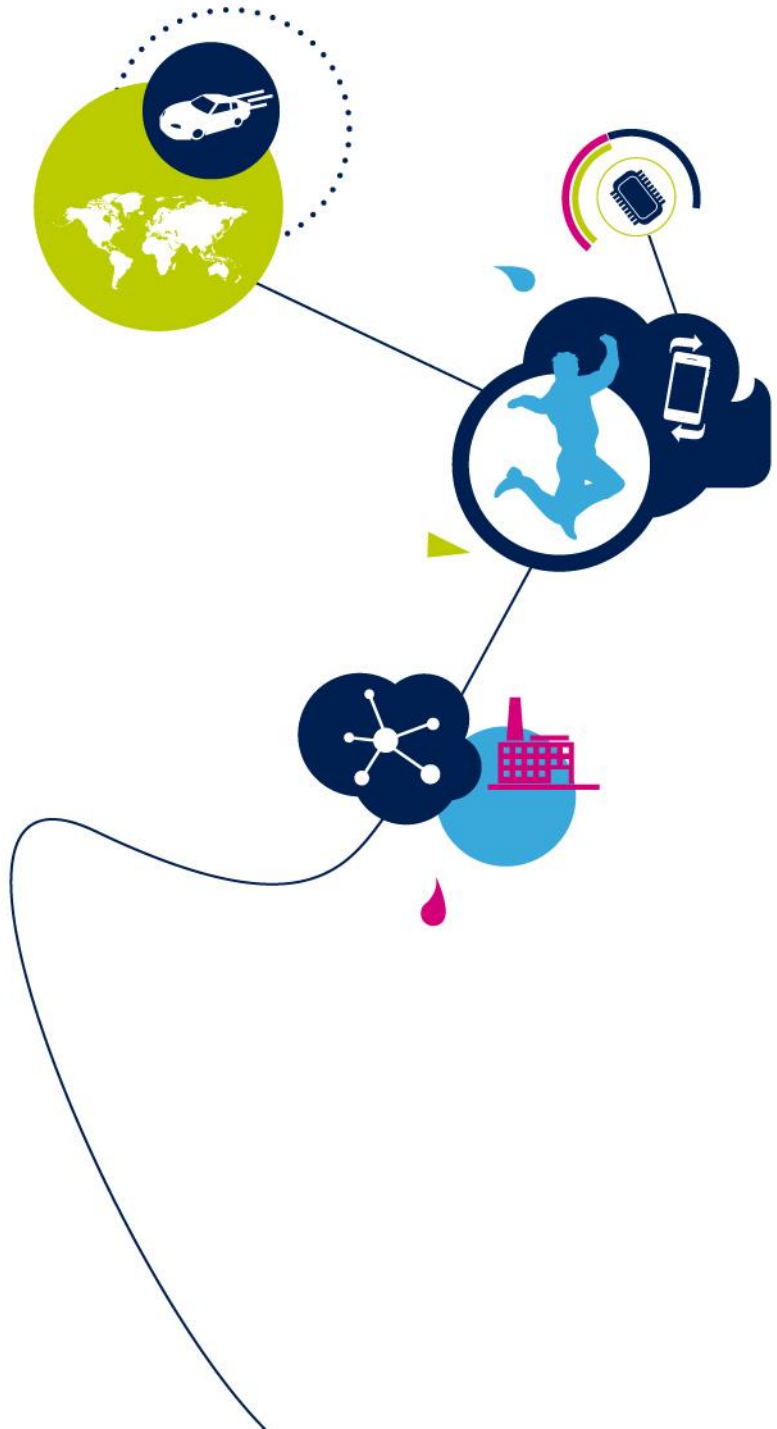
新一代无线微控制器STM32WB



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STM32 的产品布局与定位

17条产品线，超过60个产品线，千款型号，I/O兼容

Note ● ：Cortex-M0+无线协处理器 ● ：Dual Arm Cortex-A7 + Cortex-M4处理器

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新一代无线微控制器STM32WB

- 高性能
- 多协议并发
- 安全
- 低功耗
- 低成本
- 快速进入市场

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选择 STM32WB系列

七大产品特性，改变开发现状

动态多协议并发

开放的2.4 GHz 射频
多协议

高性能 低功耗

双核 / 全面控制
超低功耗

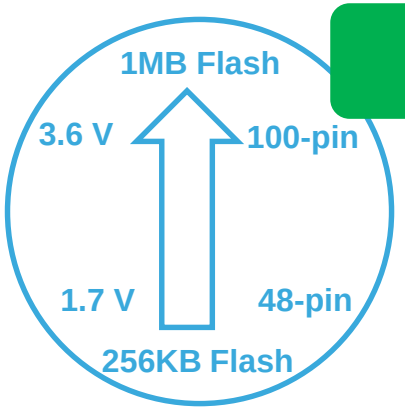
安全

物联网保护

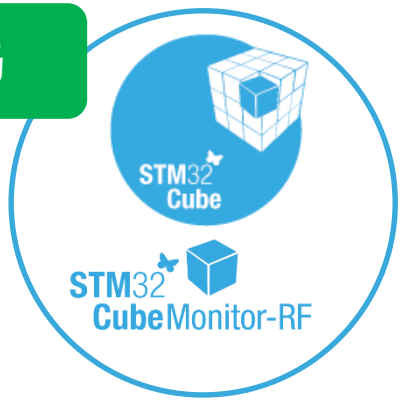
低成本

大规模集成
节省成本

快速进入市场



产品种类丰富



先进的射频开发和功耗控制
工具、能够生成C代码

10年供货保证，
免除后顾之忧

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高性能

STM32灵活的BLE解决方案

STM32产品系列包括600多个型号，从ARM Cortex-M0 +内核到M7可选
闪存从8KB到2MB，连接性，强大的模拟性能和多种封装选择

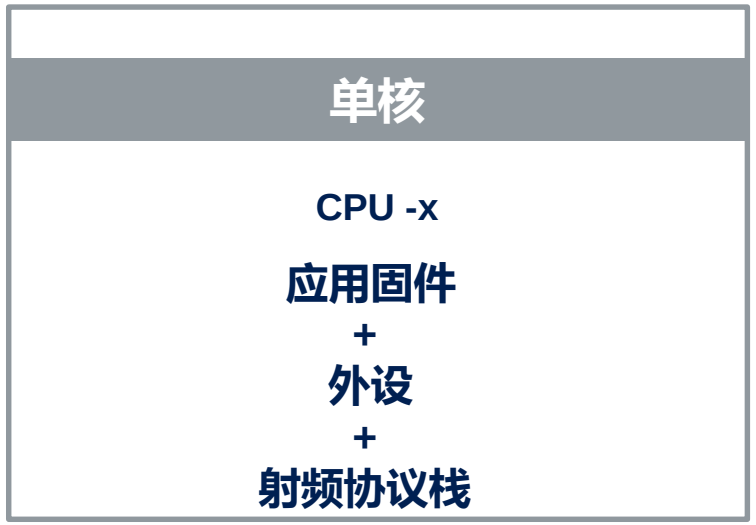
前所未有的MCU组合，实现独特的组合

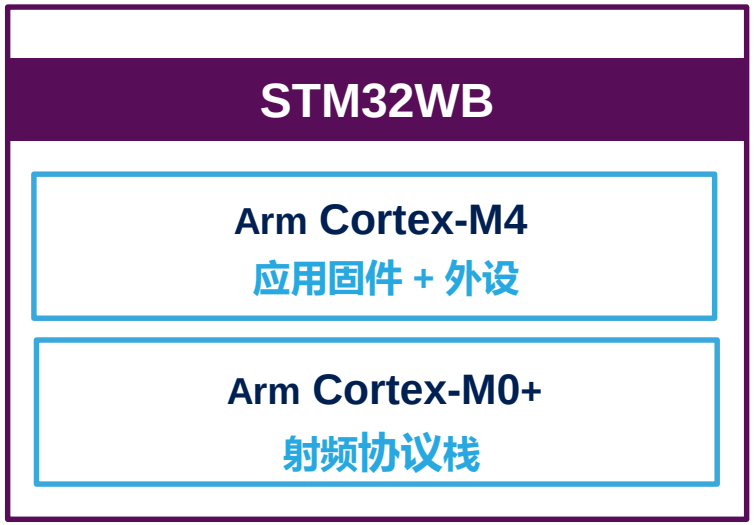
超低功耗与射频结合的微控制器

新一代无线微控制器STM32WB

双核开发简易

2个独立处理器内核，保证实时处理





- **缺点**
  - 分时共享
  - 任务处理时间长 – 功耗高
  - 需要配套 MCU (成本增加)

- **优势**
  - 单系统芯片方案 (只有一颗裸片)
  - 高灵活度-开发简易 -用户体验好
  - 延长电池续航时间
  - 全合一方案 - 节省成本
  - 加快产品上市

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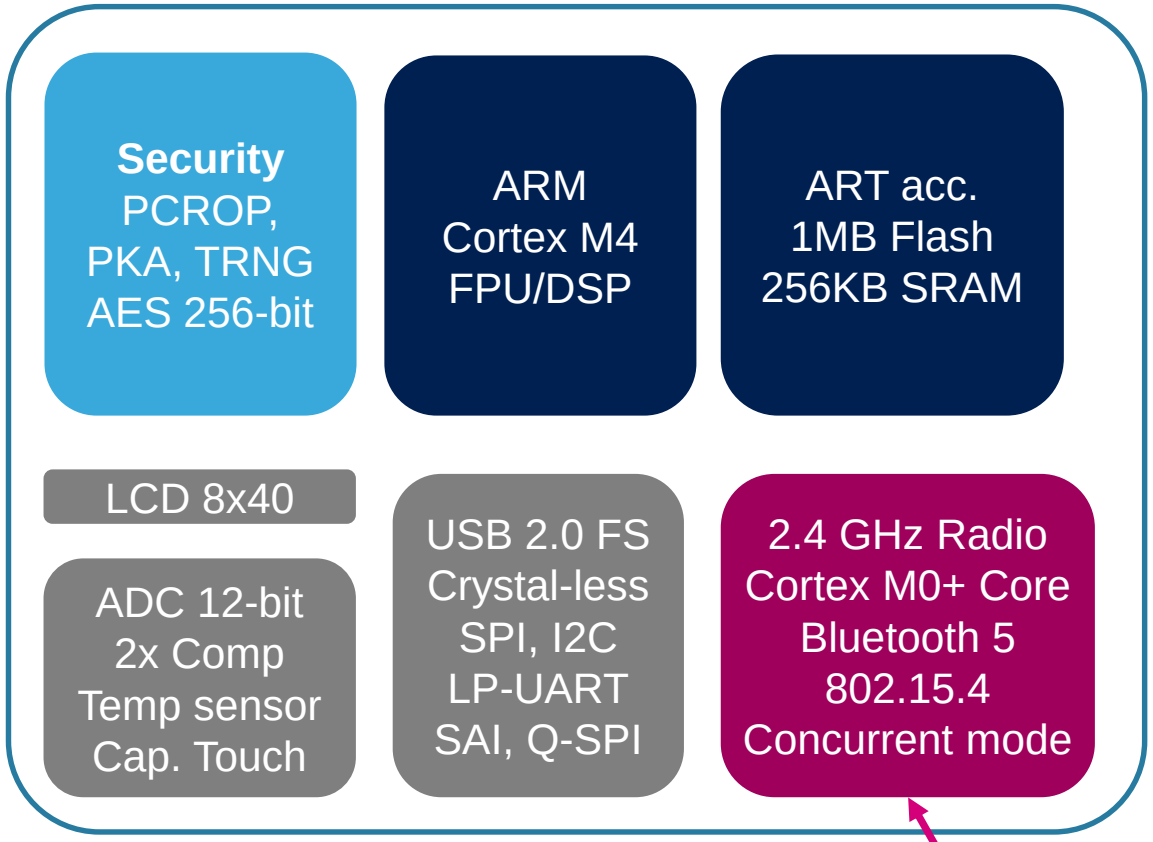
功能特性丰富



