

BlueNRG-Mesh SDK for Smart Industry

Sensors, lighting, security, and control...at your fingertips



BlueNRG-Mesh SDK
and Roadmap

BlueNRG-Mesh
and Machine Learning

Voice over Bluetooth LE
Remote Control

Long-Range Solutions
for Bluetooth LE



BlueNRG-Mesh SDK for Smart Industry

Mesh Embedded Provisioning, Machine Learning and Voice Control support



SensorTile.box

BlueNRG-Mesh support
LSM6DSOX IMU with
embedded Machine Learning
Environmental Sensors



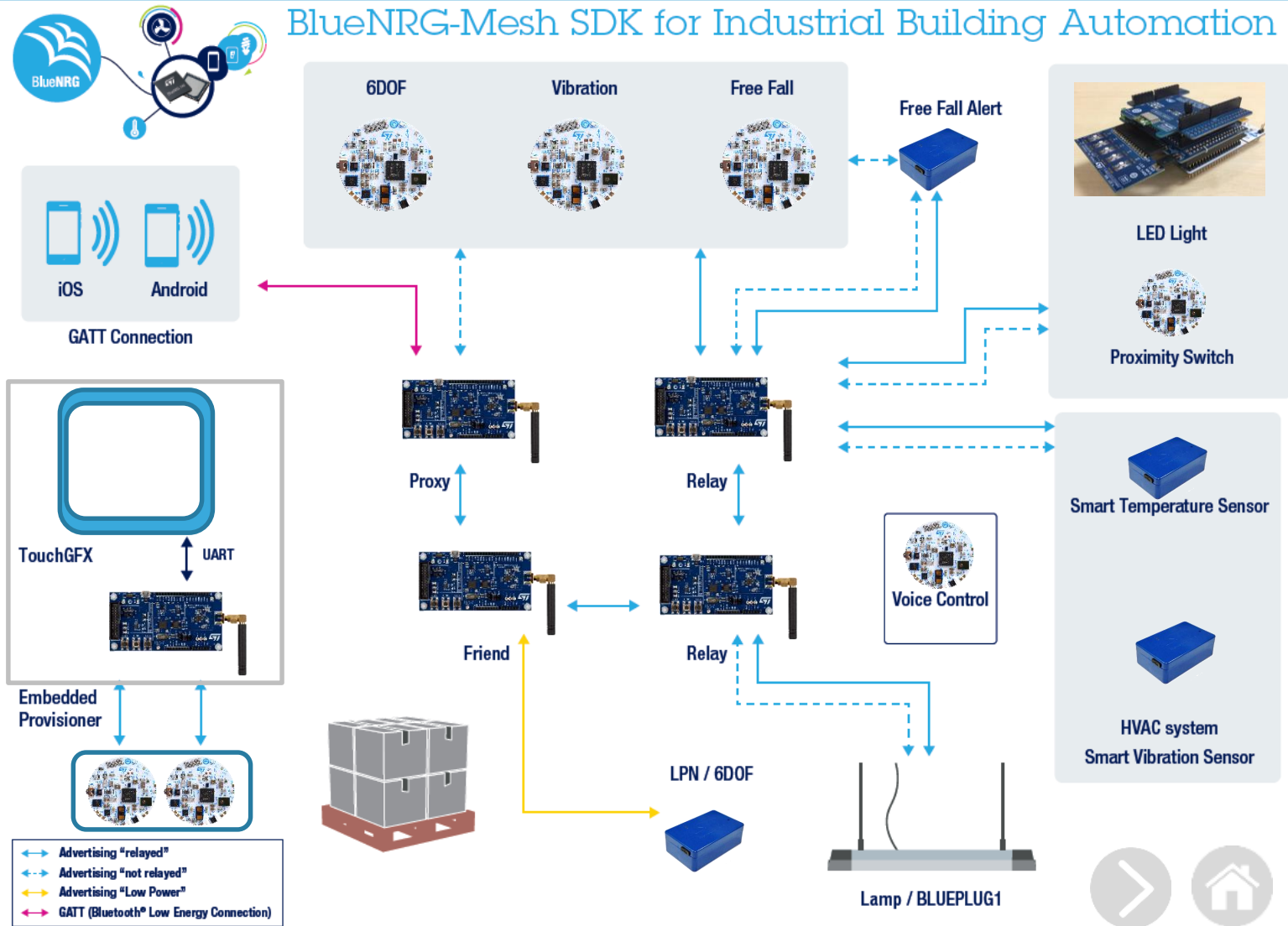
BlueNRG-2

Mesh support
Embedded Provisioner
Proxy, Relay, Friend Nodes



BlueNRG-Tile

Voice over Bluetooth LE
Proximity sensor





BlueNRG-Mesh

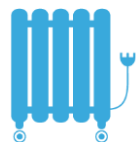
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Brings Smart-home to Your Fingertips

