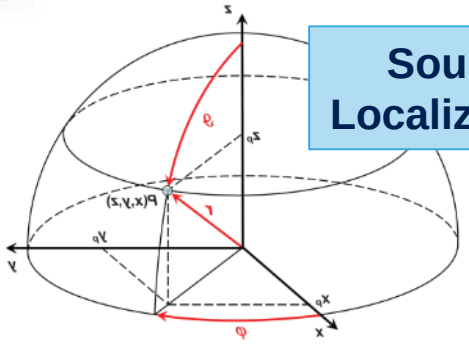


Acoustic Beamforming

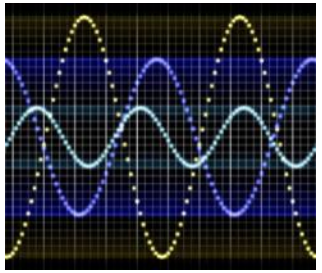


Voice over Bluetooth Low Energy

Sound Localization



Embedded Processing



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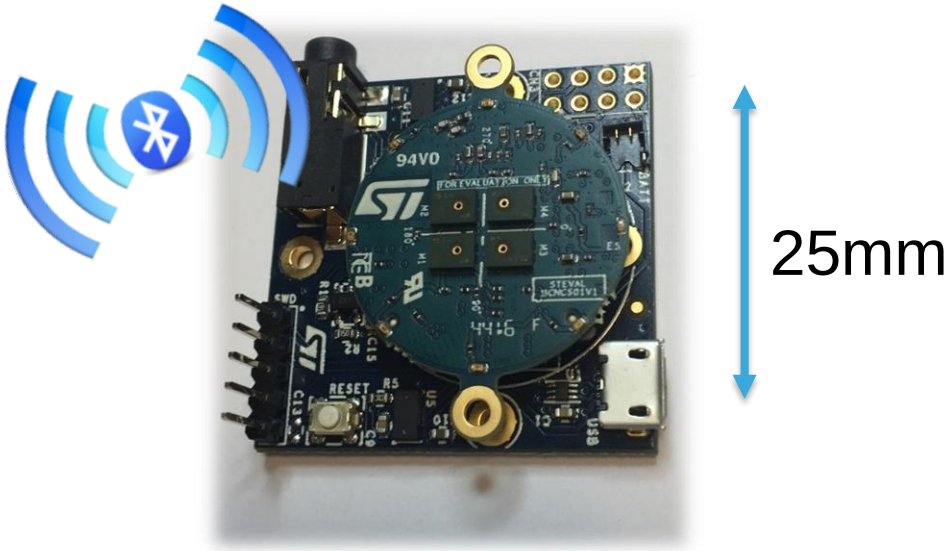
Coming in June 2017

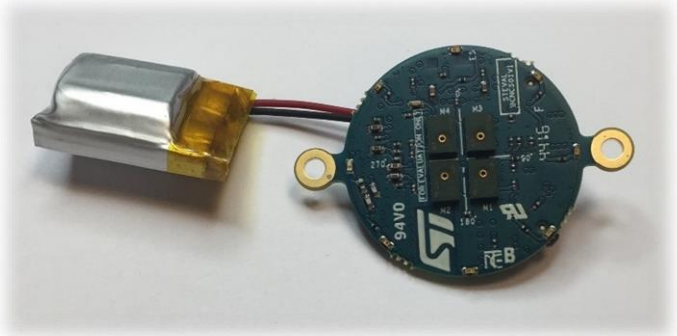
BlueCoin: the Robotic Ear

Features

- Advanced audio processing
  - Sound Source Localization
  - Beamforming
- Wide band audio over BLE (BlueVoice)
- Advanced Audio and ToF User Interaction
- Sensor fusion
  - Inertial, environmental, acoustic, optical (Time of Flight)
- Complete development kit
  - SW Compatible with STM32 ODE
  - CoinStation + small Cradle



BlueCoin + battery



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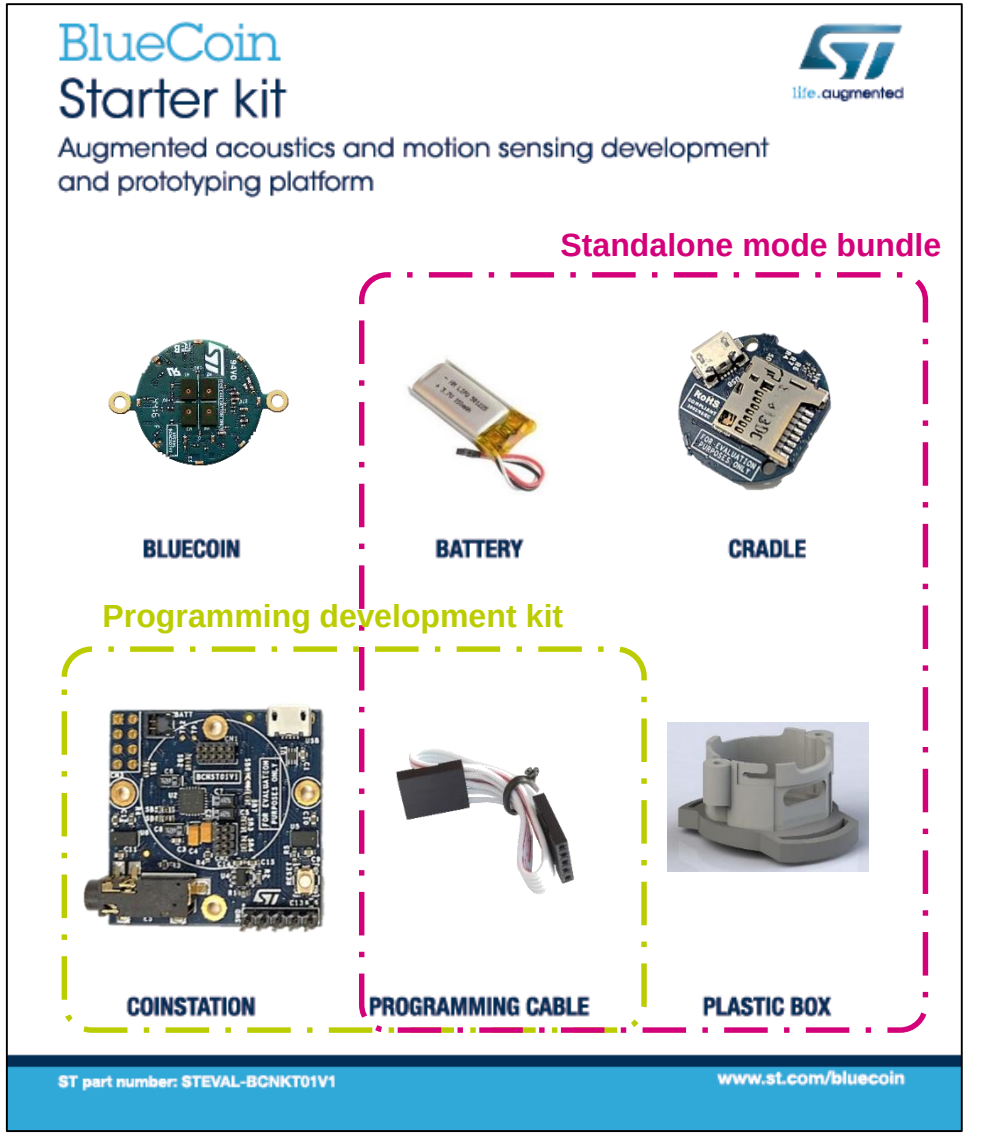
STEVAL-BCNKT01V1 - BlueCoin Starter Kit

Programming development kit

CoinStation

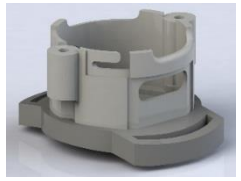
Programming cable

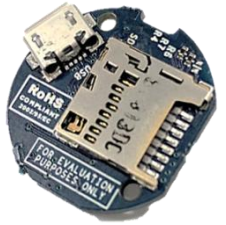


Standalone mode bundle

BlueCoin Cradle

Plastic Box





LiPo Battery

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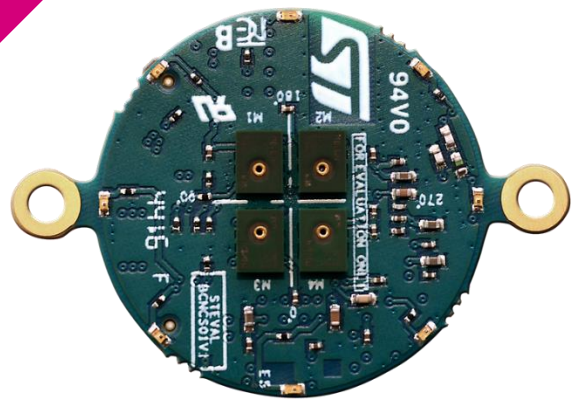
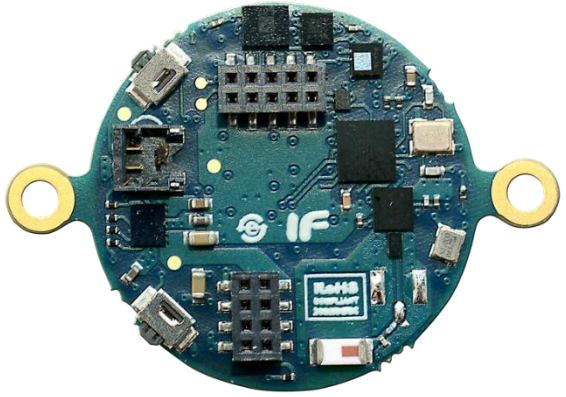
STEVAL-BCNCS01V1 - BlueCoin





Sensors — Motion MEMS; MEMS Microphones; Environmental MEMS

LSM6DSM
LSM303AGR
LPS22HB
MP34DT04

High-Performance MCU — High-performance Brain

STM32F4

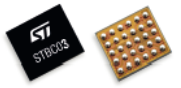
Ultra-Low-Power connectivity — Bluetooth Low-energy