独立的2.4GHz 射频子系统

主要特性

- **2颗独立内核，实时执行任务**
- **超低功耗**
  - 工作模式<53 µA/MHz (3.0V)
  - 停止模式2.1 µA (射频待机+ 256KB RAM)
  - 关闭模式< 13 nA
- **外设**
  - 2xI^2C, 1xUSART, 1xLP-UART, 2xSPI, 1x USB 2.0 FS device 支持充电检测, 1xSAI, Q-SPI (XIP), 6x 16-bit 定时器(包括LPWM 和低功耗定时器)
- **工作电压1.71 至3.6V (DC/DC, LDO)**
- **工作温度-40°C 至+105°C**

高性能

STM32WB55 – 框图

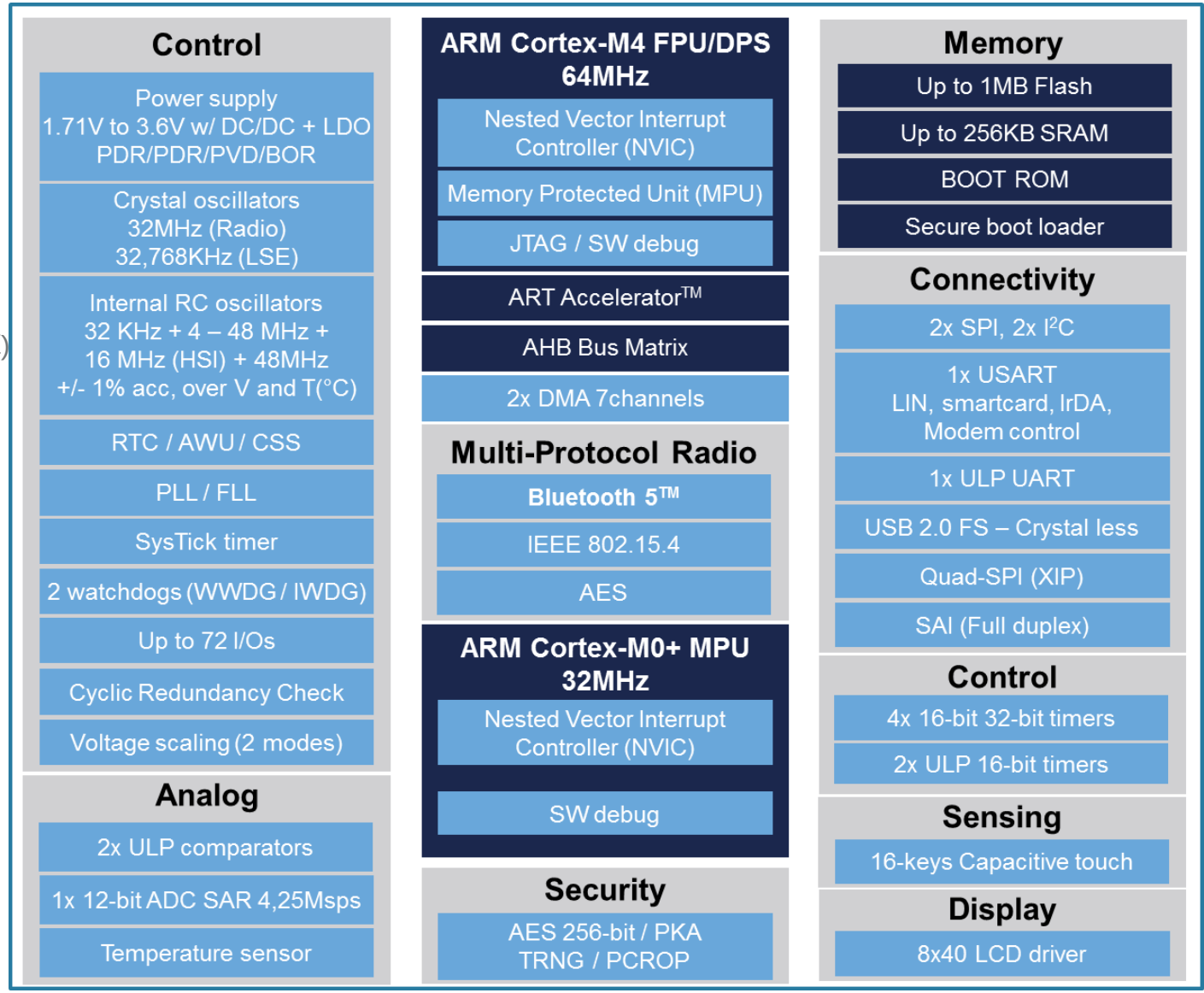
主要特征

- CM4 DSP/FPU 高达64MHz
- 高达1MB Flash 和256KB SRAM

- 射频集成平衡不平衡器(Balun)
  - 低功耗蓝牙**5.0 和**802.15.4
  - 输出功率: +6.0 dBm (支持外部PA)
  - BLE 接收灵敏度: -96 dBm @ 1Mbps (102dB链路预算)
  - 802.15.4 接收灵敏度: -100 dBm @ 250kbps (106dB链路预算)
  - 接收(RX): 4.5mA 和发送(TX): 5.2mA (0dBm)

- 外设
  - 2xI2C, 1xUSART, 1xLP-UART, 2xSPI, 1xUSB 2.0 FS device, 1xSAI, Q-SPI (XIP)
- 6x 定时器: 包括2x LP-16-bit
- 2x 超低功耗比较器

- 工作电压1.71V 至3.6V (DC/DC, LDO)
- 工作温度-40°C 至+105°C
- 功耗
  - 运行模式< 53µA/MHz (3V - RF ON)
  - 停止模式2.1 µA (射频待机+ 256KB RAM)
  - 待机模式0.6 µA (射频待机+ 32KB SRAM2a)
  - 关闭模式< 13nA



- 封装: QFN48, QFN64, QFN68, WLCSP100, BGA129

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动态多协议并发

多协议和开放射频

Bluetooth 5

- 完全认证的BLE 5.0 协议栈
- 数据速率提高2倍，支持2Mbps高速模式
- 支持BLE Mesh技术，提高网络覆盖面

THREAD ZigBee

- 支持最新的 IEEE 802.15.4无线通信标准
- OpenThread协议栈，ZigBee 3.0协议栈
- 支持BLE和OpenThread的动/静态并发模式

2.4 GHz 开放

- 支持私有协议栈 (例如BLE或802.15.4)
- 同类最好的射频收发器，输出功率高达+6dBm，射频链路预算102dB
- 接收功耗仅为4.5mA，发射功耗5.2mA(@ 0dBm)，适合能耗敏感的应用
- 集成balun巴伦平衡器，降低物料清单成本