Easily connecting appliances to iOS and Android, out-of-the-box



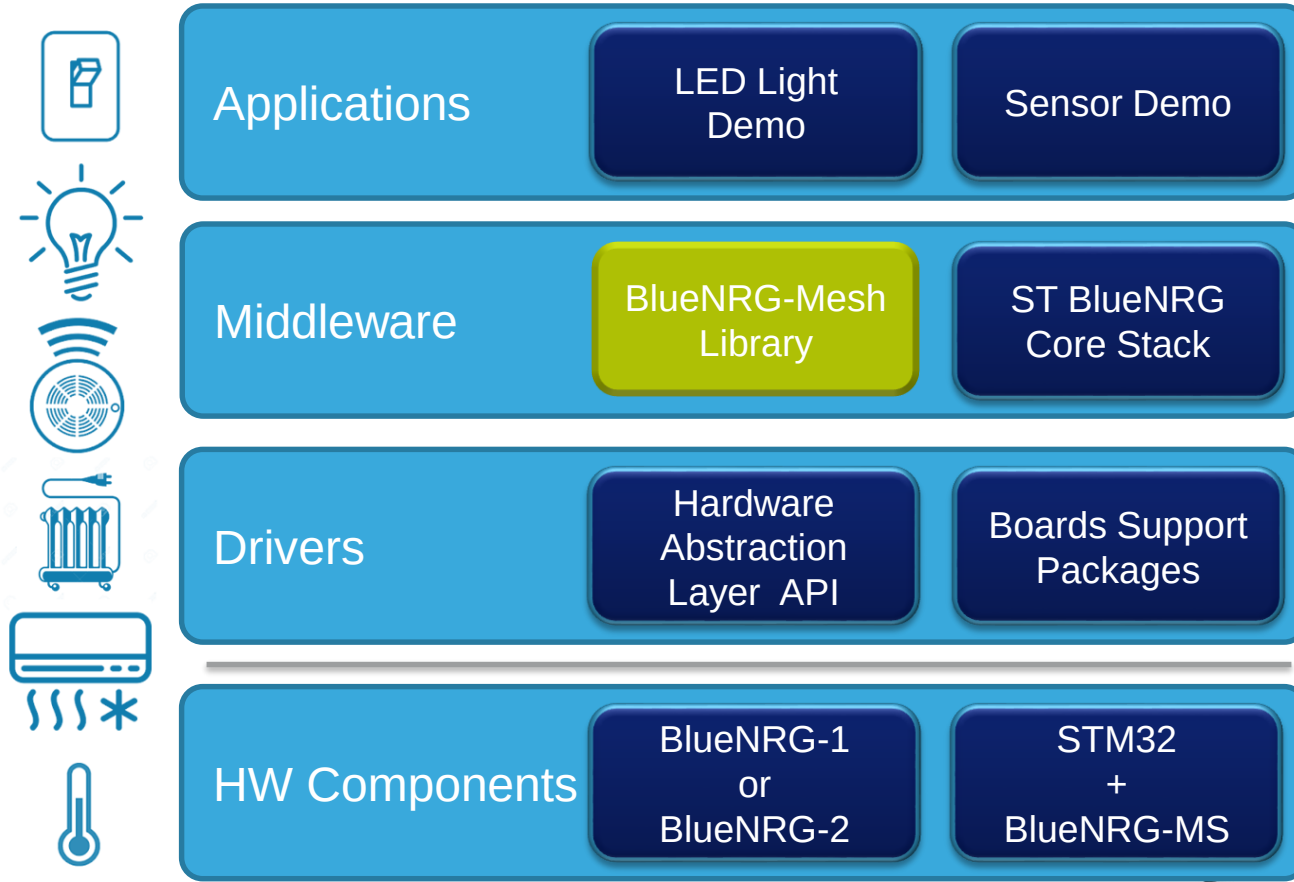
- Bluetooth **Mesh 1.0** certified **Profile Library** and **Bluetooth LE** stack
- **Two-layer security** (128-bit AES-CCM and 256-bit ECDH protocol)
- **Low-power** and **Friendship** supported
- Provisioned node **database transfer** among smartphones via Email and Cloud application
- **Embedded** and **Mobile SDK** to build both your Android and iOS Apps
- Reduces development costs and accelerates time-to-market



BlueNRG-Mesh SDK

BlueNRG-Mesh SDK: easy-to-use full ecosystem for Embedded, Android, and iOS

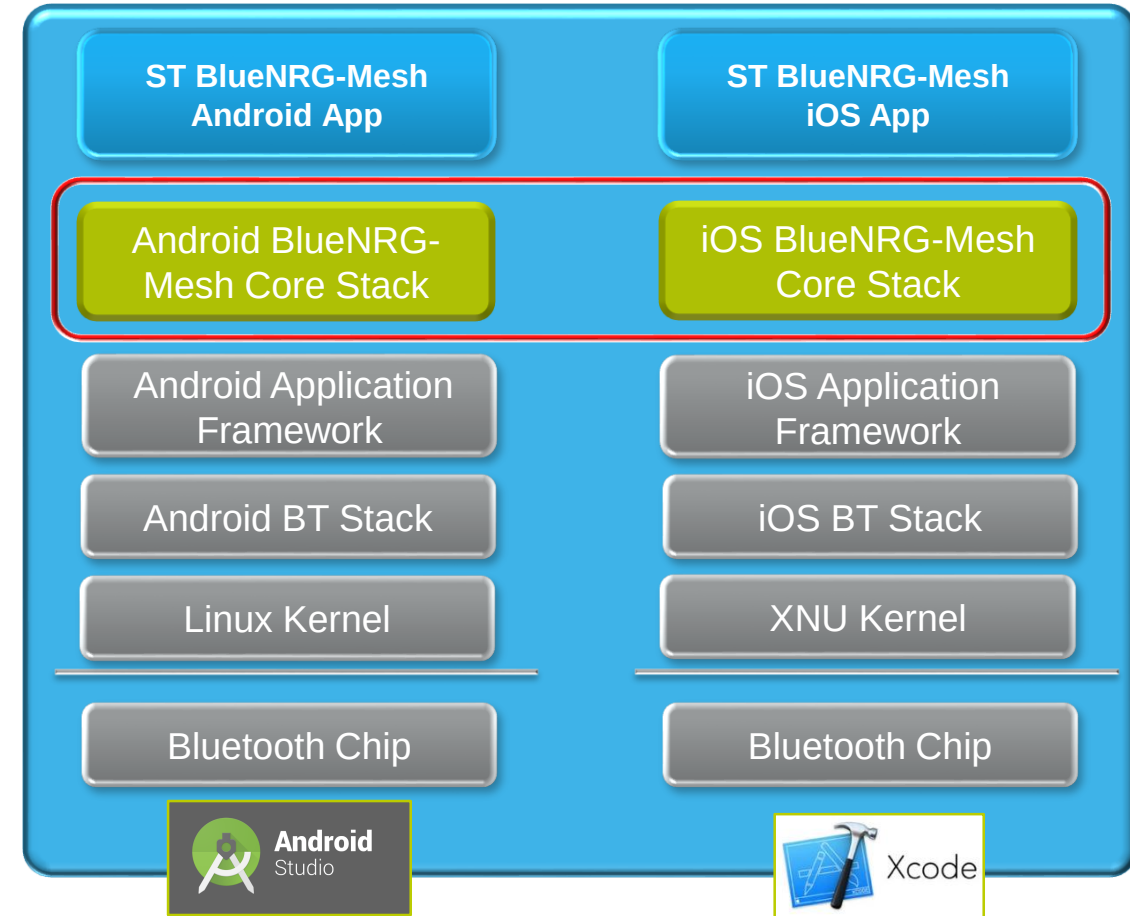
SDK SW packages: STSW-BNRG-Mesh, X-CUBE-BLEMESH1



Android SDK

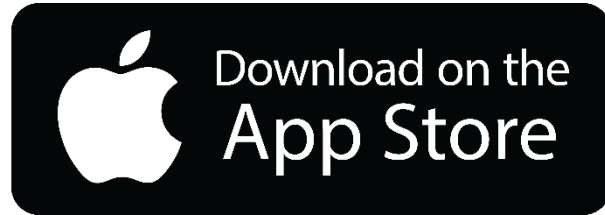


iOS SDK



BlueNRG-Mesh Apps 5

BlueNRG-Mesh SDK: easy-to-use full ecosystem for Embedded, Android, and iOS



<https://itunes.apple.com/us/app/bluenrg-mesh/id1348645067>



<https://play.google.com/store/apps/details?id=com.st.bluenrgmesh>

STSW-BNRRG-Mesh Software Suite

Documentation

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AN5285 - STSW-BNRRG-Mesh Friend and Low Power features