BlueNRG-MS

Time-Of-Flight ranging — Flight Sense

VL53L0x

Power Management — Battery Charger



STBC03J

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Coming in June 2017

STEVAL-BCNCS01V1 - BlueCoin

LSM6DSM
6-axis inertial module

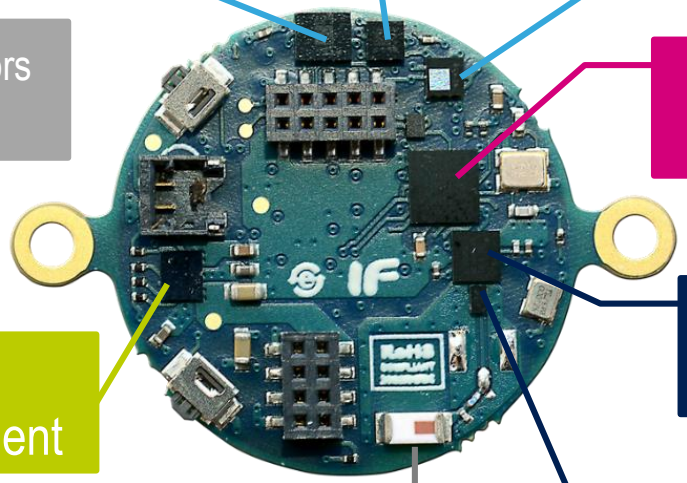
LSM303AGR
eCompass

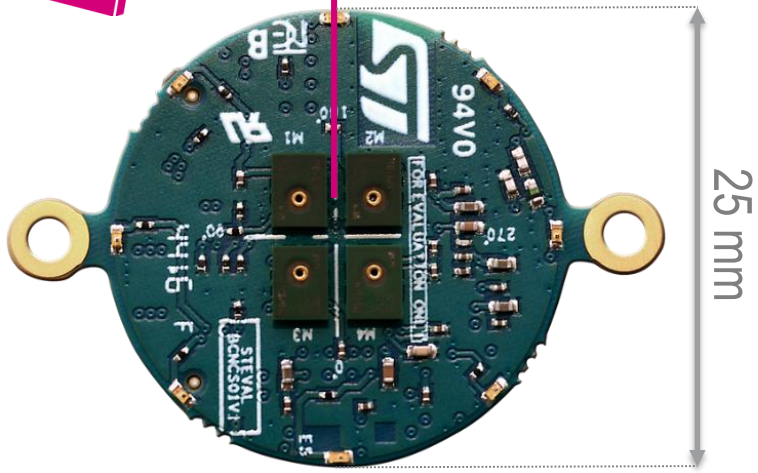
LPS22HB
Barometer

4x MP34DT04-C1
MEMS Microphone

Expansion connectors
2x buttons

STM32F446
MCU





BlueNRG-MS
Bluetooth Low Energy

STBC03J
Power management

SMD Antenna

BALF-NRG-01D3
Balun Filter

8 LEDs

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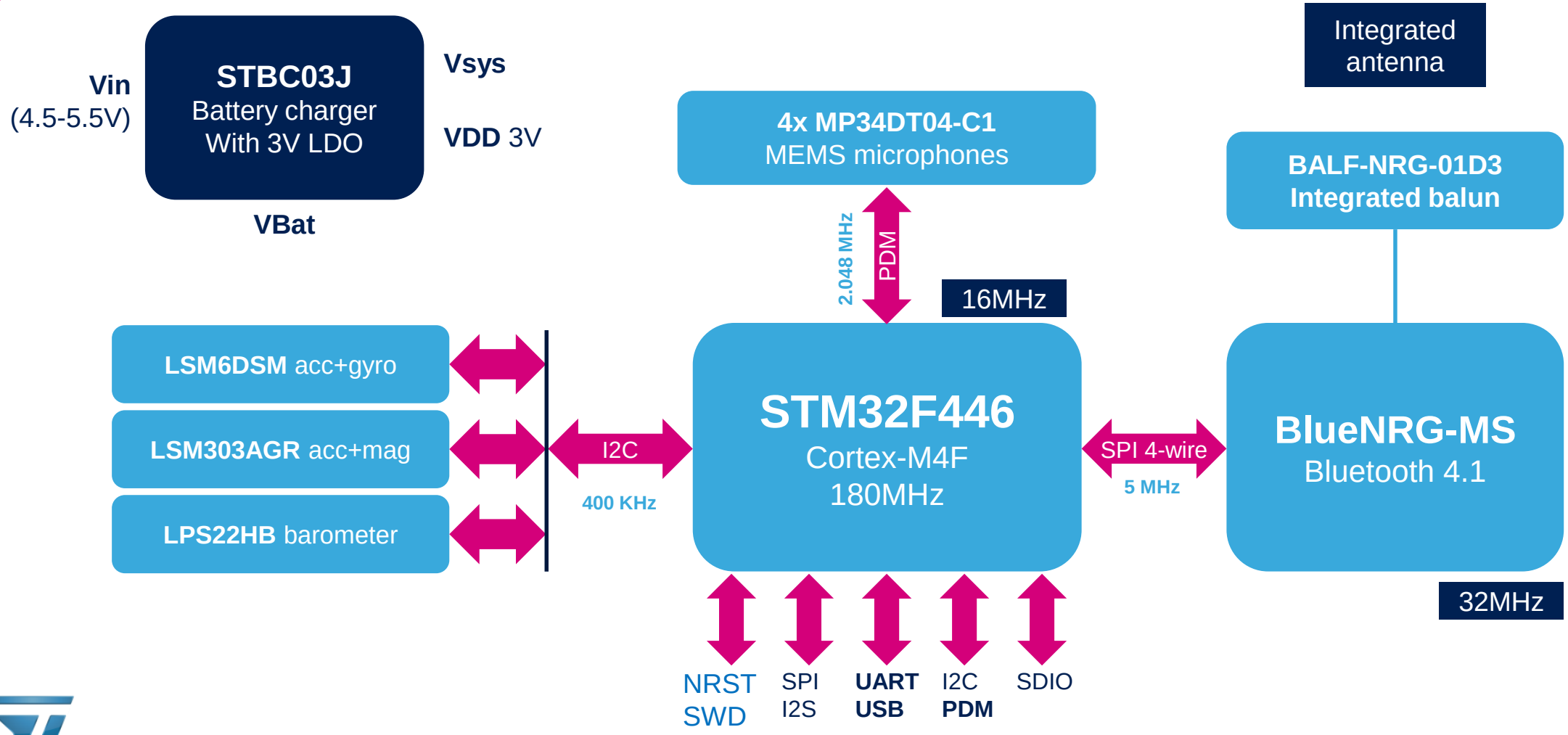
Coming in June 2017

BlueCoin Architecture



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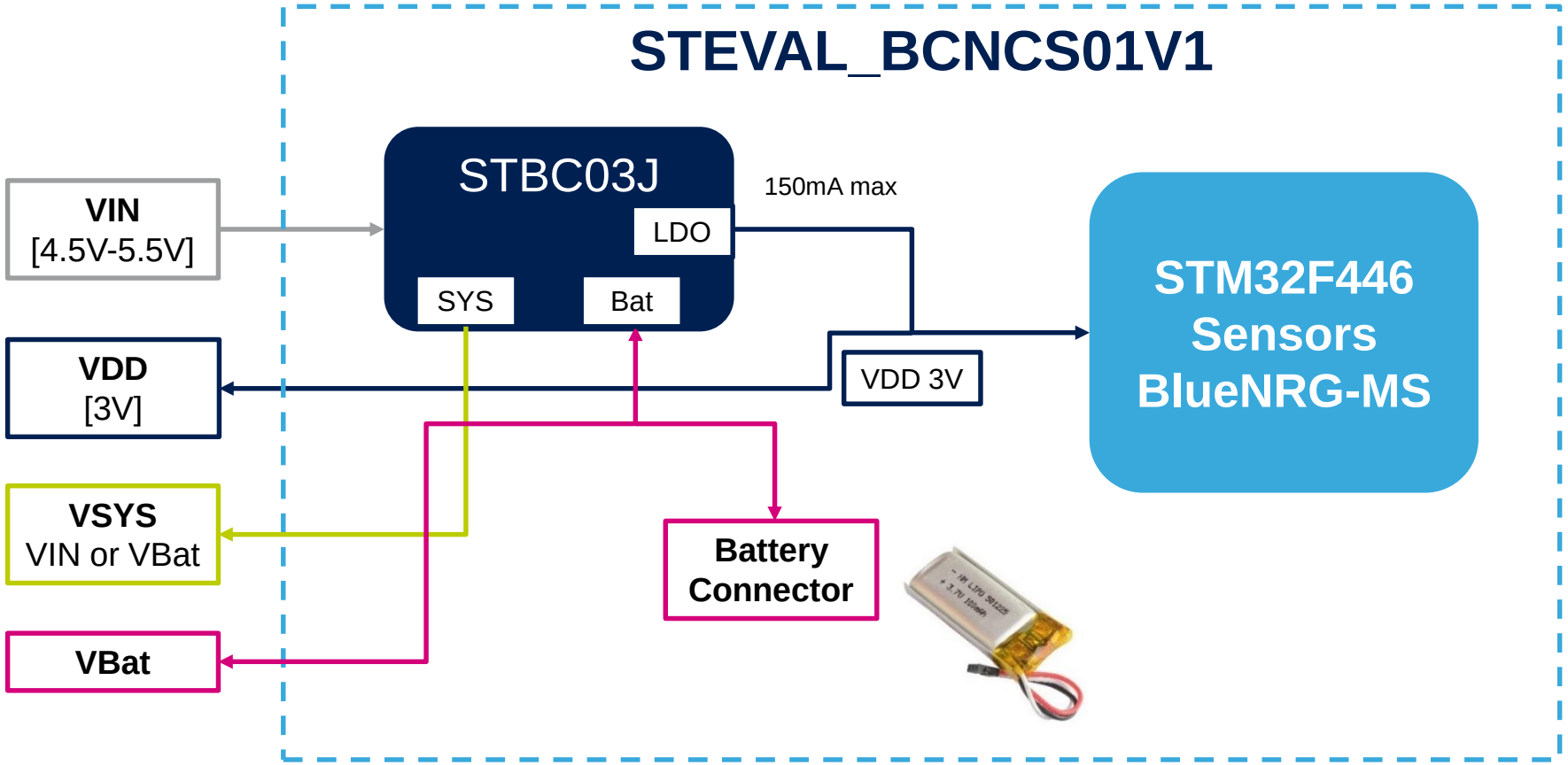
Coming in June 2017