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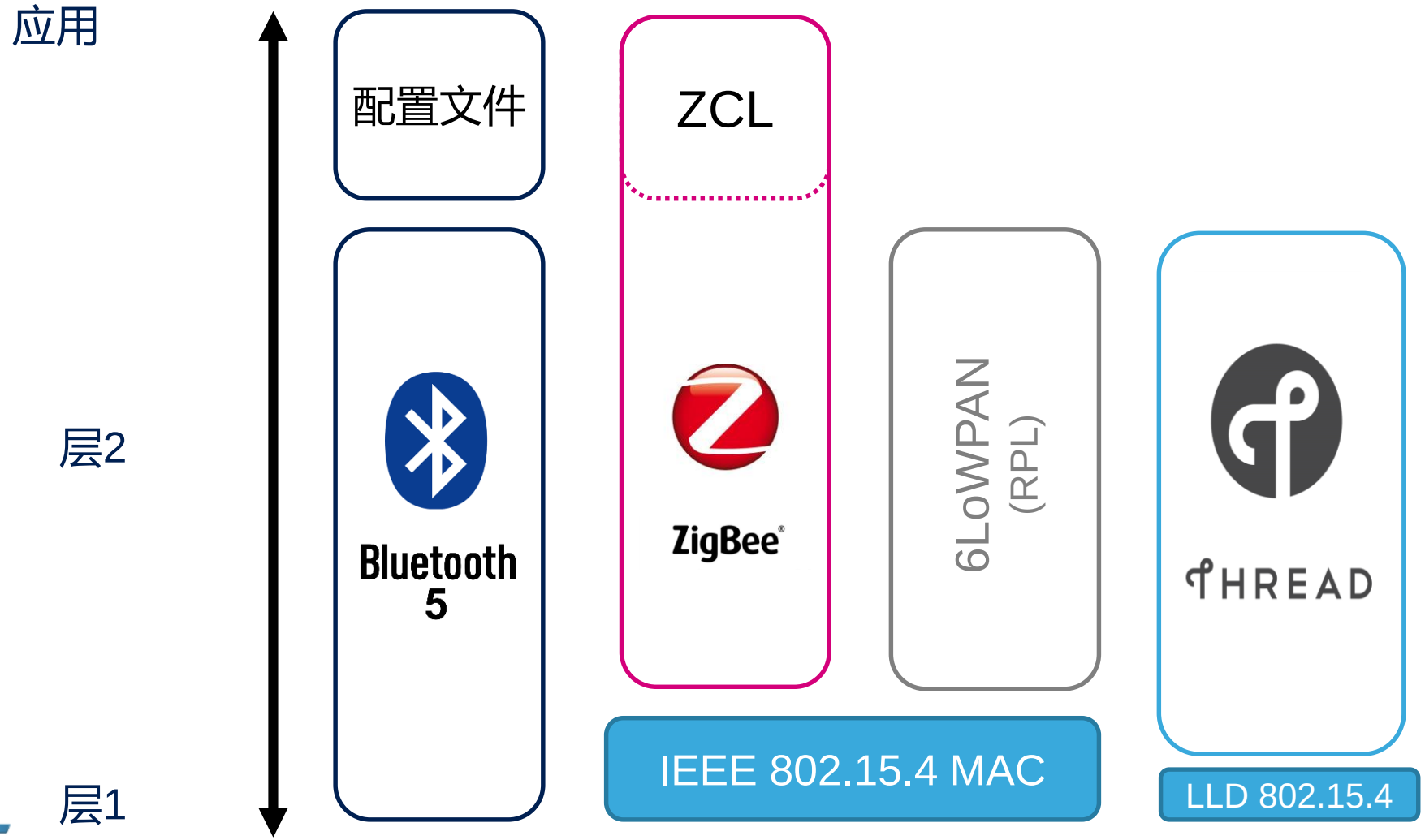
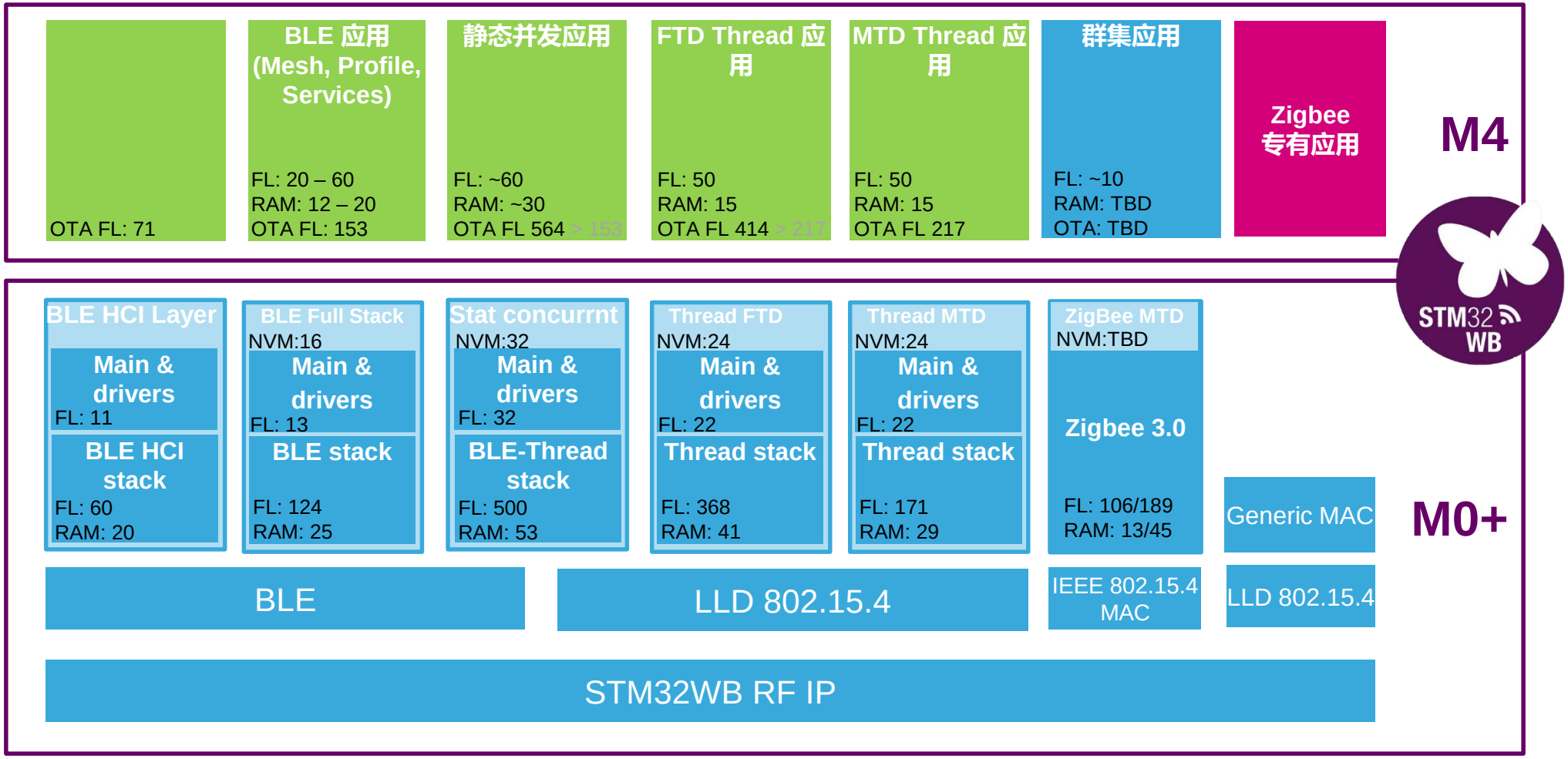
Bluetooth 5 THREAD ZigBee

多协议


应用
层2
层1
配置文件
Bluetooth 5
ZCL
ZigBee
6LoWPAN (RPL)
THREAD
IEEE 802.15.4 MAC
LLD 802.15.4

STM32WB 多协议内存占用



BootLoader / Security 占用此处未显示(M0 FL: 56 / RAM: 28 KB)
Thread Stack配置 = Router / 10 child, 全功能
BLE Link Layer配置 = 8 links
BLE Mesh 应用

Main & Drivers: IPCC, BLE cmd, NVM 驱动和 Main
HCI (主机控制器接口): 支持低功耗蓝牙主机协议栈的标准接

源代码 "黑盒子"
单位: KB

** 即使基于开放源代码，也没有计划以源代码交付*

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STM32WB 内存占用分析

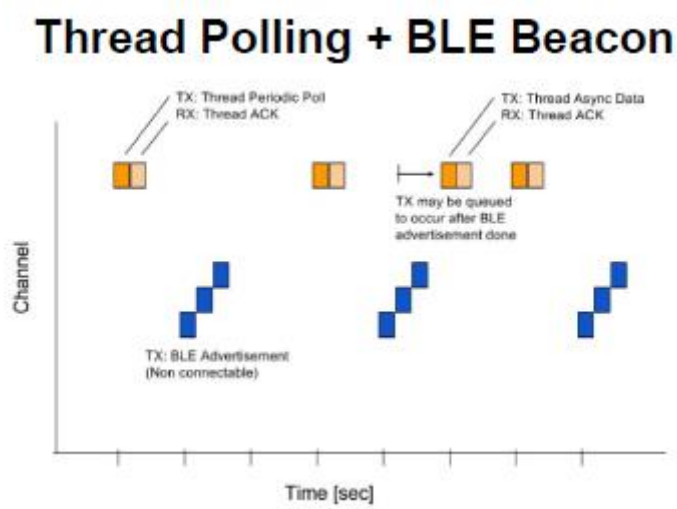
帮助你的客户选择正确的内存配置

Memory Footprint	STM32WB55		
	density 1	density 2	density 3
Flash	256 kB	512 kB	1 MB
SRAM1	64 kB	192 kB	192 kB
SRAM2a	32 kB	32 kB	32 kB
SRAM2b	32 kB	32 kB	32 kB

	BLE Alert notification		BLE Mesh		Thread Router full feature		BLE / Thread static concurrent mode	
FL / RAM w/o OTA (KB)	209 / 45		246 / 46		464 / 56		670 / 88	
FL / RAM w/ OTA (KB)	362 / 45		399 / 46		878(681) / 56		1234(823) / 100	
STM32WB55 density 1	w/ OTA	No OTA	w/ OTA	No OTA	w/ OTA	No OTA	w/ OTA	No OTA
STM32WB55 density 2	w/ OTA	No OTA	w/ OTA	No OTA	w/ OTA	No OTA	w/ OTA	No OTA
STM32WB55 density3 (RSS: 56k)	w/ OTA	No OTA	w/ OTA	No OTA	w/ OTA	No OTA	w/ OTA	No OTA

BLE+Thread多协议并发

- 静态多协议

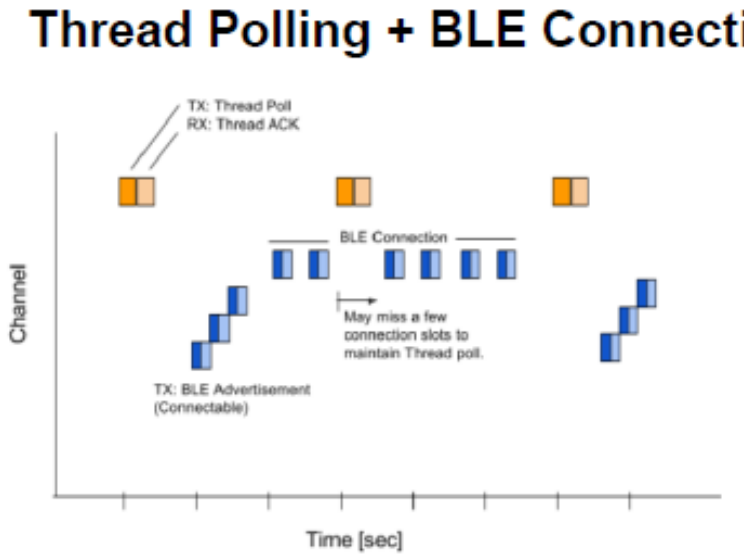


Bluetooth® 5 + THREAD

(static)

Bluetooth® 5 +

- 动态多协议

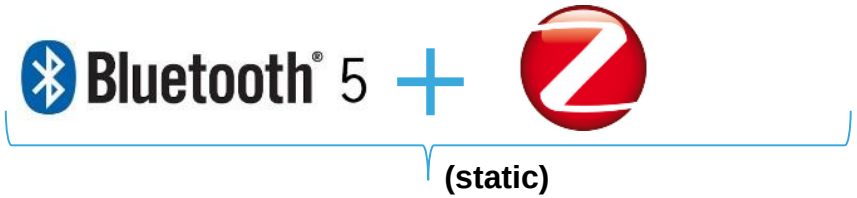


Bluetooth® 5 + THREAD

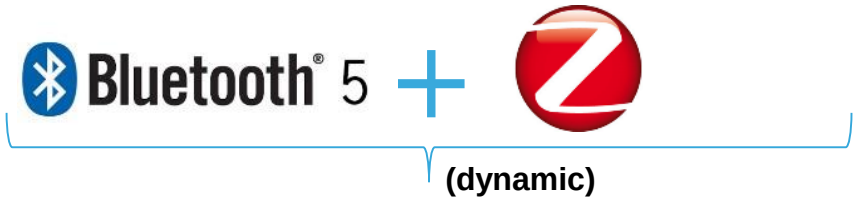
(dynamic)