How to enable low power operation, according to Bluetooth Mesh Profile v1.0 and Friendship concept

UM2290 - BlueNRG Mesh Android API guide for Mesh over Bluetooth Low Energy

UM2417 - BlueNRG Mesh iOS API guide for Mesh over Bluetooth Low Energy

Start developing Bluetooth Low Energy Mesh applications on Android devices

- Network creation
- List un-provisioned nodes
- Provision a new node
- Send unicast/broadcast commands
- Save/Restore network configuration
- Register/Un-register callbacks

UM2180 - Getting started with the ST BlueNRG-Mesh Android application (*)

UM2361 - Getting started with the ST BlueNRG-Mesh iOS application (*)

Provision, un-provision, and control nodes in Bluetooth Low Energy Mesh network

UM2295 - Getting started with the ST BlueNRG-Mesh embedded firmware

Start developing Bluetooth Low Energy Mesh applications on available platforms

- Core functionality for secure provisioning and communication
- Smart Light sample application

(*) Differences due to available control and libraries to design the App
Unified User Interface available since v1.05.000



BlueNRG-Mesh SDK

BlueNRG-Mesh SDK: Certified by SIG

- **Mandatory Features:**

- **FW library compliant to the SIG specs v1.0**
- Role: Node (Features: Proxy, Relay)
- Bearer: Advertising, GATT
- Provisioning: PB-GATT
- Provisioning Protocol: Provisioning Server
- Provisioning: Public Key No OOB
- Foundation Mesh Models: Configuration Server, Health Server

- **Optional Features:**

- Friendship, Low Power Node

- **ST Additional Features**

- **Models: Generic, Lighting, Sensor, Vendor, Time & Scene**
- Light Intensity control (i.e. dimming) via Generic-Level message using PWM control
- Light LC controller' State Machine included
- **Provisioning information sharing** between mobile device (Android and iOS) **via JSON file by eMail & Cloud Synchronization**

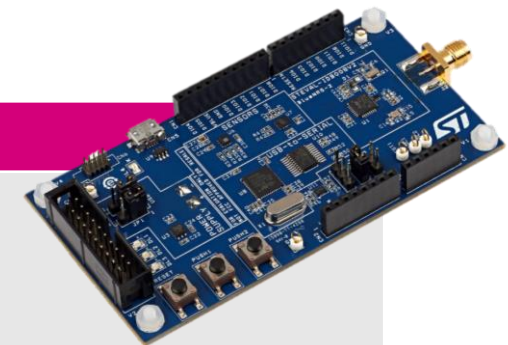


BlueNRG-Mesh Software Roadmap 8

August 2018	November 2018	March 2019	July 2019	December 2019
STSW-BNRG-Mesh v1.05.000 X-CUBE-BLEMESH1 v1.0.0	STSW-BNRG-Mesh v1.06.000 X-CUBE-BLEMESH1 v1.1.0	STSW-BNRG-Mesh v1.07.000 X-CUBE-BLEMESH1 v1.2.0	STSW-BNRG-Mesh v1.08.000 X-CUBE-BLEMESH1 v1.3.0 FP-SNS-BLEMESH1 v1.1.0	STSW-BNRG-Mesh v1.09.000 X-CUBE-BLEMESH1 v1.4.0* FP-SNS-BLEMESH1 v1.2.0*
• Friendship & Low Power • Health Model • Lighting Model • Key-refresh • IV Update procedure • DataBase transfer (via Cloud) • BT Mesh v1.0 Profile Certification • QDID 116029	• Performance Optimization • Generic Model • Server: OnOff, Level • Client: OnOff, Level • Lighting Model: Lighting HSL • Android & iOS supporting HSL Model • CID & PID Configuration • Sensor Model Example • Static OOB Provisioning	• Sensors Model • Lighting Model: Client • Time and Scene Model • Empty wrappers • PB-ADV – Provisioning over advertising	• Multiple App Keys • Neighbor table (indoor navig) • Output OOB, Input OOB, Public Key OOB Provisioning • Vendor Model to application layer	• Multiple Network Keys • Embedded Provisioner • BT Mesh v1.0 Server Models Certification ready (*) Deliverable in Q1-2020

Available Platforms

- STEVAL-IDB009V1 (BlueNRG-248)
- STEVAL-IDB008V2 (BlueNRG-2)
- STEVAL-IDB007V2 (BlueNRG-1)
- STEVAL-IDB007V1M (SPBTLE-1S) (**)
- STEVAL-BLUEMIC1 (SPBTLE-1S) (**)
- STM32 Open Development Environment (X-NUCLEO-IDB05A1)
 - On NUCLEO-L152RE, NUCLEO-L476RG, NUCLEO-F303RE, NUCLEO-F401RE
- BlueNRG-Plug (SPBTLE-1S)
- BlueNRG-Tile (BlueNRG-2)