BlueCoin Power Supply



Coming in June 2017

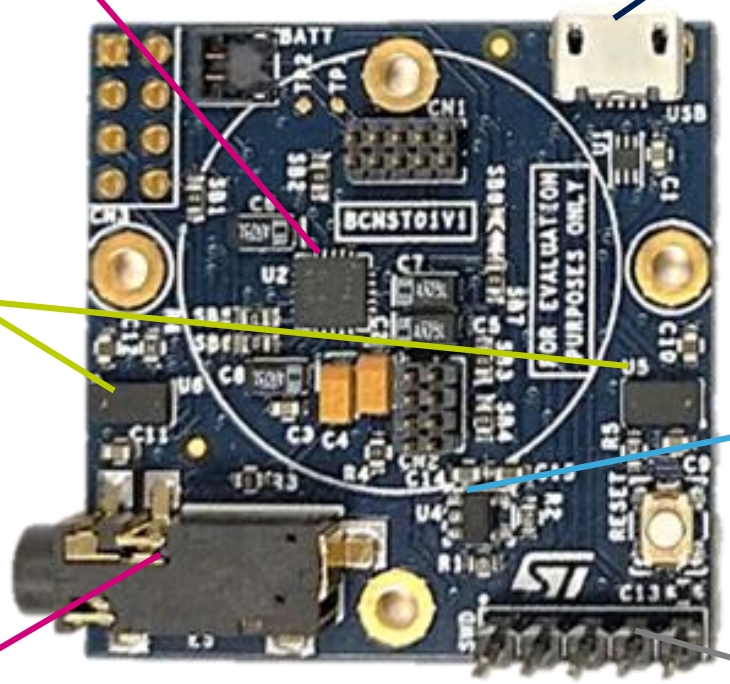
STEVAL-BCNST01V1 - CoinStation

Stereo Audio DAC

USB connector

36x36mm

Expansion connector



VL53L0X
Time-of-Flight sensors

LDK120M
2.8V LDO

3.5mm Jack

SWD Programming interface

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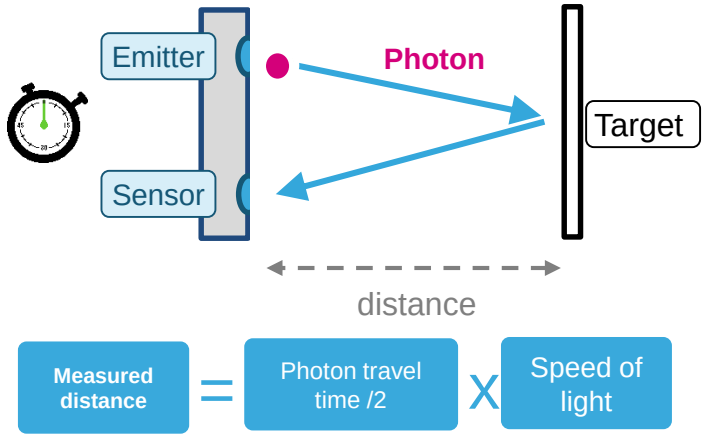
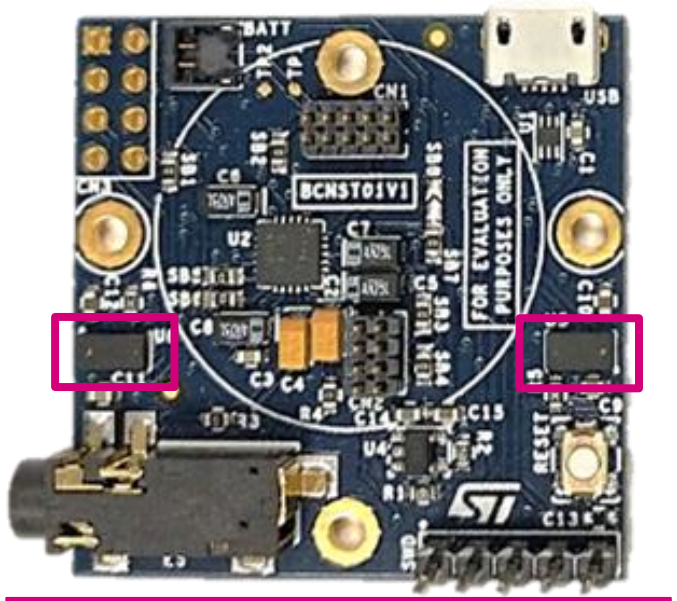
Coming in June 2017

VL53L0X FlightSense™

FlightSense™ Principle



CoinStation



Time-of-Flight

Time-of-Flight: VL53L0X

Distance measurement	**Ranging up to 2 meters**
Field of View	25 degrees
Accuracy	+/-3 % (*)
Programmable modes	3 modes in API (High-speed, long distance, high accuracy)
Small all-in-one module	2.4 x 4.4 x 1 mm
Low power consumption	HW stdby <5uA Ranging: 20mW (average at 10Hz with 33ms ranging sequence)

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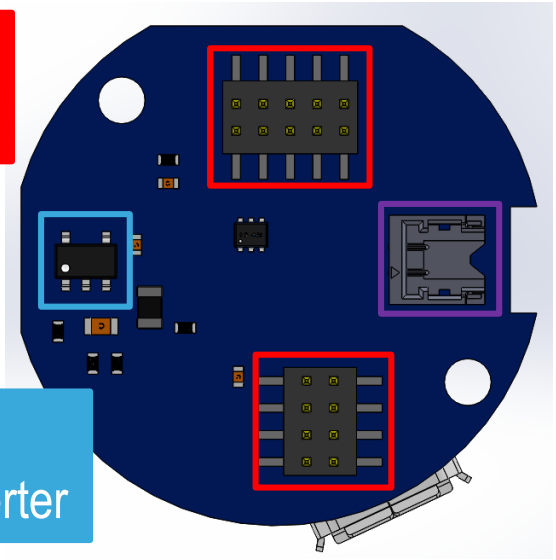
STEVAL-BCNCR01V1 – uCradle

Support for standalone operation

TOP VIEW

BlueCoin Connectors

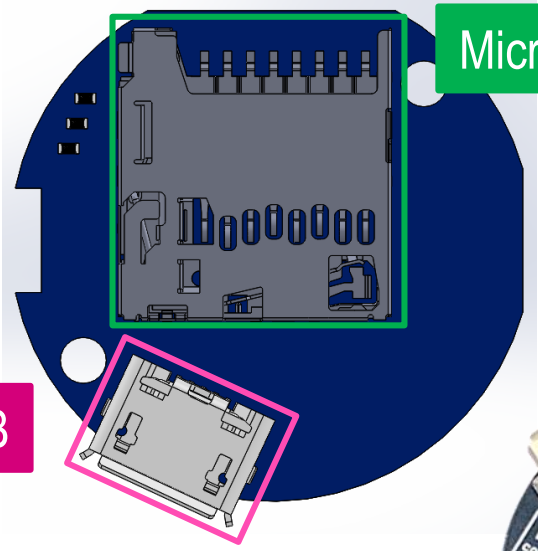


Battery Connector

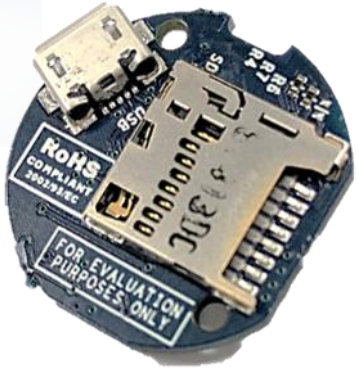
ST1S12XX
3.3V DCDC converter

BOTTOM VIEW

Micro SD Card



Micro USB



Plastic Case

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Coming in June 2017

BlueCoin

Integrated Development Platform

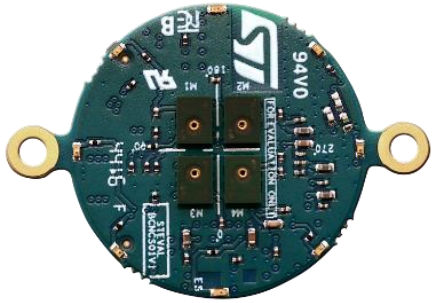
STM32 Open Development Environment

open.AUDIO
open.MEMS
open.RF

STM32 Cube

BlueMS

Core System



Coin Station

Cradle

Memory

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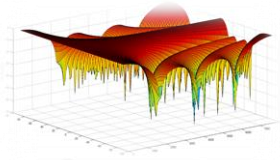
Entry Level to Advanced Audio in 3 steps

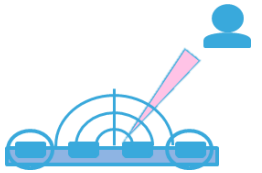
Integrated Development Platforms

Advanced Free-Licensed Premium libraries

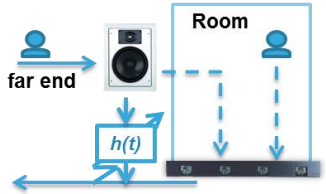
Audio Over BLE



Beamforming



Source Localization

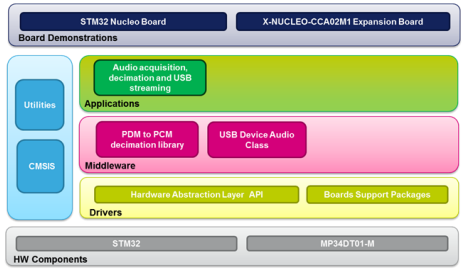


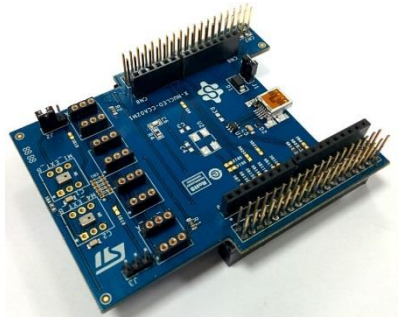
Acoustic Echo-Cancellation

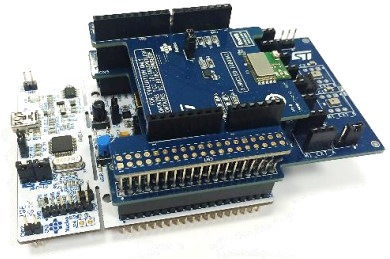
MEMS microphones on Function Packs

open.AUDIO

STM32 Cube







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STM32 Open Development Environment