BLE+ZigBee多协议并发

- 静态多协议



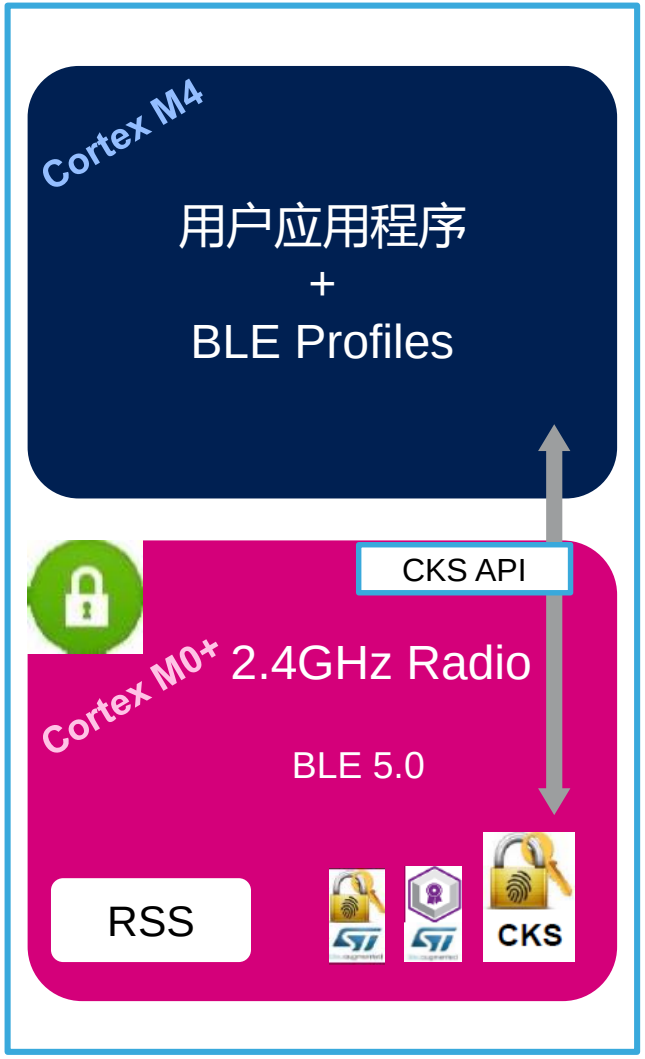
- 动态多协议



安全

软件安全架构

- Cortex-M4 (非安全)
  - 非安全区 / 开放调试功能
  - 运行用户应用程序 + BLE配置文件
- Cortex-M0+ (安全)
  - 安全区域代码和数据 / 禁止调试
  - BLE 射频协议栈与应用程序隔离
  - 带有安全固件升级功能 (w/ ST keys)
  - 为运行在CM4的应用程序提供客户密钥存储功能(CKS)
- CKS “Customer Key Storage客户密钥存储”
  - 密钥长度: 可达256-bits (典型长度为128或256-bits)
  - 密钥数量
    - 1 主密钥
    - 100 简单密钥 (可由主密钥加密或明文)



应用程序

→ 安全启动与
安全固件升级(SBSFU)

射频协议栈

→ 安全固件安装(SFI)
→ 安全固件升级(SFU)

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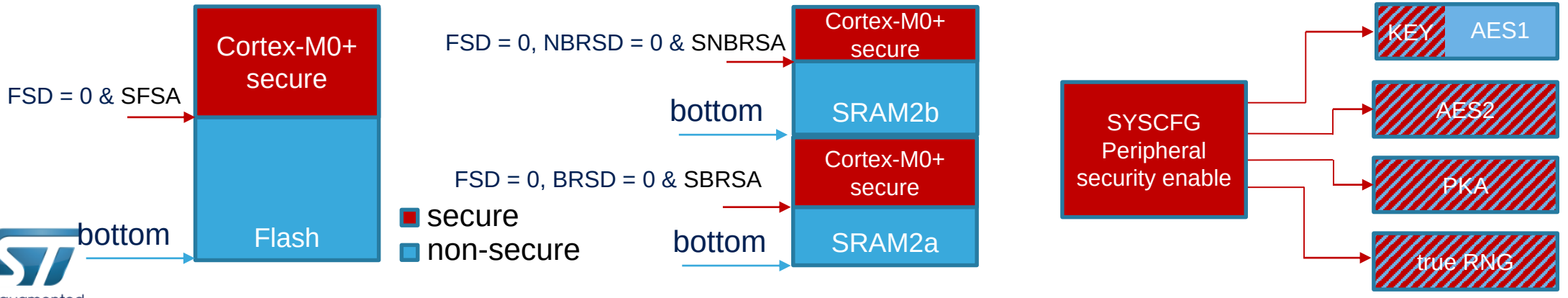
存储器安全性

- 保护闪存的上部让Cortex-M0+独占访问.
  - 由安全用户选项FSD和SFSA定义.
- 使能全局安全性.
  - 允许通过安全用户选项SBRD和SBRSA添加SRAM2a上部安全性
  - 允许通过安全用户选项SNBRD和SNBRSA添加SRAM2b上部安全性
  - 允许在SYSCFG中启用外设安全性.



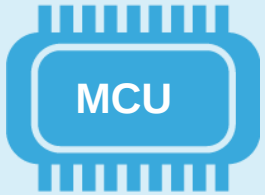
物联网保护功能(2/2)

STM32W的攻击防御措施

先进

基本

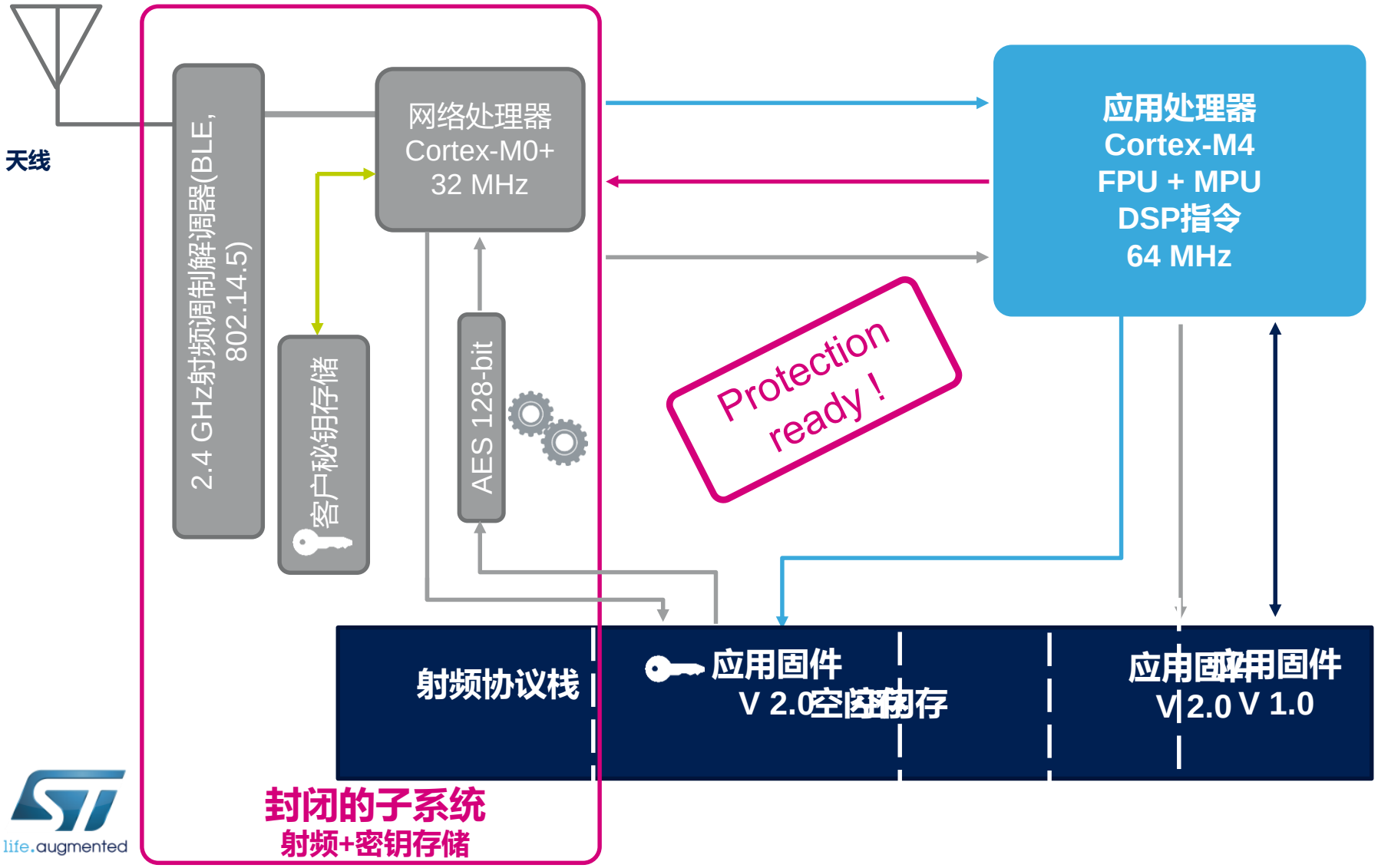
攻击	攻击描述	STM32WB防御措施

非入侵式攻击
 
	• 篡改工作环境
	  • 温度
	  • 电压
	  • 时钟 ….
	• 注入错误信号(小故障….)
	• 利用调试功能
	• 侧信道攻击、功耗分析 …
		• 温度传感器
		• 电源完整性监控器
		• 时钟安全系统
		• 防篡改焊盘
		• 内存ECC，奇偶校验
		• RTC报警，寄存器，SRAM批量擦除
		• JTAG读出保护
		• 仅限从闪存启动

软件攻击 	• 底层软件验证/加密 • 提取秘钥 • 利用应用测试功能 • 恶意软件 / 病毒软件 • 重放或权限升级攻击	• 客户密钥存储（CKS） • RNG，加密加速器，CRC • 内存写入保护 • 内存读取保护 • 存储保护单元（MPU） • 根安全服务（RSS） • 安全固件安装和更新（SFI和SFU） • 专有代码读取保护（PCROP） • 96位ID

物联网保护功能 (1/2)

射频协议栈和应用固件更新



1. 新固件包下载成功
2. 发现新固件包
   启动更新程序
3. 应用处理器发送固件包签名和秘钥进行验证
4. 如果验证签名与设置的秘钥不匹配，更新过程终止，设备重置
5. 用专有秘钥对新固件包进行解密，设备开始烧写代码

超低功耗

多种低功耗模式

灵活的功耗控制

- 高效运行
- 8 个低功耗模式, 几个子模式
- 高灵活性

		唤醒时间
RUN (Range1) at 64 MHz	117 (53) µA / MHz**	9 cycles
RUN (Range2) at 16 MHz	109 µA / MHz**	9 cycles
LPRUN at 2 MHz	103 µA / MHz**	1.7 µs
SLEEP at 64 MHz	41 µA / MHz	4 µs (19 µs)
LPSLEEP at 2 MHz	45 µA / MHz	5 µs (20 µs)
STOP 0 (full retention)	100 µA	14 µs (25 µs)
STOP 1 (full retention)	9.2 µA / 9.6 µA*	14 µs (25 µs)
STOP 2 (full retention)	1.8 µA / 2.1 µA*	50 µs
STANDBY + 32 KB RAM	320 nA / 600 nA*	
STANDBY	110 nA / 440 nA**	
SHUTDOWN	13 nA / 315 nA*	
VBAT	2 nA / 300 nA*	