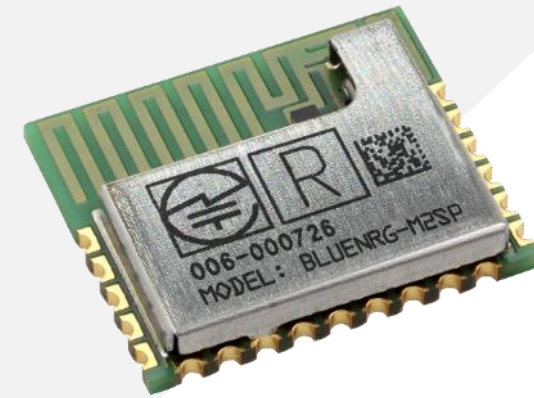
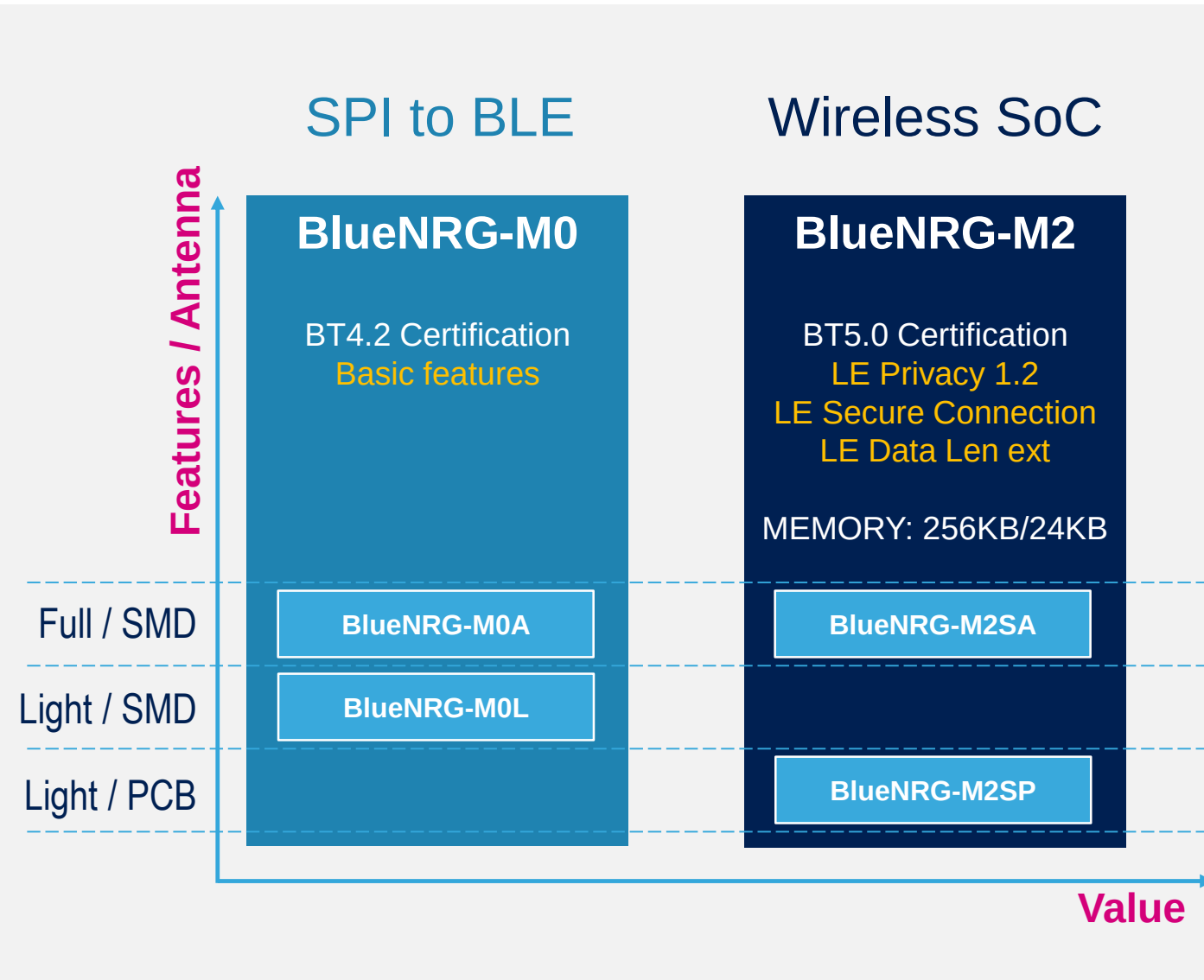
(**) Library package available upon request





BlueNRG Product Family

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Bluetooth 5

2.4 GHz
proprietary

Bluetooth SIG
Mesh





BlueNRG Modules Portfolio

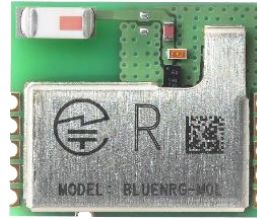
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Suitable for motion algorithms, audio, Mesh over BLE

SPI to BLE

based on

BlueNRG-M0L
BlueNRG-M0A



Ramp-up now

- Including high efficient chip antenna, filter and balun **BALF-NRG-01D3**
- BLE4.2 certification
- Up to **+6 dBm** output power
- 5-wires **SPI interface** to external host



BLE SoC

based on

BlueNRG-M2SA
BlueNRG-M2SP



Ramp-up Q4 2019

- Including high efficient chip antenna [-M2SA] or PCB antenna [-M2SP], filter and balun **BALF-NRG-02D3**
- BLE5.0 certification
- Up to **+5 dBm** [-M2SA] or **+7 dBm** [-M2SP] output power
- Extensive **peripheral set**



- Bluetooth SIG End Product certification
- CE/RED qualified, FCC/IC/TELEC modular approval certified

- -85 dBm Rx sensitivity
- Small form factor: 13.5 x 11.5 x 2 mm

- Industrial temperature range: -40 °C to +85 °C
- Power supply voltage from 1.7V to 3.6V



Featured BlueNRG-LP SoC

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FEATURED BLUETOOTH 5.0 RADIO

- Full Featured **Bluetooth LE 5.0**
 - Long-range 125Kbps and 500Kbps
 - Channel Selection Algorithm #2
 - Advertisement Extension
 - Advertising Data Set
 - 2Mbps Data Rate
 - GATT caching
- Bluetooth LE 5.1 Errata

RADIO PERFORMANCES

- -104dBm RX Sensitivity @ 125Kbps
- -100dBm RX Sensitivity @ 500Kbps
- -97dBm RX Sensitivity @ 1Mbps
- -93dBm RX Sensitivity @ 2Mbps
- +8dBm Power Output (1dBm steps)
- LF RC oscillator jitter 135ppm

ULTRA LOW-POWER

- 3.8mA (*) Rx Current @ Sensitivity Level
- 4.3mA Tx Current @ 0dBm
- 50nA in SHUTDOWN mode
- 1.2 uA in DEEPSTOP mode (w/ LSE osc)

AUDIO PERIPHERALS

- Digital microphone input (PDM)
- Analog microphone with bias and PGA
- I2S digital I/O interface up to 96KHz

SOFTWARE and SDK

- Linkable BLE 5.0 stack library
- 2.4GHz proprietary driver
- L2CAP channel-oriented connections driver
- BLE Mesh featured SDK

DESIGN FLEXIBILITY

- Designed for 2-layer PCB
- Integrated DC/DC and LDO step-down converter
- Integrated RF BALUN with 50Ω single-ended output

DIGITAL and ANALOG PERIPHERAL SET

- Up to 32 GPIOs
- 1xSPI, 2xSPI/I2S, 2xI2C, 1xUSART, 1xLPUART
- 1xRTC, 1xSysTick, 1x16-bit Timer/PWM
- 12-bit ADC up to 200KHz Fs
 - ENOB: 11.5 bit in DIFF, 11.1 bit in SE
 - STHD: 80.5dB in DIFF, 78dB in SE

PACKAGE

- WLCSP49 3.14 x 3.14 mm, pitch 0.4mm, 30 I/Os
- QFN32 5x5 mm, pitch 0.5mm, 20 I/Os
- QFN48 6x6 mm, pitch 0.4mm, 32 I/Os

PROCESSING UNIT

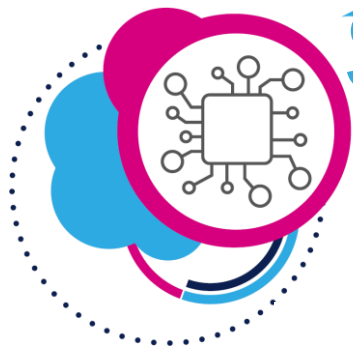
- ARM Cortex-M0+, 64 MHz, 256 KB Flash, 64 KB SRAM
- Dynamic power consumption: 40uA/MHz