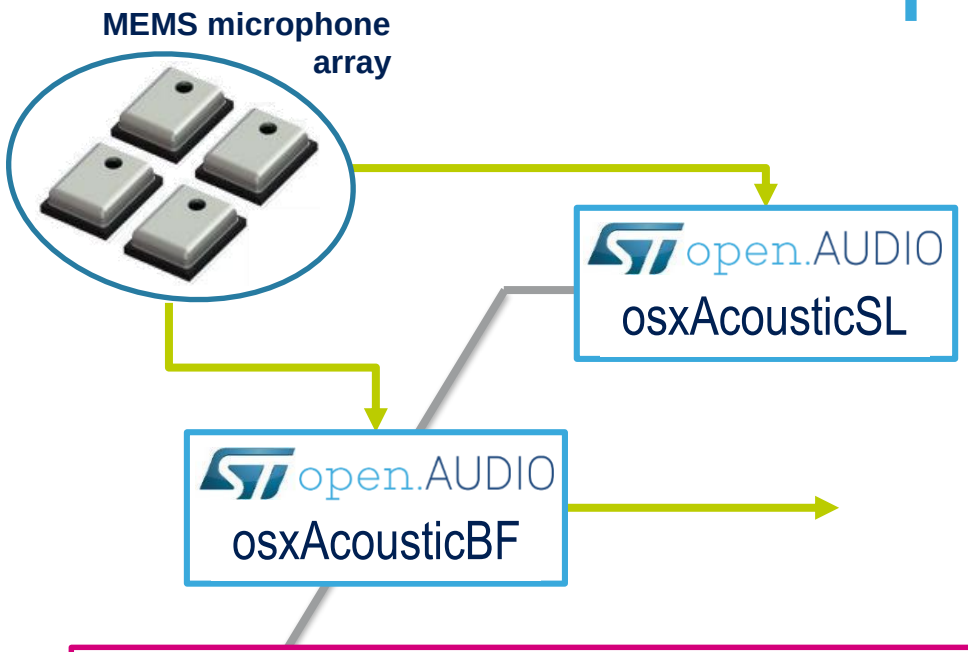
Coming in June 2017

BlueCoin compatible software

Software Free Download from www.st.com in June 2017

- STSW-BCNKT01
  - Embedded software examples for BlueCoin firmware package, including sensor data streaming via USB and BLE, data logging on SD card, gesture recognition, audio acquisition and playback
- FP-SNS-ALLMEMS1 (former BLUEMICROSYSTEM2)
  - IoT node with BLE connectivity, digital microphone, environmental and motion sensors, motion and audio middleware libraries
- FP-AUD-SMARTMIC1 (former SMARTACOUSTIC1)
  - Smart audio IN-OUT software expansion for STM32Cube
- FP-AUD-BVLINK (former BLUEVOICELINK1)
  - Bluetooth Low Energy and microphones software expansion for STM32Cube

Spatial Audio Processing



OpenSoftware.X

Freely licensed FW Libraries for STM32

open.AUDIO

www.st.com/openaudio

Beamforming: **osxAcousticBF**

Spatial Filter

Outputs the Audio that comes **from a given direction**

Adaptively **cancels** audio signals coming from **other directions**

Sound Localization: **osxAcousticSL**

Estimates the **Direction of Arrival** of **the Main sound source**

Independent from beamforming

May **control** the beam direction

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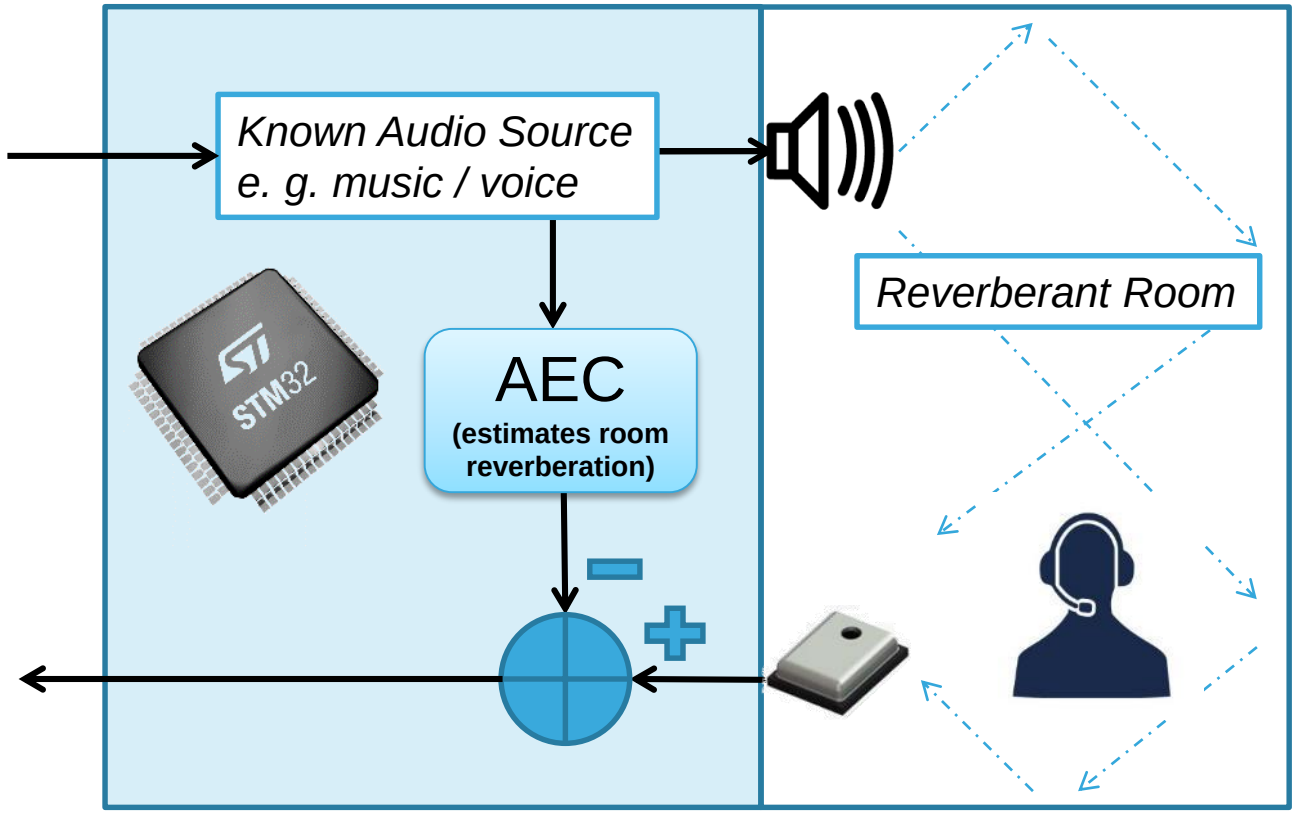
Acoustic Echo Cancellation

Removes echo of playback audio in speech capture application

- ✓ Single Microphone application
- ✓ STM32 is connected to both the microphone and the loudspeaker



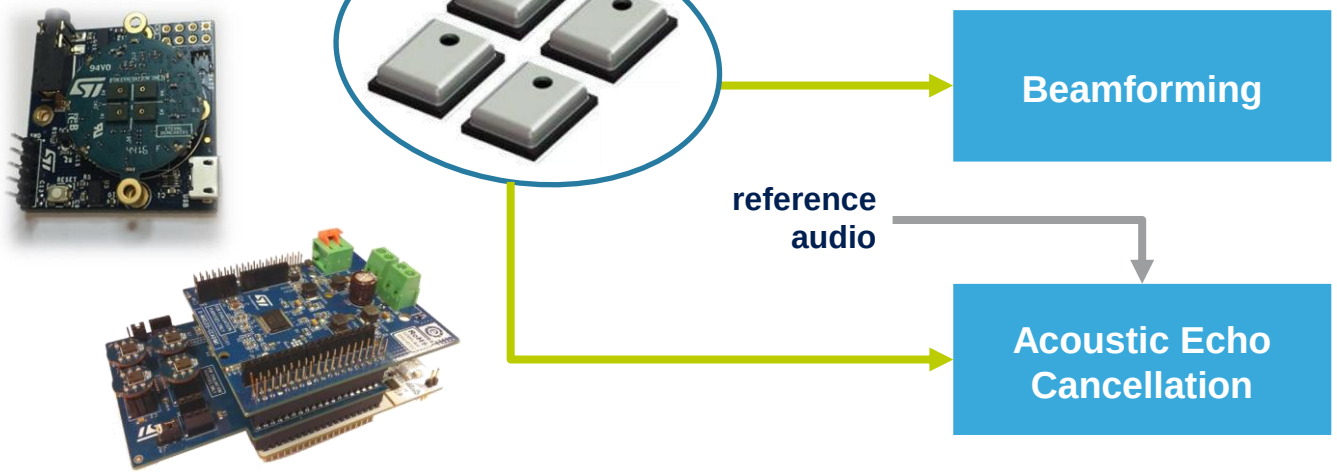
The Open.AUDIO AEC library is an optimized STM32 port based on the Open Source project *Speex:*

http://www.speex.org/

Putting together SW libraries

OpenSoftware.X SmartAcoustic1

- Example project in source code built on STM32Cube software technology
- Includes acoustic Beam Forming, Echo Cancellation, and Source Localization.
- Immediate test and performance evaluation