() 典型值SMPS模式

RF 射频操作

Typ @ VDD =1.8 V @ 25 °C

** with RTC*
*** from SRAM1*

应用程序优势

- 高性能
  - ➔ CoreMark 分数= 215
- 卓越的功耗效率
  - ➔ ULPBbench 分数= 175

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低成本

大幅节省成本

片上集成的功能特性越多，物料清单成本降幅越大！

芯片成本

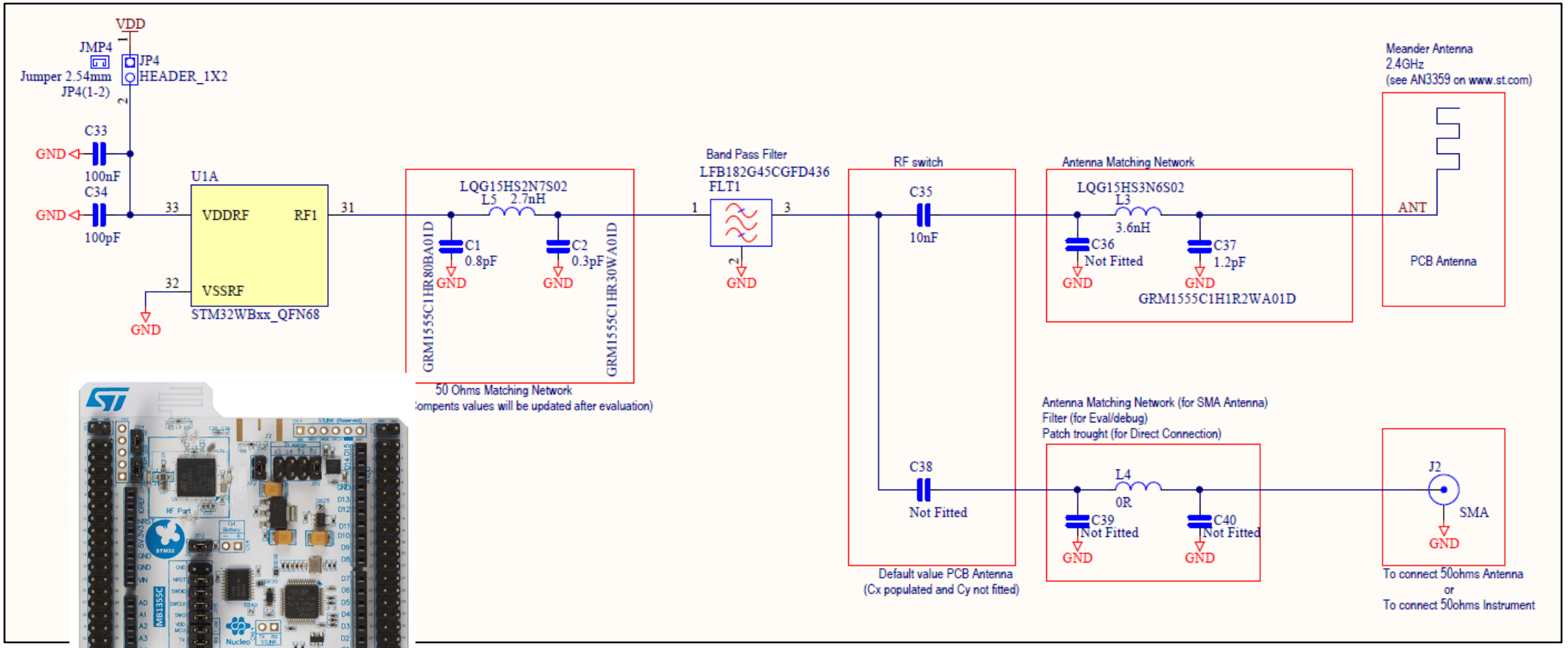
- 射频巴伦: 内置
- 外部器件: 7 (包括晶体)
- 32MHz单晶体运行
- 32 kHz主时钟输出
- USB 2.0 FS 晶体: 内置
- LCD升压器:内置
- 电容触控器: 内置
- 电路板成本: 只需2层印刷电路版(QFN48,BGA129)

生态系统成本

- BLE 5协议栈: 免费
- ZigBee协议栈: 免费
- OpenThread协议栈: 免费
- Generic 802.14.5 MAC: 免费
- Generic HCI驱动软件: 免费
- STM32CubeMX: 免费
- STM32CubeMonitor-RF: 免费
- IDE (Atollic, AC6: SW4STM32): 免费
- BLE和802.15.4并发避免使用第二个射频微控制器

射频输入输出阻抗匹配网络

AN 5165



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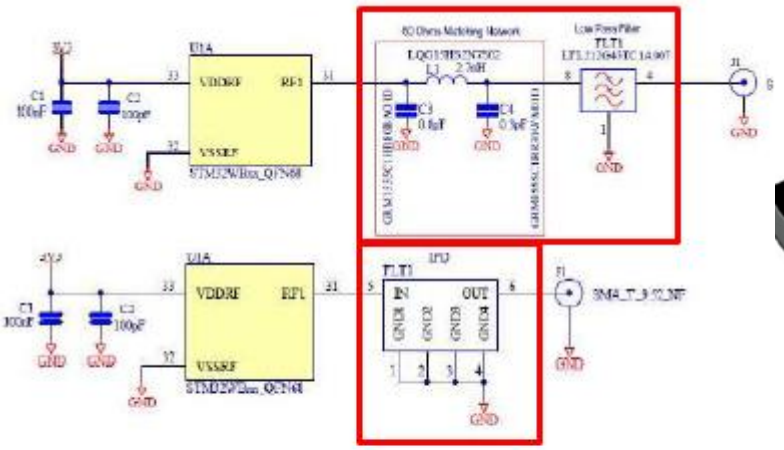
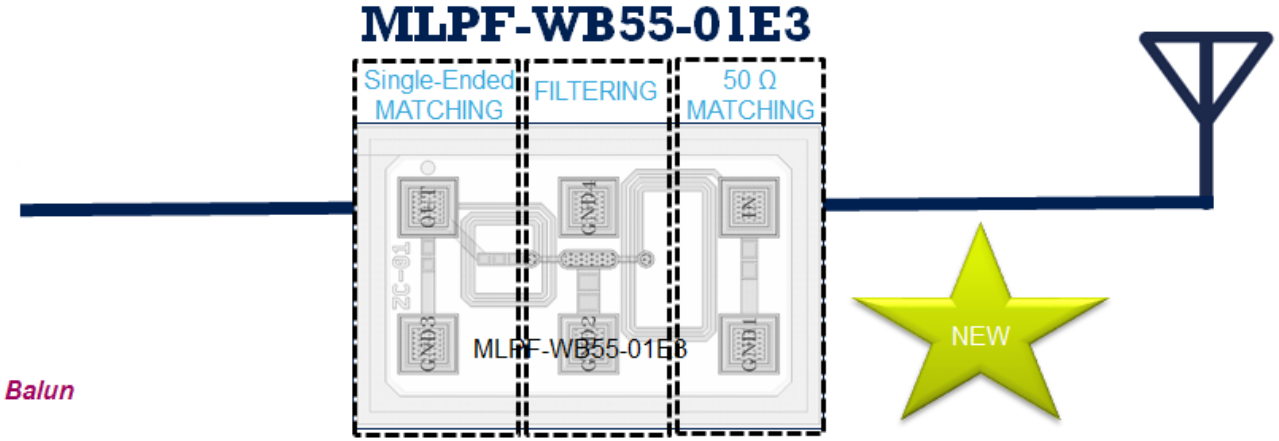
IPD* - MLPF-WB55-01E3

集成阻抗匹配谐波滤波器



*IPD : Integrated Passive Device
➔ Integrating matching + filter

Integrated Balun



STM32WB

- Arm Cortex-M4
  Application Firmware + Peripherals
- Arm Cortex-M0+
  Radio Stack

MLPF-WB55-01E3

- Integrated STM32WB **Impedance Matching**
- **Harmonic Filter** with deep rejection

LTCC-like assembly
0.5mm pitch

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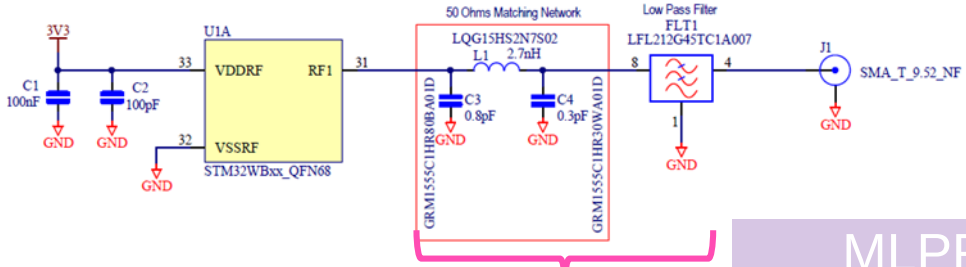
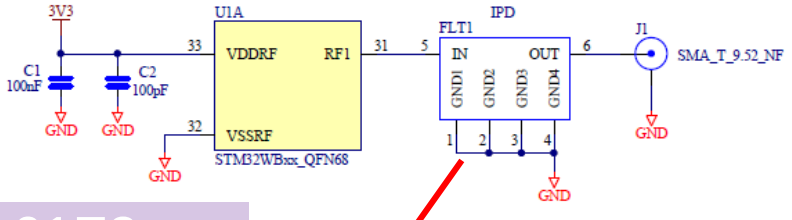
集成无源器件 – MLPF-WB55-01E3