SECURITY FEATURES

- PKA, AES (256-bit), ECC (256-bit), TRNG, CRC
- 48-bit unique ID
- Secure boot and firmware update

(*) A lower power mode exists at 3.5 mA with sensitivity 2dB higher





SensorTile.Box and Machine Learning

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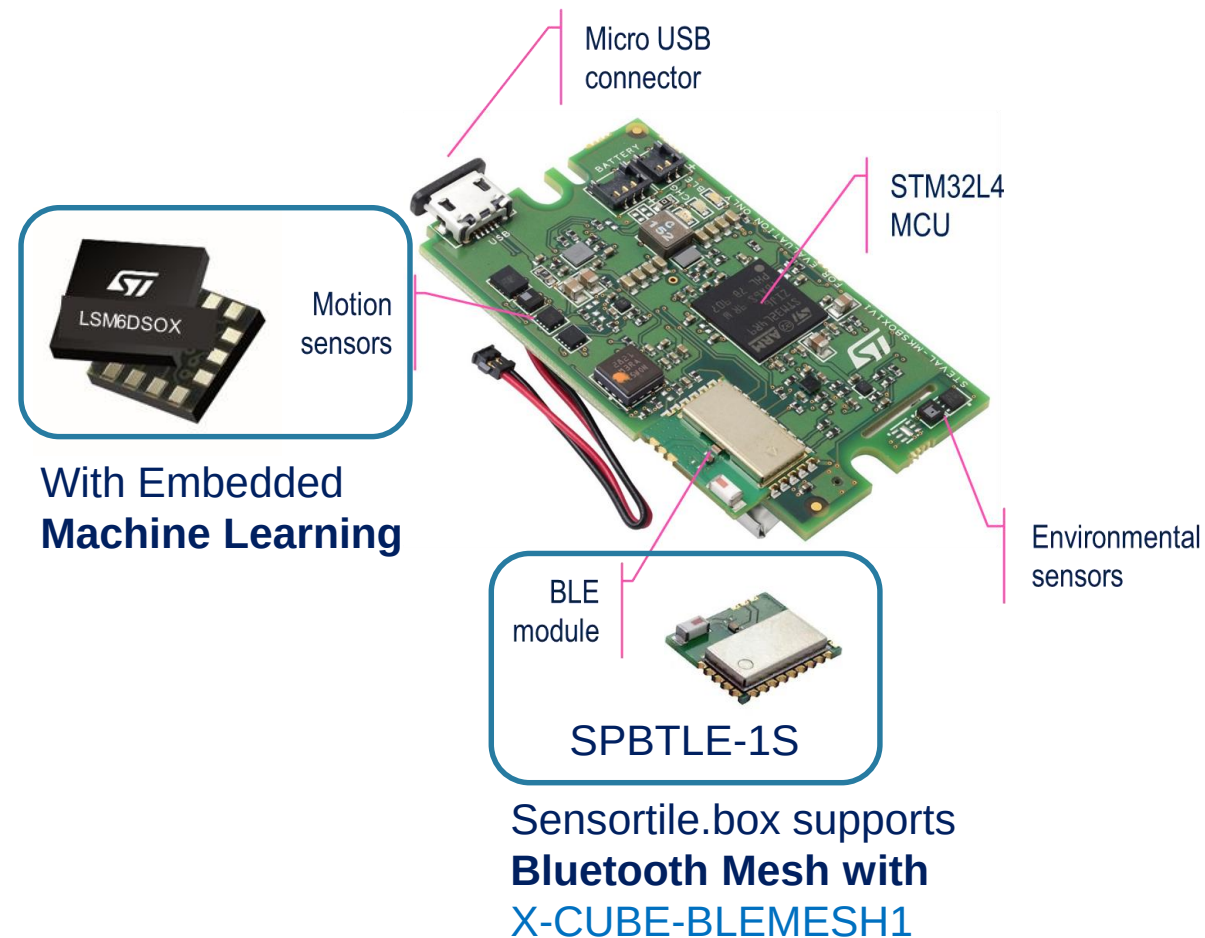


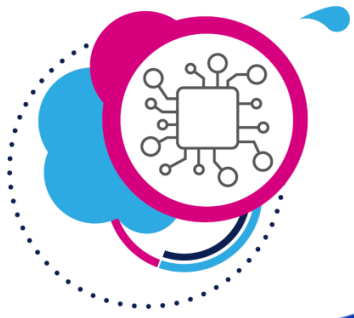
A ready-to-go IoT Node

Built into a compact IP54 casing

Bundled with app for Smartphone

- 500 mA-h Li-Po battery
- 8 GB μ SD card as mass memory extendable to 64 GB





Inside the SensorTile.box

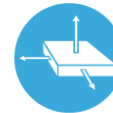
Sensing, Processing and Connectivity

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Motion Sensors



Low-power 6-axis IMU,
embedding Neural Network
LSM6DSOX



High-performance and low
power accelerometers
LIS3DHH & LIS2DW12



Magnetometer
LIS2MDL

Environmental Sensors



Altimeter / Pressure sensor
LPS22HH



Accurate temperature sensor
STTS751



Humidity sensor
HTS221



Analog wide-band microphone
MP23ABS1

Processing



STM32L4
STM32L4 low-power MCU
STM32L4R9ZIJ6

Connectivity



Bluetooth Low Energy Module
SPBTLE-1S

Power management



Battery charger
STBC02

Compatible with “ST BLE Sensor” app



- Compact casing, IP54-compliant
57 x 38 x 20 mm (L x l x h)
- 500 mA-h Li-Po battery
- 8 GB μ SD card as mass memory
extendable to 64 GB

Machine Learning Core steps

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Machine Learning Core configuration



Operating Mode

Capture Data



1

Build Decision Tree



3

Process new data
using trained Decision Tree



5

2

Label Data
Filters and Features
computation



4

Embed Decision Tree
in MLC configuration



Current Consumption Improvement

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10 to 100 times better current consumption with MLC!