- User-selectable angle resolution
- User-selectable activation treshold
- Based on 4 MEMS microphones
- 360° localization range

- User-selectable neam direction
- User-selectable beamforming algorithm
- Based on 4 MEMS microphones
- GUI highlights the chosen microphone couple

- Based on a single MEMS microphone
- Reference audio is stored on STM32 FLASH
- Uses Audio OUT to play back audio while streaming cleaned speech on USB

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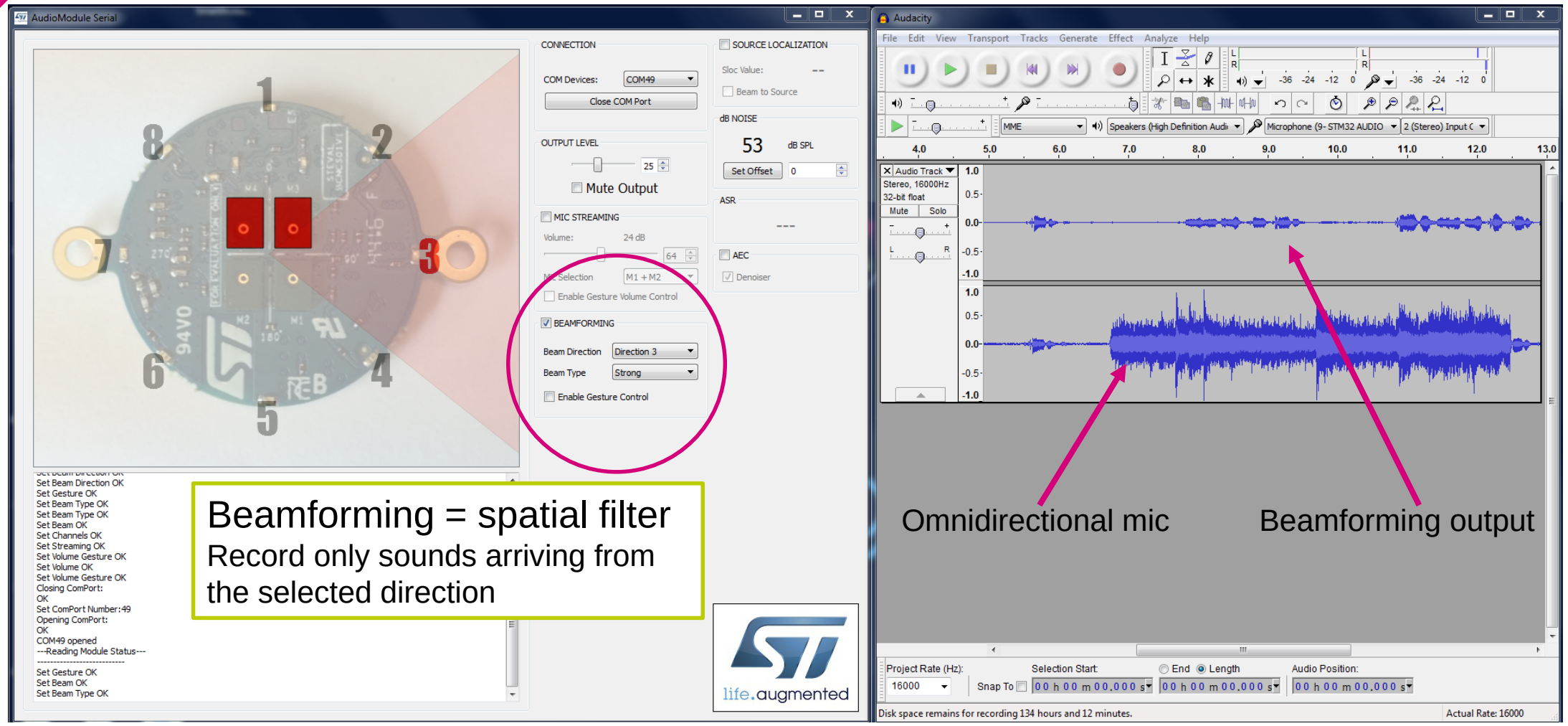
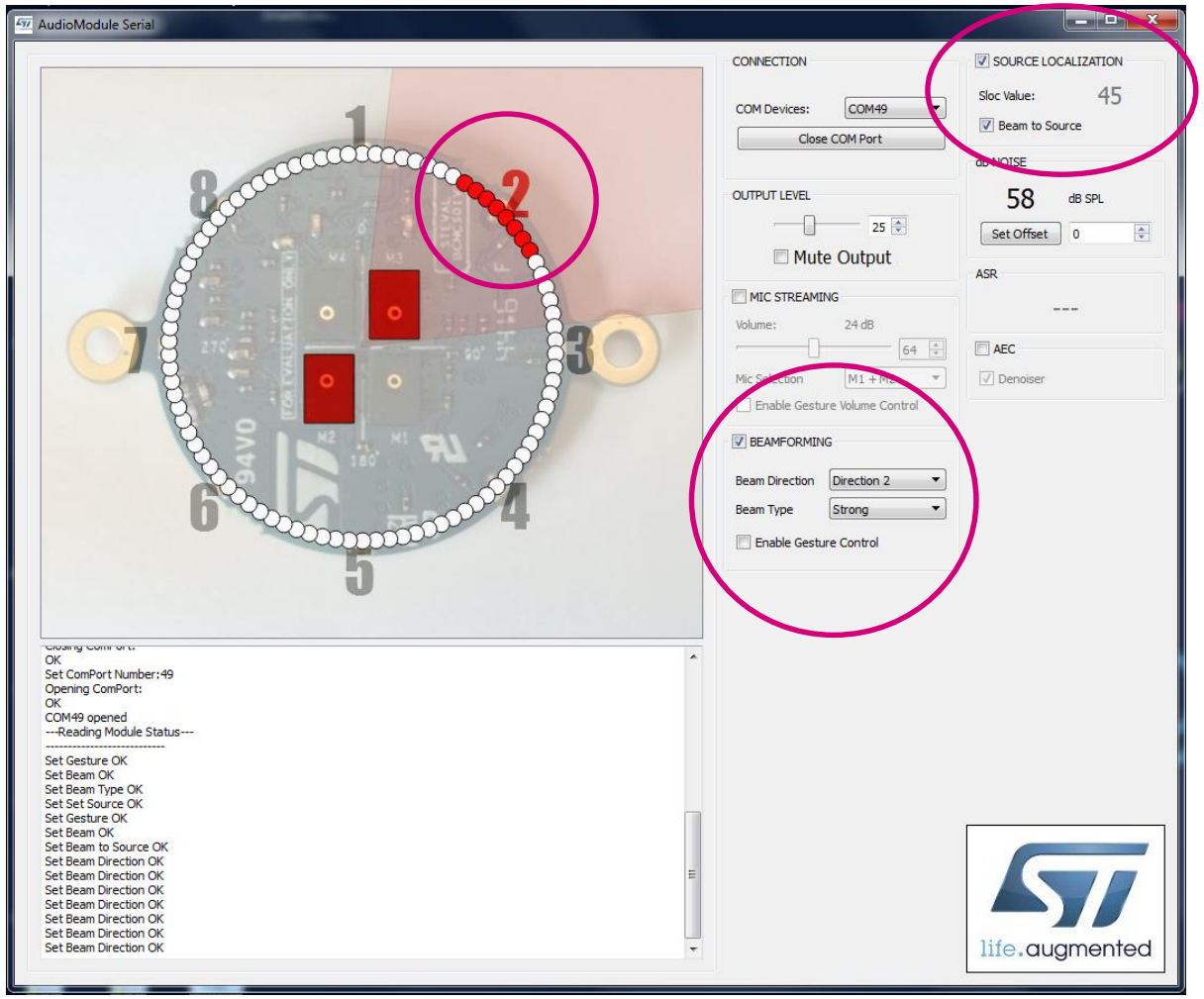
Coming in June 2017

FP-AUD-SMARTMIC1 - Beamforming



Coming in June 2017

FP-AUD-SMARTMIC1 - BeamToSource



- Select the desired Beamforming
- Switch on the Source Localization
- Beam to Source can understand the source direction and select the related mics