- 以集成无源器件替代离散匹配网络+集成滤波器，可至少达到相同的TX/RX性能



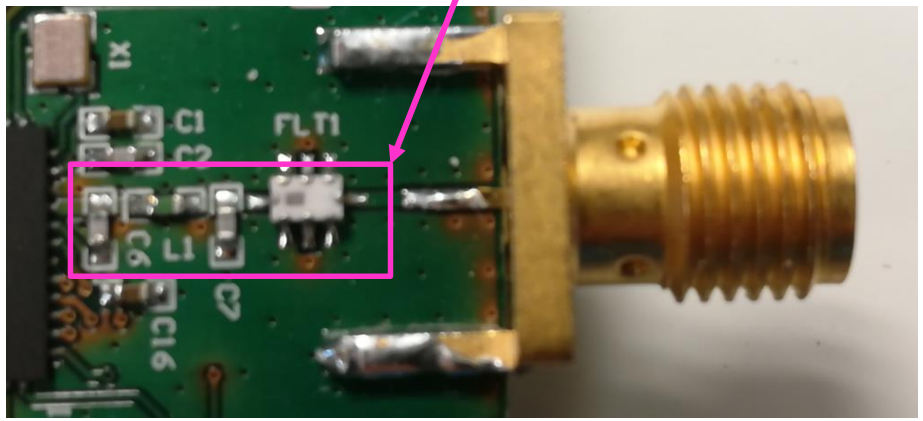
离散匹配网络+谐波滤波器

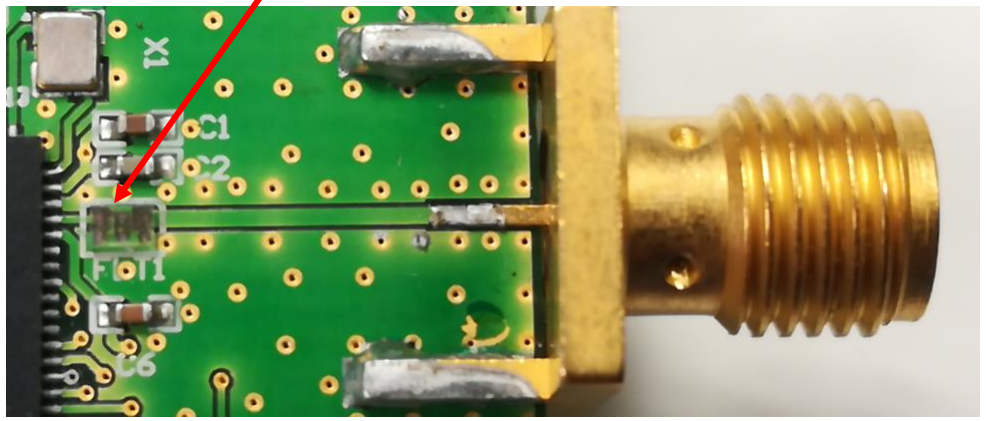


MLPF-WB55-01E3

MLPF-WB55-01E3

Matching Network ⟷ (50Ω) ⟷ Filter





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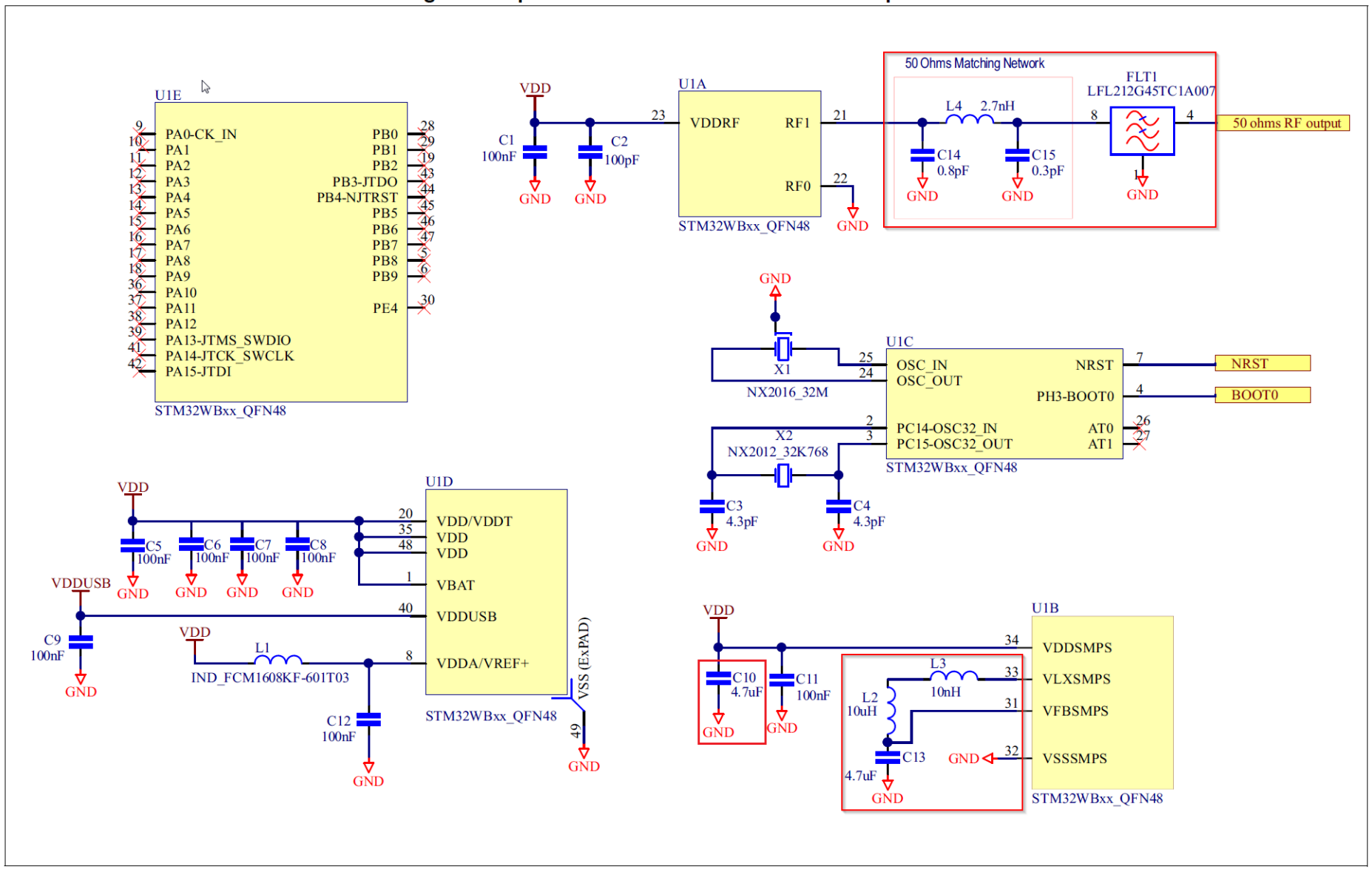
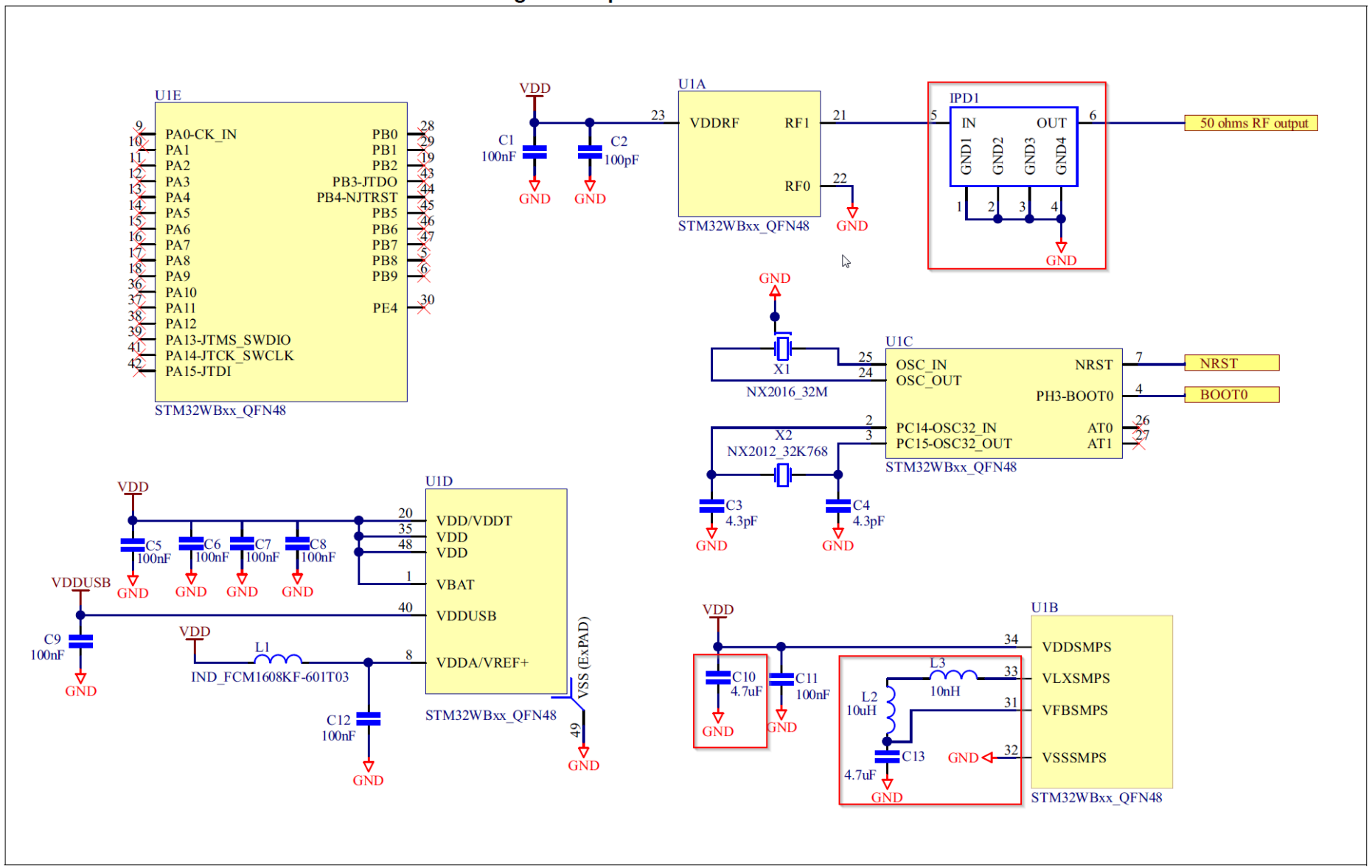
Optimized solution with SMPS with discrete components