Activity recognition library (MotionAR)
running **in SW in MCU**

LSM6DSOX Sensor	Sensor Current consumption
Core	15 μ A
MLC – not used	0 μ A

MCU	Wake-up rate	MCU Current consumption
STM32L476RG	1/16 = 63ms	51 μ A

Activity recognition algorithm
running **inside LSM6DSOX**

LSM6DSOX Sensor	Sensor Current consumption
Core	15 μ A
MLC	4 μ A

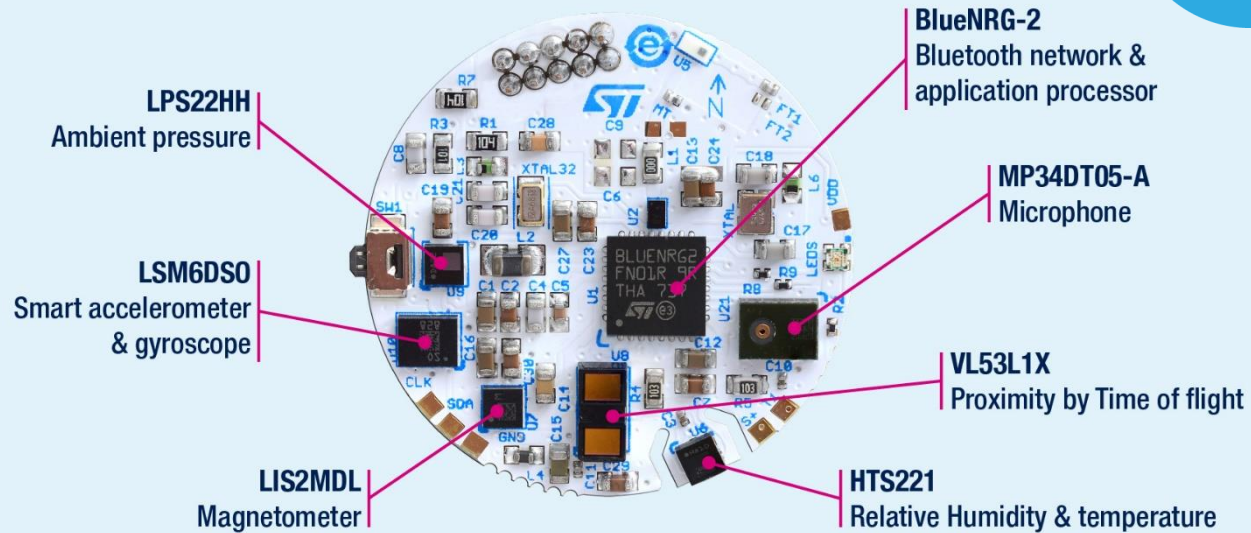
MCU	Wake-up rate	MCU Current consumption
STM32L476RG	1 s	2.8 μ A
	30 s	0.65 μ A
	100 s	0.59 μ A

BlueNRG-Tile: STEVAL-BCN002V1B

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Sensing, Processing and Streaming

BlueNRG-Tile, all-in-one sensor node
just 25mm diameter



Ultra-low-power software libraries for:

Voice over BLE:

- High quality voice capturing and compression

Motion Algorithms:

- Gesture and Activity recognition

BLE Mesh:

- Range-extending networks with duplex communication

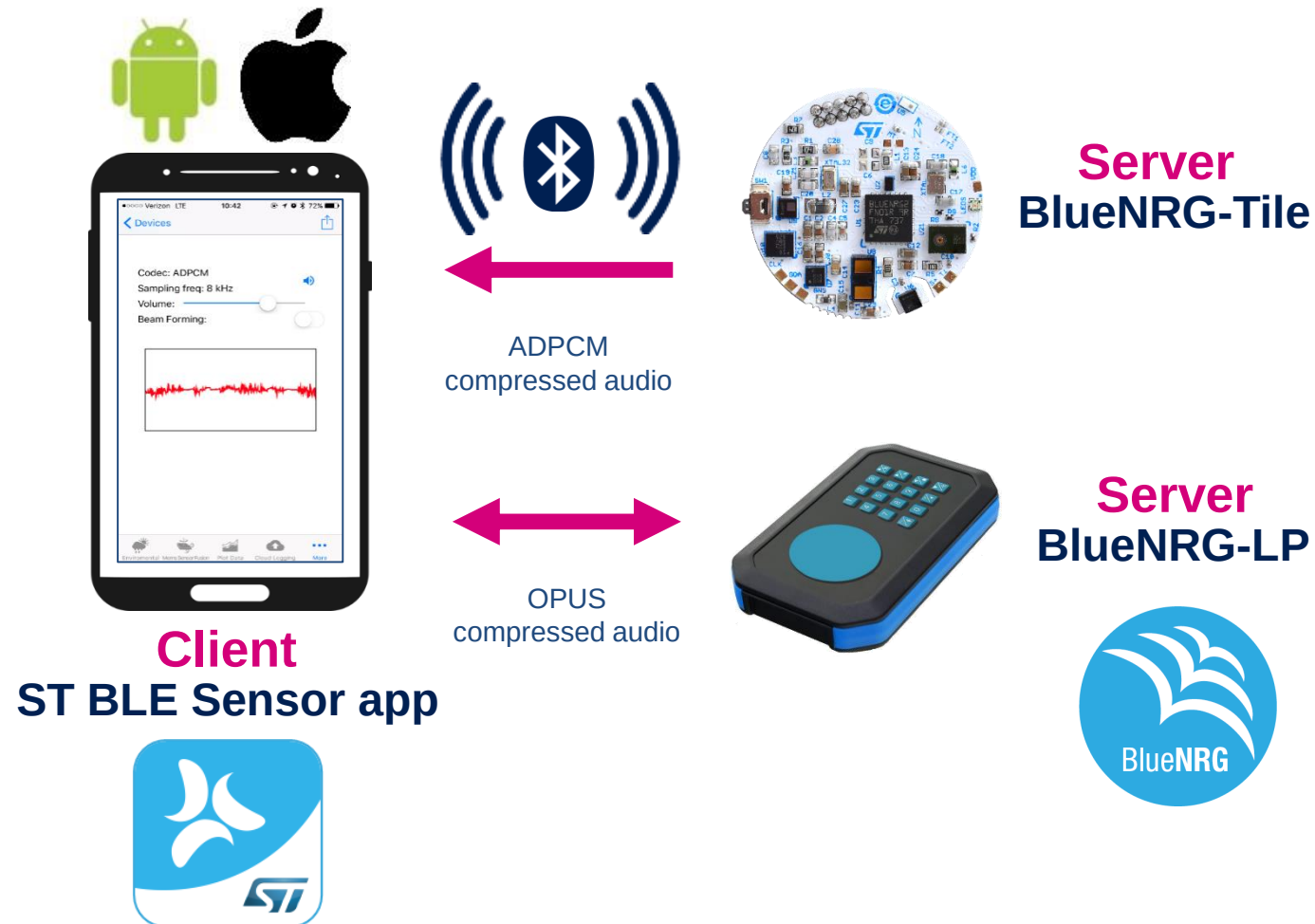


BlueNRG-Tile: STEVAL-BCN002V1B

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ADPCM compressed Audio

Voice over BLE

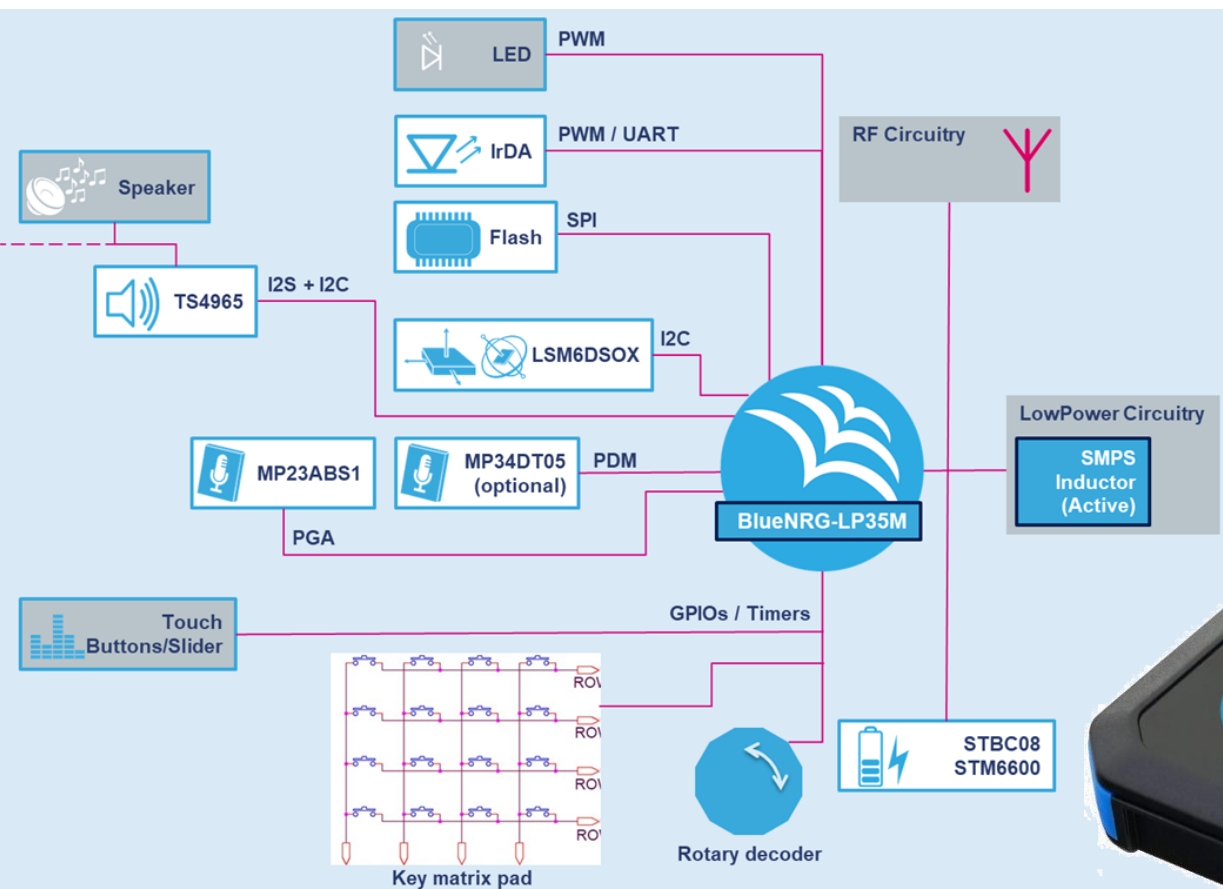




Voice over Bluetooth LE Block Diagram

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Remote and Gaming-controller reference design



2-layer PCB & Printed Antenna

~30-40% cost saving

Very low-power consumption

~50-60% power saving

Featured capabilities

Gesture, Voice input, Audio playback,
Touch slider, IrDA, Wireless charger

+30% added value





BlueNRG-LP: Full featured Bluetooth 5.0

Go Faster, Go Further

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Who

Long-Range Bluetooth 5

What

Extended coverage

How

Adaptive on-Air bitrate down to 125kbps and LE Coded PHY with Forward Error Correction

Why

New Smart City, Smart Home and Industrial applications

When

now! Using **BlueNRG-LP**

Demo setup: Coded PHY vs 1M PHY vs 1M PHY + PA in indoor environment

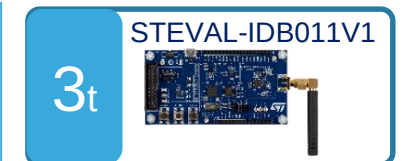
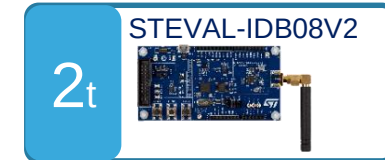
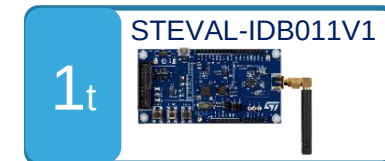
Receivers

(continuously measure PER)



Transmitters

(continuously send 100 packets)



d1

d2

Demo setup: Coded PHY vs 1M PHY vs 1M PHY + PA in indoor environment

Receivers

(continuously measure PER)