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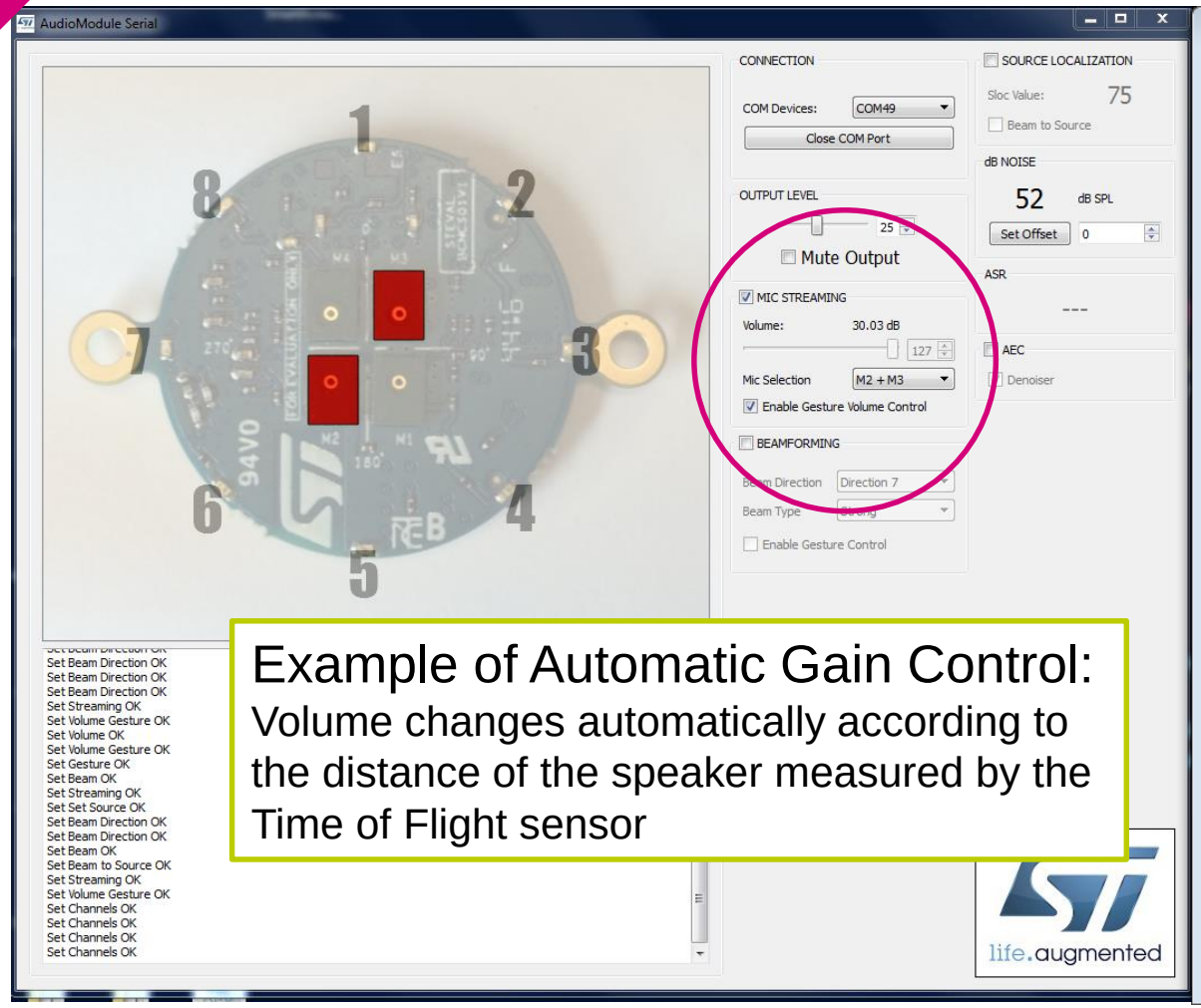
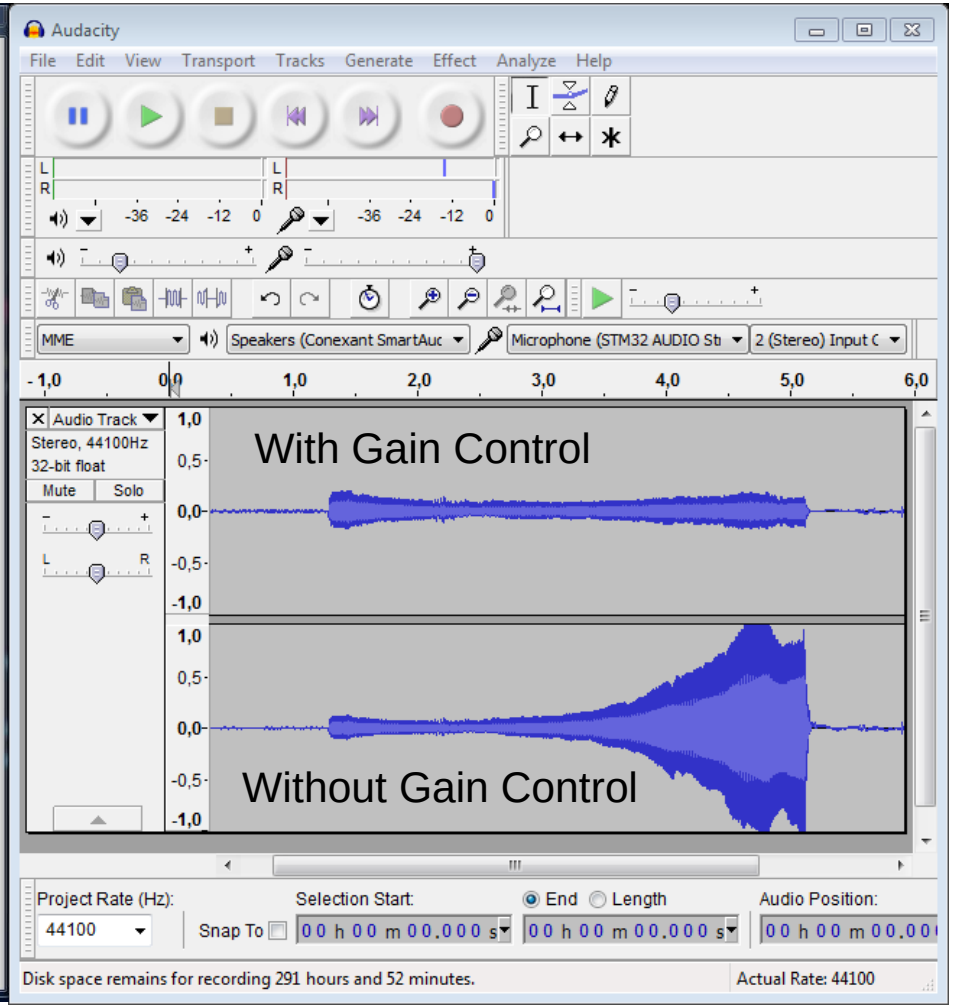
Time-Of-Flight Gain Control





Example of Automatic Gain Control:

Volume changes automatically according to the distance of the speaker measured by the Time of Flight sensor

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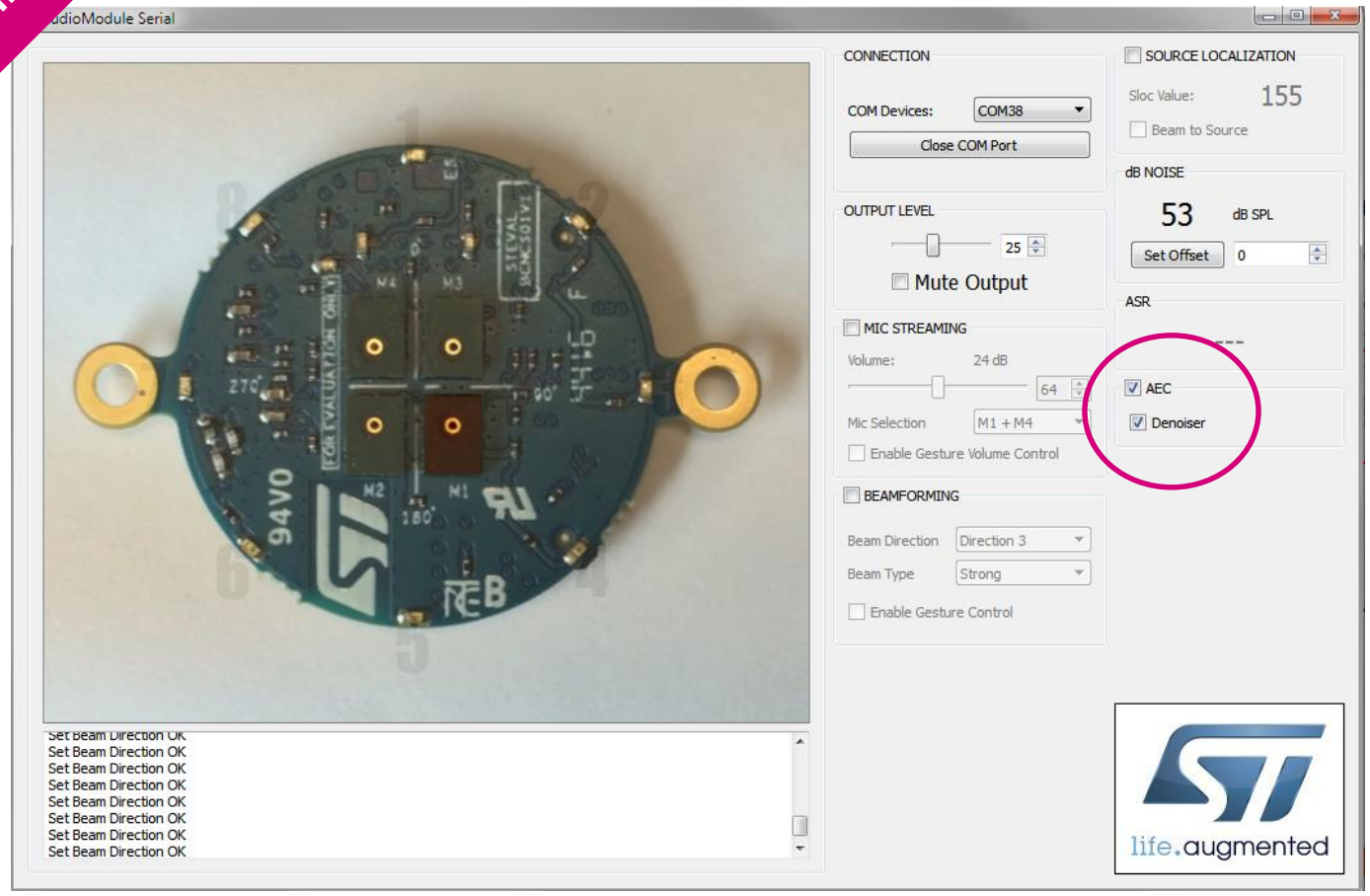
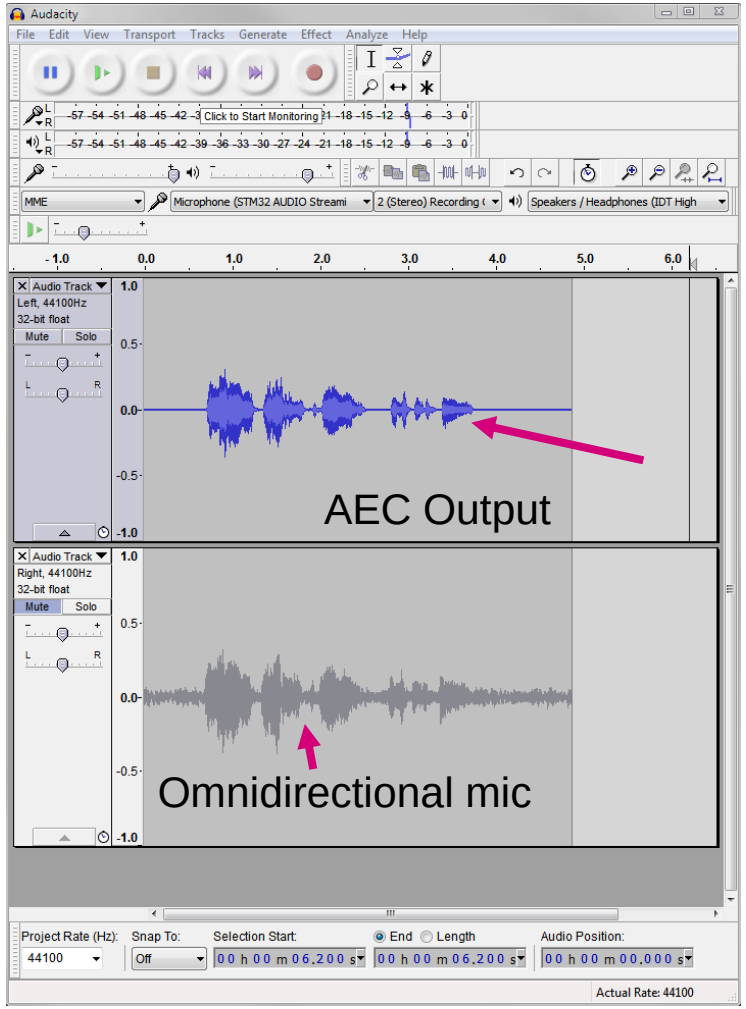
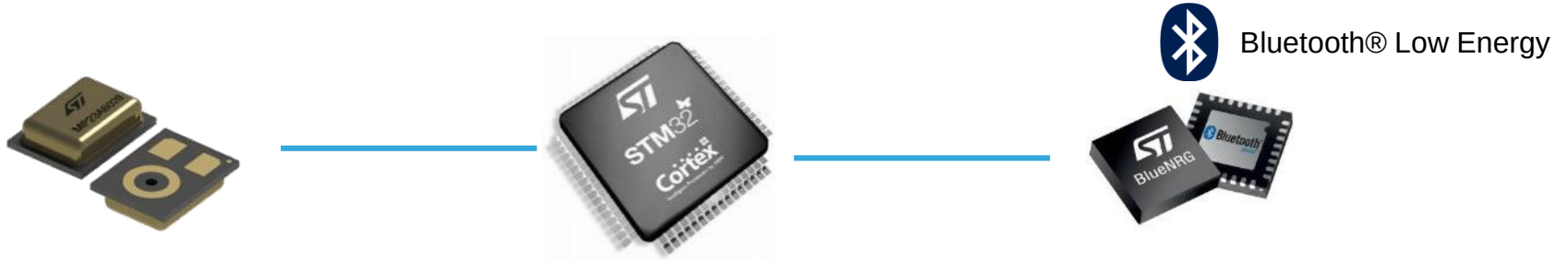
Acoustic Echo Cancellation