Figure 4. Optimized solution with discrete components



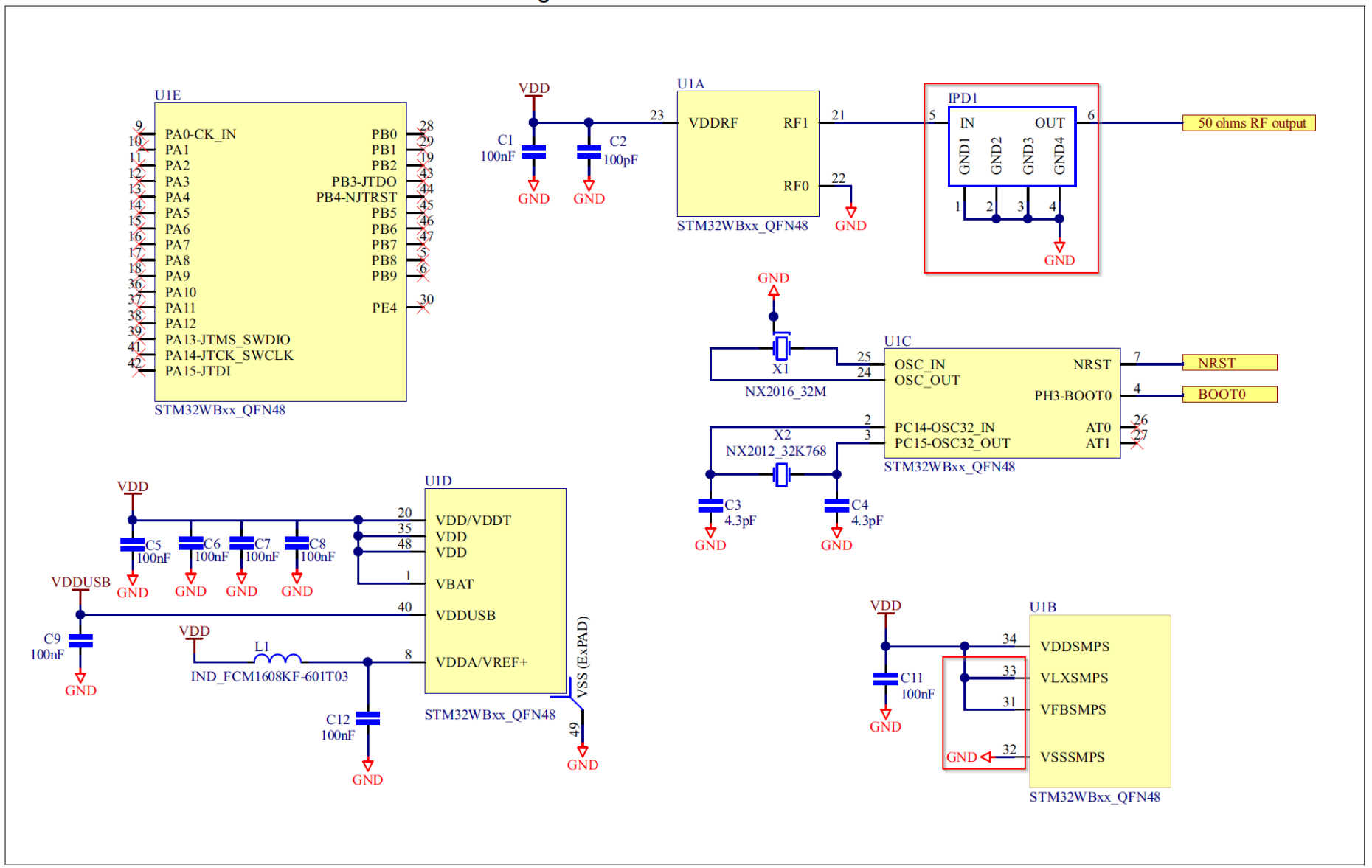
Optimized solution with SMPS with IPD

Figure 5. Optimized solution with IPD



Optimized solution without SMPS with IPD

Figure 6. Solution without SMPS



产品快速上市

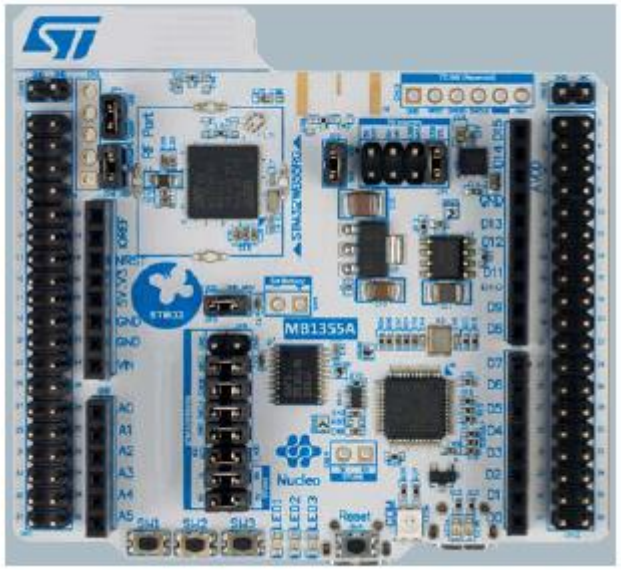
STM32WB55 开发套件

Wireless and ultra-low-power BLE 5.0 & IEEE 802.15.4

STM32WB55 FEATURES

- Arm® Cortex®-M4 MCU with **64 MHz/80 DMIPS** and dedicated Arm® Cortex®-M0+ radio co-processor at **32 MHz**
- **Multiprotocol:** BLE 5.0, 802.15.4, concurrent mode
- 1 Mbyte of Flash memory
- 256 Kbytes of SRAM
- **High RF performances :** RX - 96dBm/-100dBm; TX + 6dBm

Includes:



NUCLEO BOARD FEATURES

- **STM32WB55RGV6 MCU**
- PCB Antenna and SMA connectors
- Flexible power supply supporting CR2032
- Dual USB Port (Application/debug)
- Multiple USER switch/LEDs
- Supports Arduino™ and ST Morpho connectors
- Embedded ST-LINK/V2-1 debugger and programmer
- Arm® Mbed Enabled™

USB DONGLE

- **STM32WB55CGU6 MCU**
- PCB Antenna and UFL connectors
- Seccable PCB

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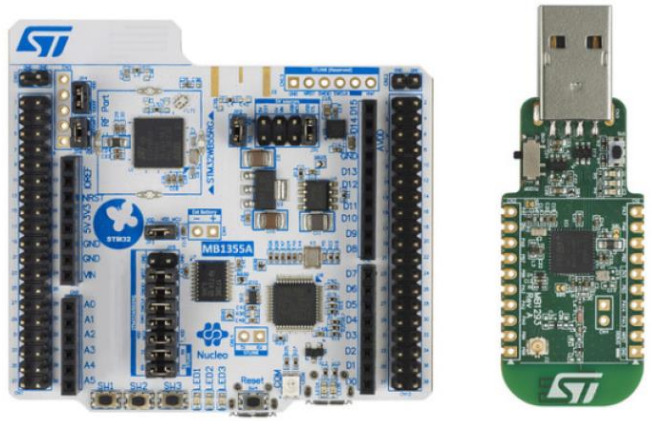
Note: For more information about the BLE protocol, see the appendix at the end of this document

硬件开发工具



硬件

评估板套件

STM32CubeMX

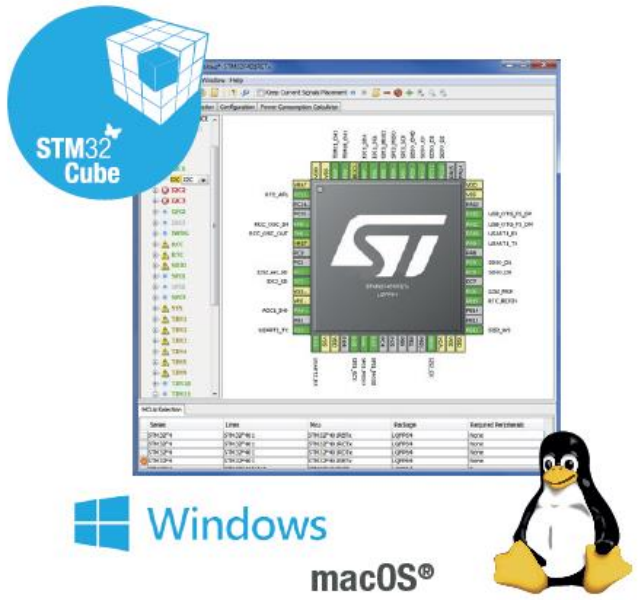
代码生成

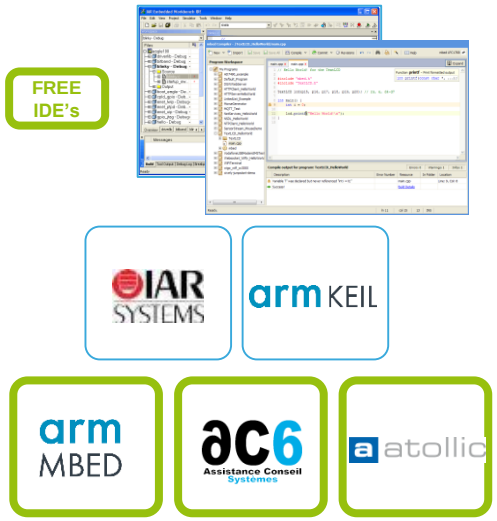
功耗计算

STM32CubeMonRF

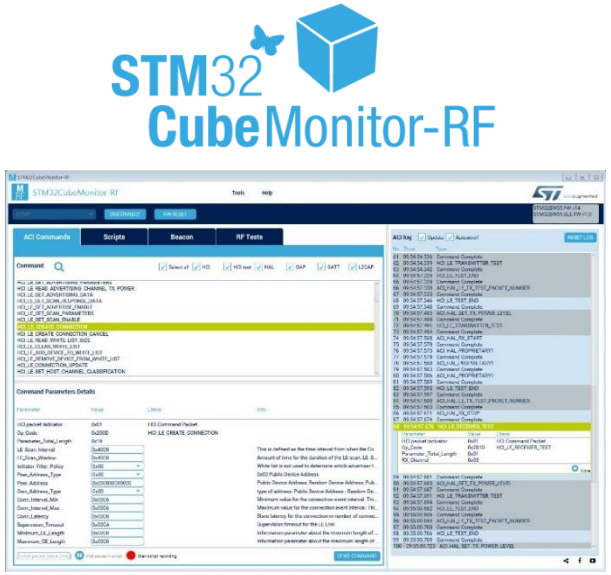
软件开发工具

从配置到监测的完整开发流程





大众市场发布后还将有更多工具推出



STM32CubeMX
配置和生成代码

合作伙伴的IDE环境
编译与调试

STM32CubeMonRF
监测

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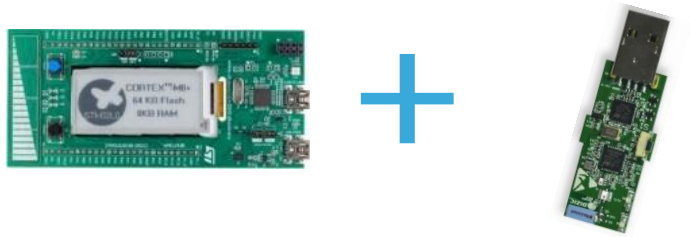
生态系统