1_r

STEVAL-IDB011V1

BlueNRG-LP
Coded PHY S8

2_r


BlueNRG-2
1M PHY Legacy

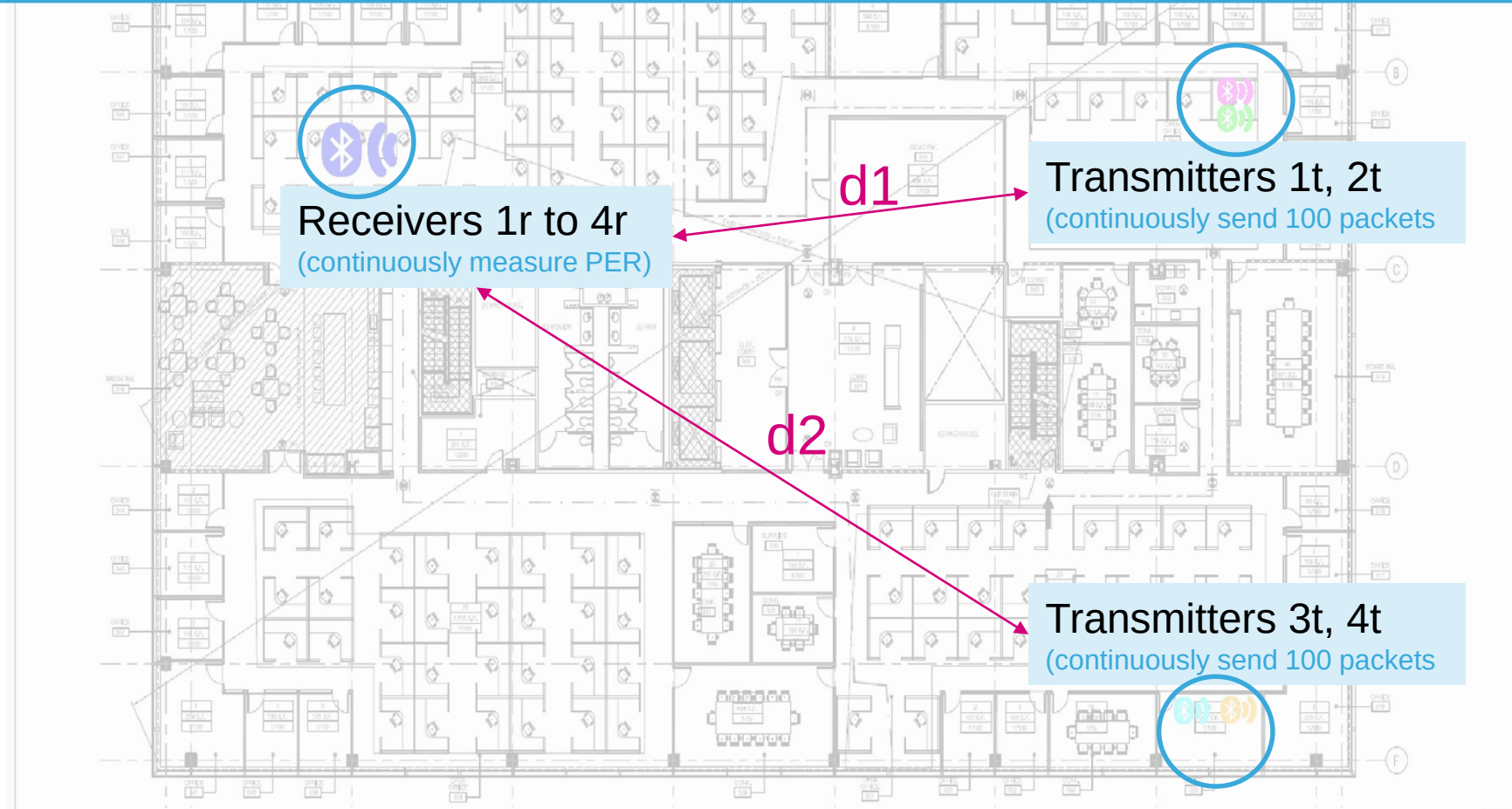
3_r

STEVAL-IDB011V1

BlueNRG-LP
Coded PHY S8

4_r


BlueNRG-2 + PA
1M PHY Legacy



Coded PHY improves robustness in indoor multipath environment

Receivers

(continuously measure PER)

1r

STEVAL-IDB011V1

BlueNRG-LP
Coded PHY S8

2r

BlueNRG-2
1M PHY Legacy

3r

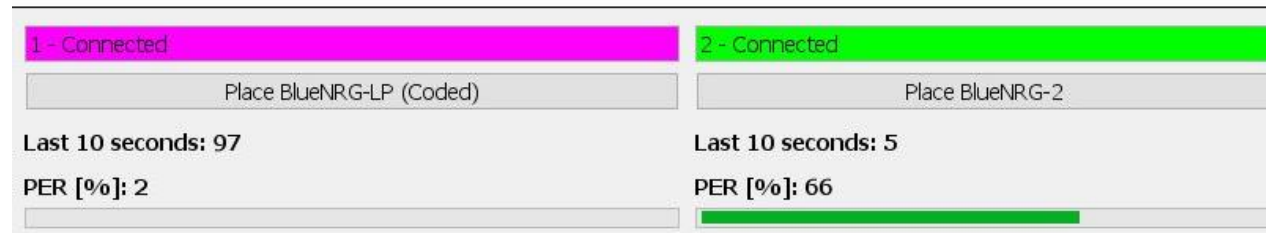
STEVAL-IDB011V1

BlueNRG-LP
Coded PHY S8

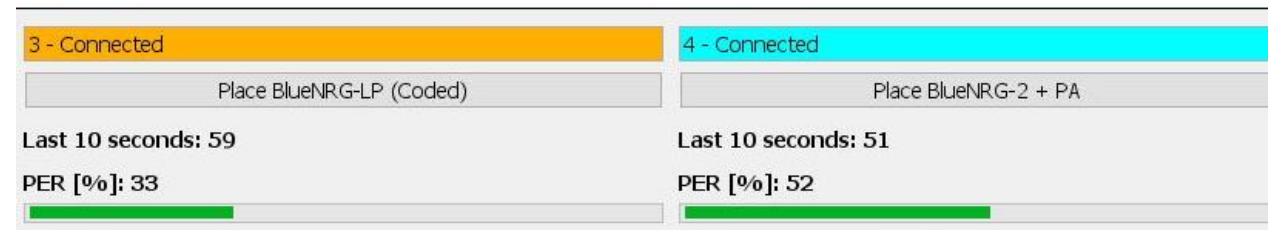
4r

BlueNRG-2 + PA
1M PHY Legacy

Coded PHY vs 1M PHY PER



Coded PHY vs 1M PHY + PA PER





BlueNRG SoC product family

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Device	BlueNRG-MS	BlueNRG-1	BlueNRG-2	BlueNRG-LP (ALPHA SAMPLING)
Bluetooth certification	BLE 4.2	BLE 4.2	BLE 5.0 (*)	BLE 5.1 (2Mbps / LR / AE, GC)
Core	Network Processor	ARM CM0 up to 32MHz	ARM CM0 up to 32MHz	ARM CM0+ up to 64MHz
Core efficiency	-	25 µA/MHz @ 32MHz	25 µA/MHz @ 32MHz	25 µA/MHz @ 64MHz
Memory [KB]	-	160KB Flash 24KB Ram	256KB Flash 24KB Ram	256KB Flash 64KB RAM
BLE Sensitivity[dBm]	-88	-88	-88	-97
Max Power level [dBm]	+8	+8	+8	+8
RX Current consumption [mA] @ sensitivity level	7.7	7.7	7.7	3.8
TX Current consumption [mA] @ 0dBm	8.3	8.3	8.3	4.3
Sleep Current [µA] (RAM=24KB)	1.1	0.9	0.9	1.0
Operating Voltage [V]	1.7-3.6	1.7-3.6	1.7-3.6	1.7-3.6
Clock Low Freq. [KHz]	32 (crystal or RO)	32 (crystal or RO)	32 (crystal or RO)	32 (crystal or RO)
Clock High Freq. max [MHz]	32	32	32	64
Operating Temperature [°C]	-40 up to +85	-40 up to +105	-40 up to +105	-40 up to +105
Package	QFN32 5x5 15 GPIOs WLCSP34 2.66 x 2.56 14 GPIOs	QFN32 5x5 15 GPIOs WLCSP34 2.7x2.6 14 GPIOs	QFN32 5x5 15 GPIOs QFN48 6x6 26 GPIOs WLCSP34 2.7x2.6 14 GPIOs	QFN48 6x6 WLCSP49 3x3