BlueVoice: audio over BlueTooth 4

The ST HW and SW solution for
Ultra low-power Voice streaming over Bluetooth Low-Energy



MEMS Microphone — Microcontroller — BlueNRG RF connectivity

STM32 Signal Processing and Application Firmware & Software

BLUEVOICELINK	BLE and microphone reference application based on STM32Cube
OSXBLUEVOICE	Voice-over-BLE vendor-specific profile library for STM32 and BlueNRG
BLUEMICROSYSTEM	Voice and Sensor data over a BLE link to an Android - iOS Smartphone App
BlueMS, BlueST-SDK	Bluetooth Smart and Sensors Technology Application for Android and iOS

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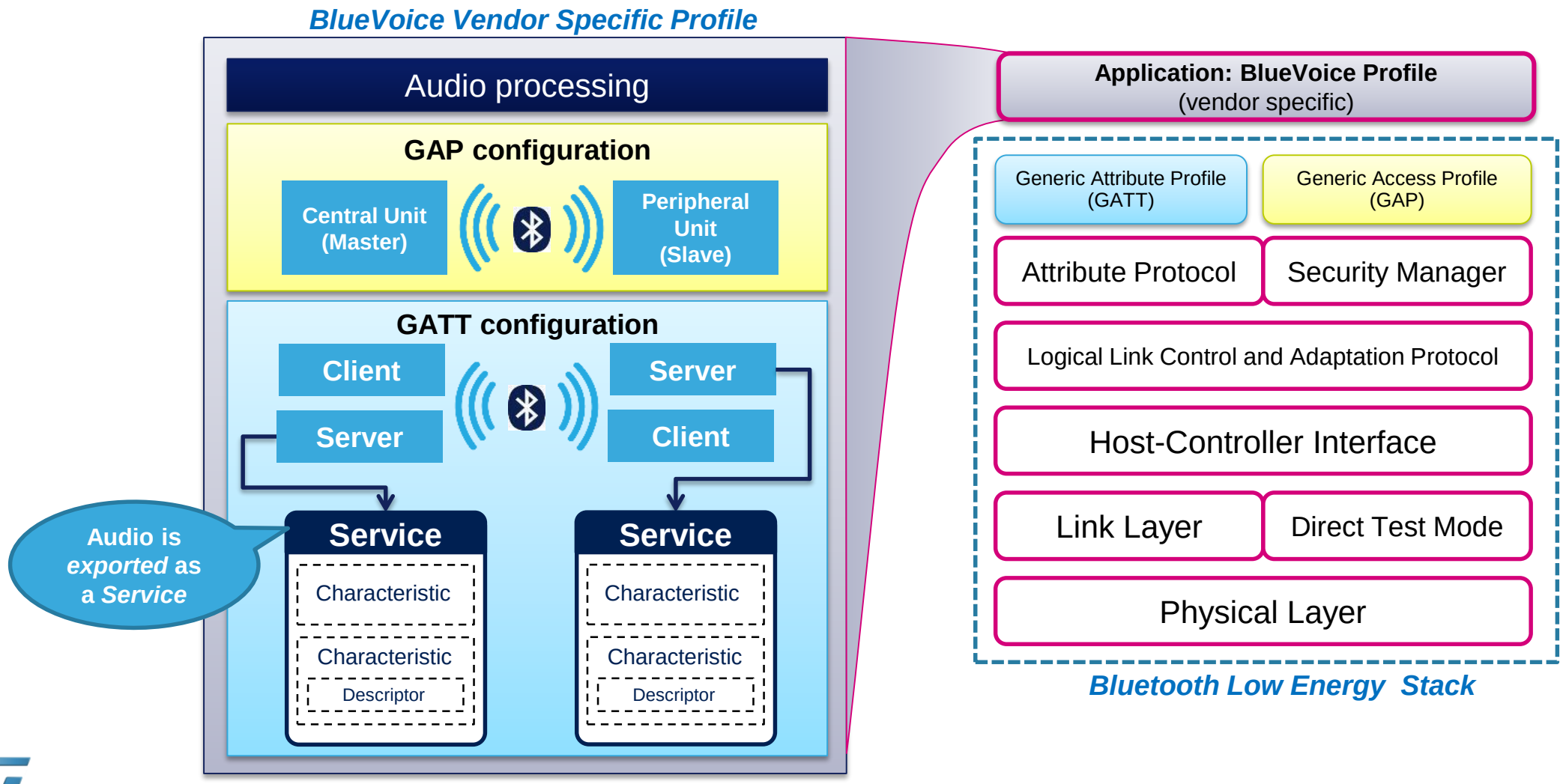
BlueVoice Mapping over Standard Bluetooth 4.0 protocol stack



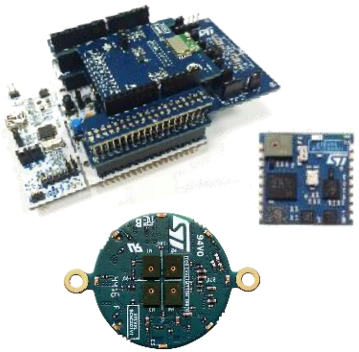
ST BlueMS & BlueVoice library

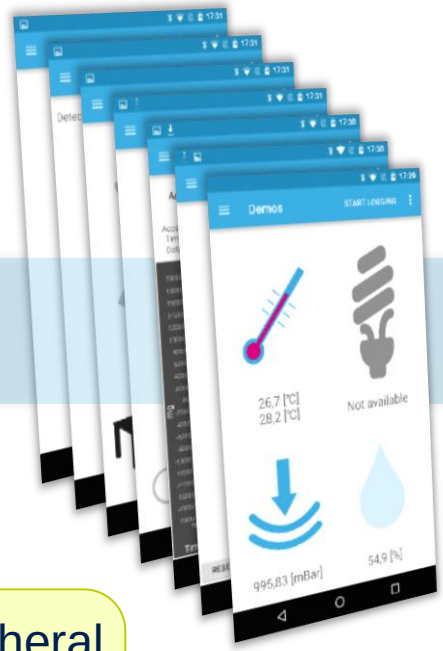
BlueVoice Service Integration in BlueMicrosystem environment

ST BlueMS available on Google Play and App Store

Download on the App Store

GET IT ON Google Play



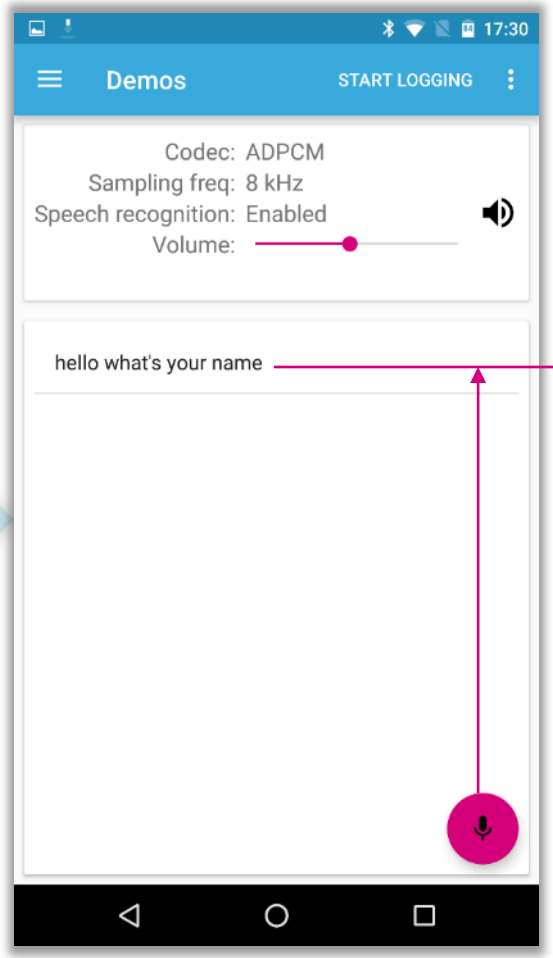


BlueVoiceLink1 2.0.0 - Peripheral

osxBlueVoice 2.0.0

8 kHz

ADPCM



Cloud-based ASR Service

Google

科大讯飞 iFLYTEK

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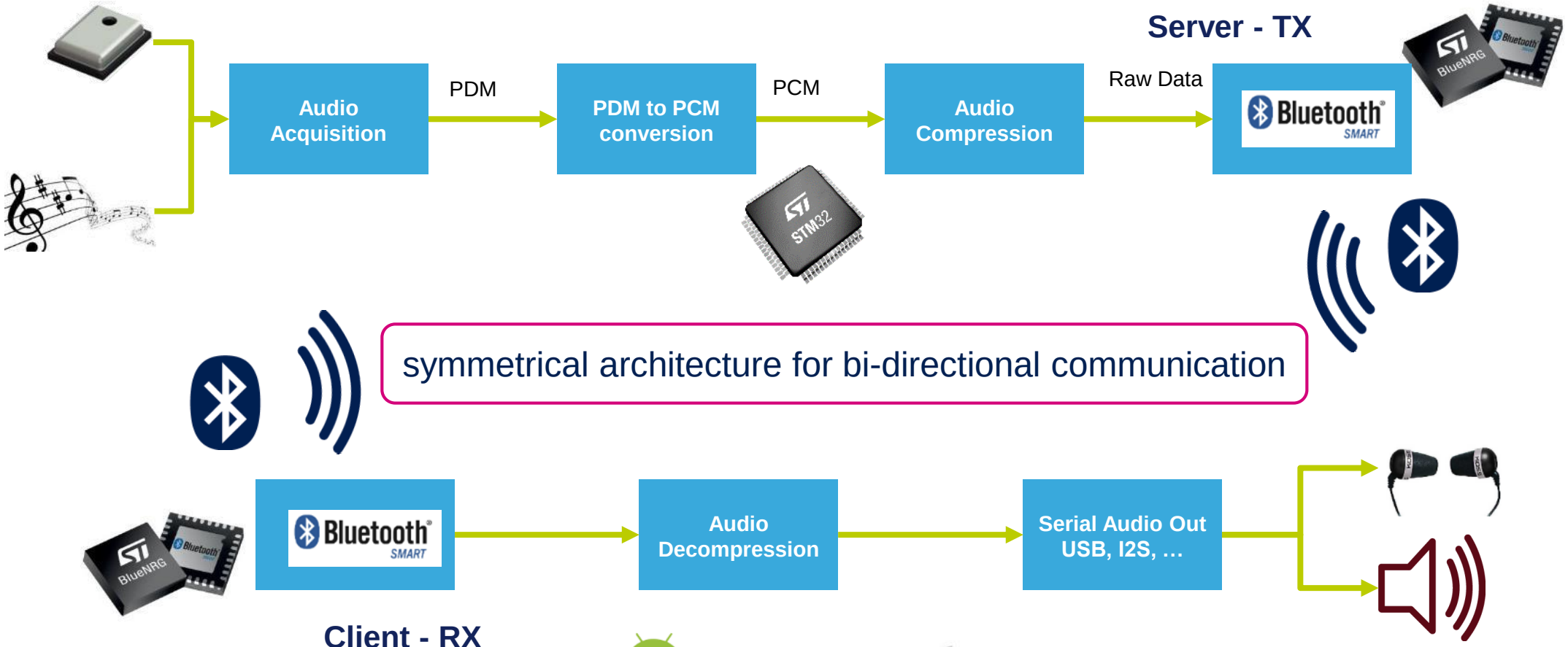
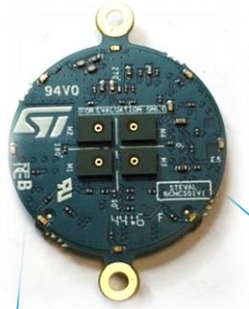
BlueVoice Architecture:

Audio processing and transmission



Coming in June 2017

BlueCoin Support for BlueVoice

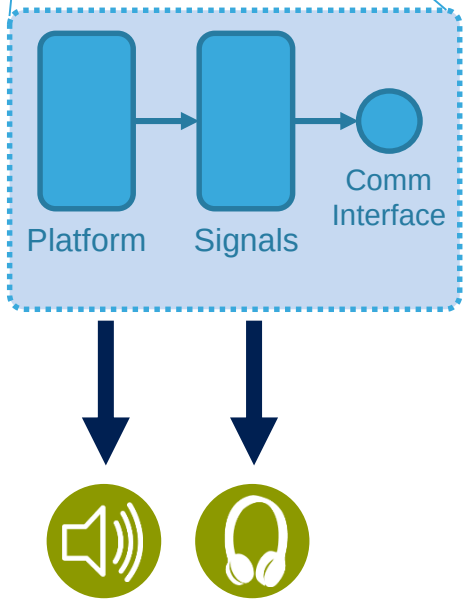


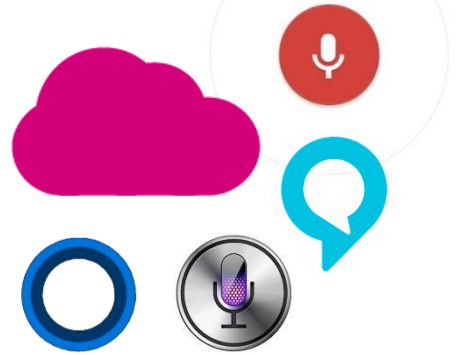
BlueCoin Terminal

Mobile Device

Cloud-based Services

«Natural Language»





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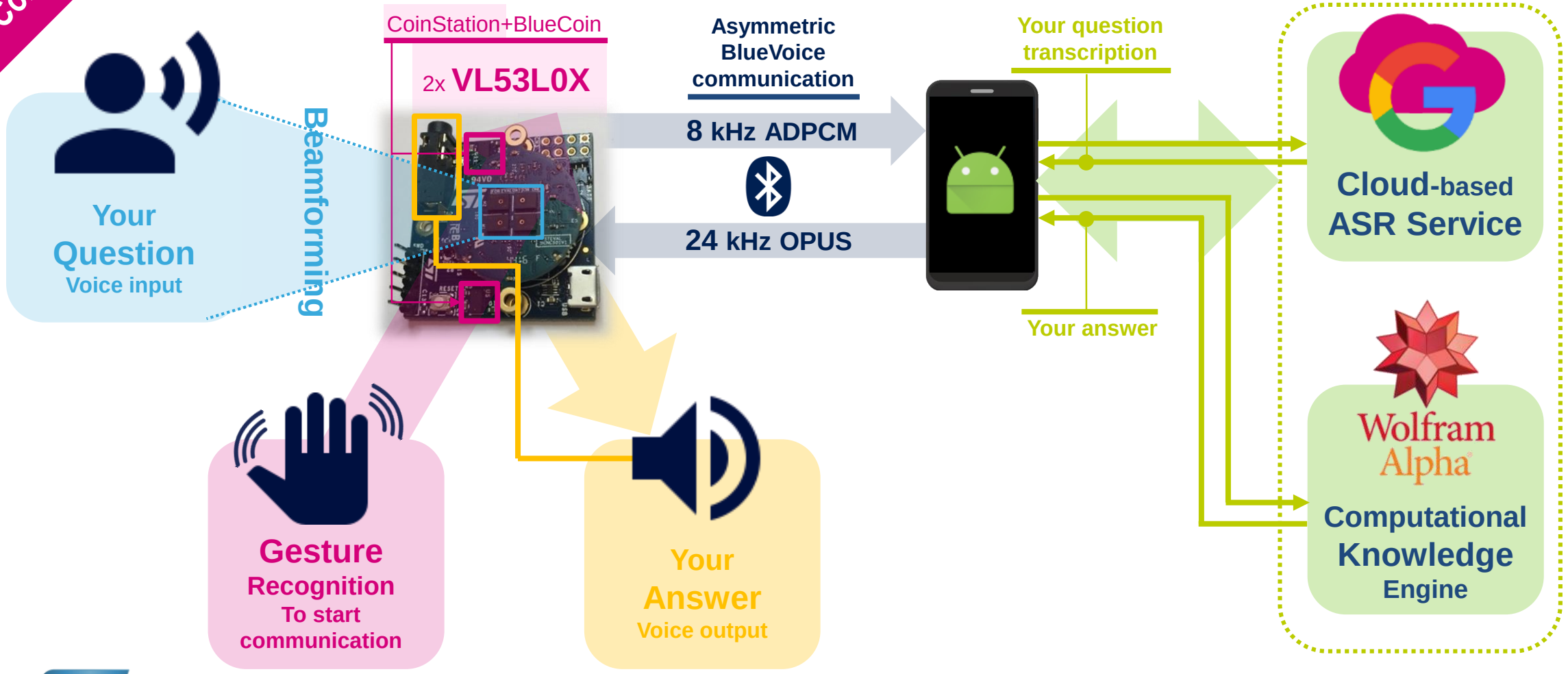
Coming in June 2017

Samantha VUI

Conversational Interface dev with Android and BlueCoin



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