Fully part of the STM32 existing wide ecosystem

HW tools + Demos

Nucleo + USB dongle



Discovery + USB dongle

Dev tools

STM32CubeMX

STM32CubeProgrammer

Partners IDE

STM32CubeMonitor-RF

KEIL™ Tools by ARM

mbed Enabled

atollic

System Workbench for STM32

IAR SYSTEMS

Stacks

Bluetooth 5

Thread

ZigBee 3.0

HomeKit

WorkwithNest

OS

RTOS

mBed

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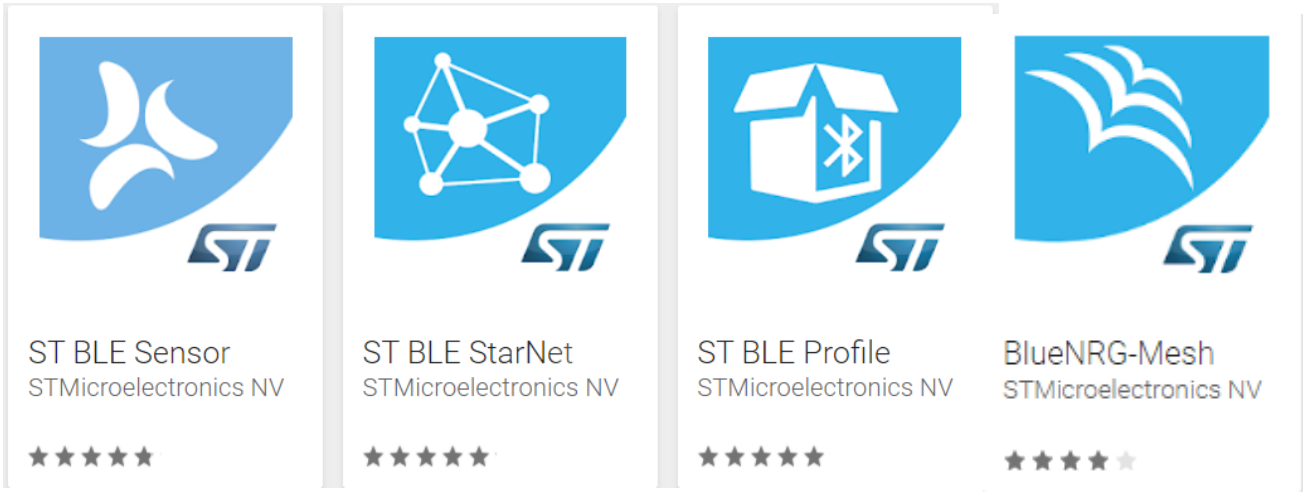
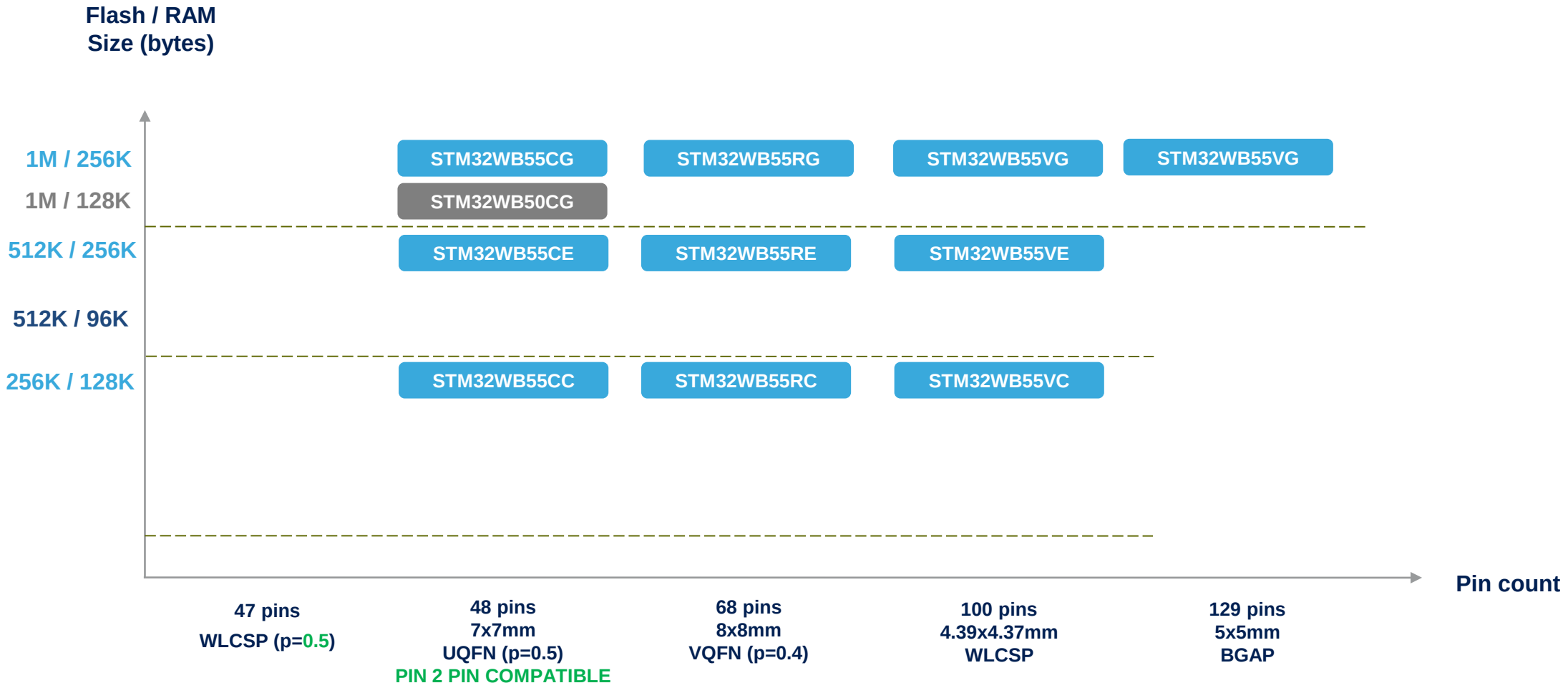
免费智能手机软件

- 智能手机 – STM32WB官方支持的软件
  - ST BLE Sensor - Google Play / Apple Store
    - https://github.com/STMicroelectronics/STBlueMS_Android
    - https://github.com/STMicroelectronics/STBlueMS_iOS
  - ST BLE StarNet - Google Play / Apple Store
    - https://github.com/STMicroelectronics/STSensNet_Android
    - https://github.com/STMicroelectronics/STSensNet_iOS
  - ST BLE Mesh – Google Play / Apple Store



STM32WB 产品系列



STM32WB50 Value line in QFN48 Production: Jul’19

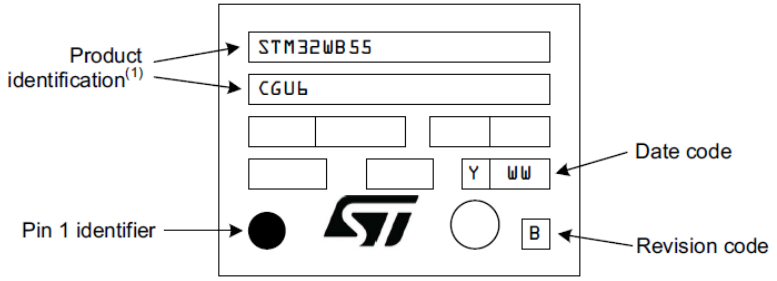
- ST Slaes 可在系统里直接申请样品

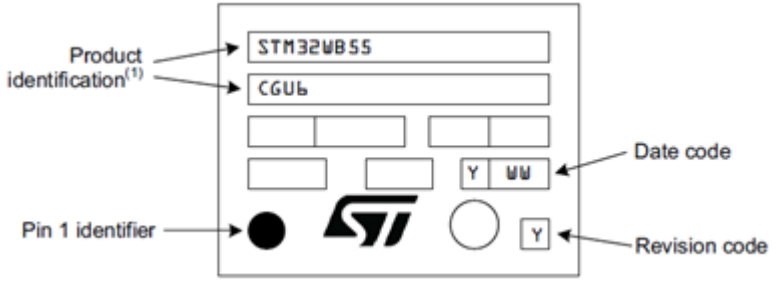
–欧盟区外需要EUC文档 (因为WB有加密模块)

- cut 2.1样品

QFN48, QFN68, WLCSP100

Package	Product	Revision	MML
UFQFPN48 7 x 7 mm (with solder pad)	STM32WB55CxUy	Y	19w9
VFQFPN68 8 x 8 mm (with solder pad)	STM32WB55RxVy	Y	19w9
WLCSP100 0.4 mm pitch	STM32WB55VxYy	Y	TBC





Example: STM32 WB 55 V G V 6 TR

Device family
STM32 = Arm® based 32-bit microcontroller

Product type
WB = Wireless Bluetooth®

Device subfamily
55 = Die 5, full set of features

Pin count
C = 48 pins
R = 68 pins
V = 100 pins

Flash memory size
C = 256 KB
E = 512 KB
G = 1 MB

Package
U = UFQFPN48 7 mm x 7 mm
V = VFQFPN68 8 mm x 8 mm
Y = WLCSP100 0.4 mm pitch

Temperature range
6 = Industrial temperature range, -40 to 85 °C (105 °C junction)
7 = Industrial temperature range, -40 to 105 °C (125 °C junction)

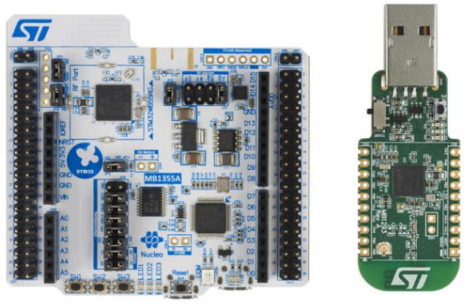
Packing
TR = tape and reel
xxx = programmed parts

Nucleo Pack申请

- 通过客户服务团队订购STM32WB55 Nucleo Pack(包括一块Nucleo 和一块USB dongle): europe.toolsmanufacturing@st.com

– 欧盟区外需要EUC文档 (因为WB有加密模块)

- STM32WB55 Nucleo Pack with cut2.1　　Product: P-NUCLEO-WB55



智能锁参考平台(1/3)

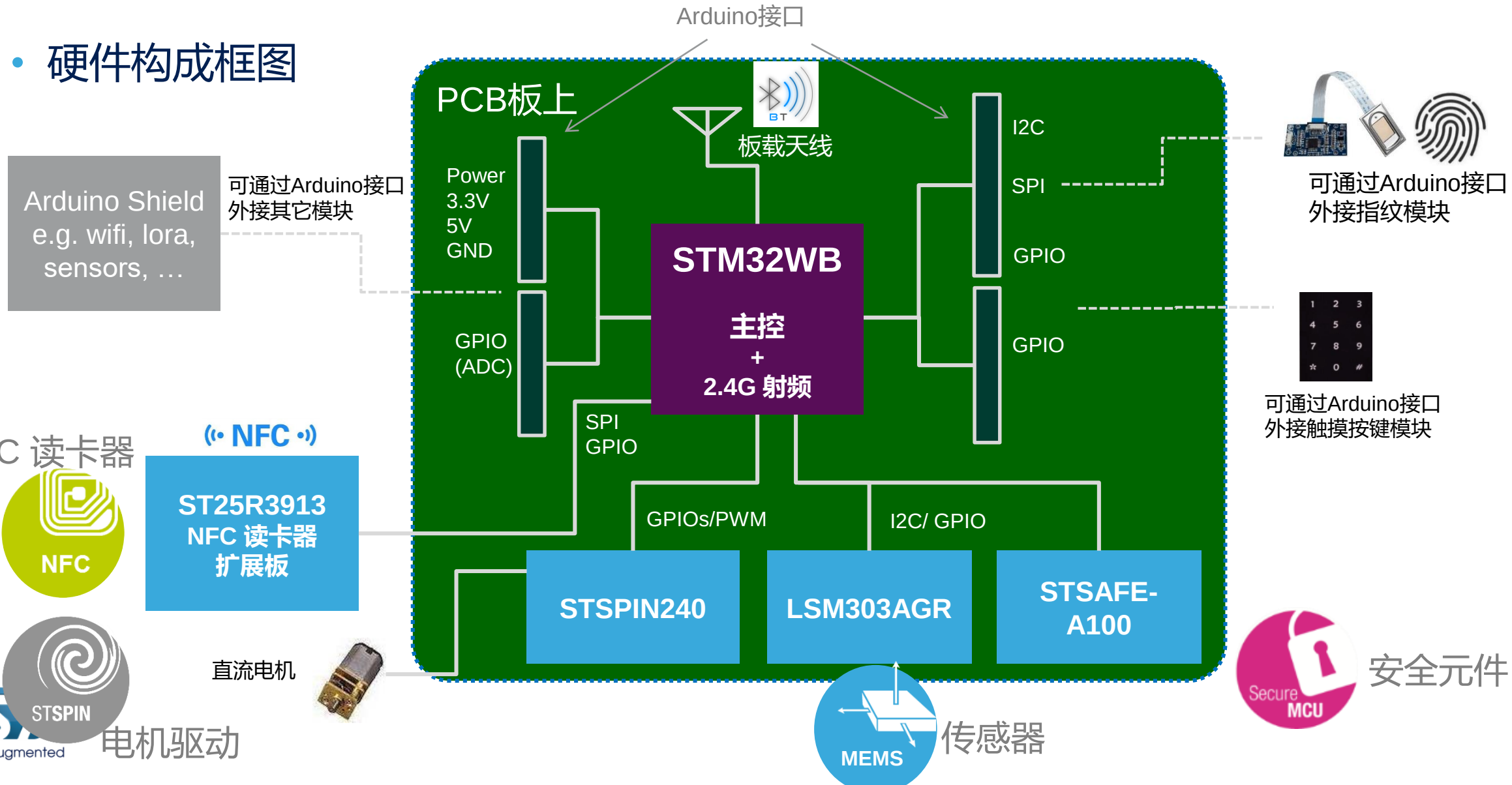
硬件参考平台

STM32 WB

- NFC 读卡器
- 电机驱动
- 安全元件
- 传感器

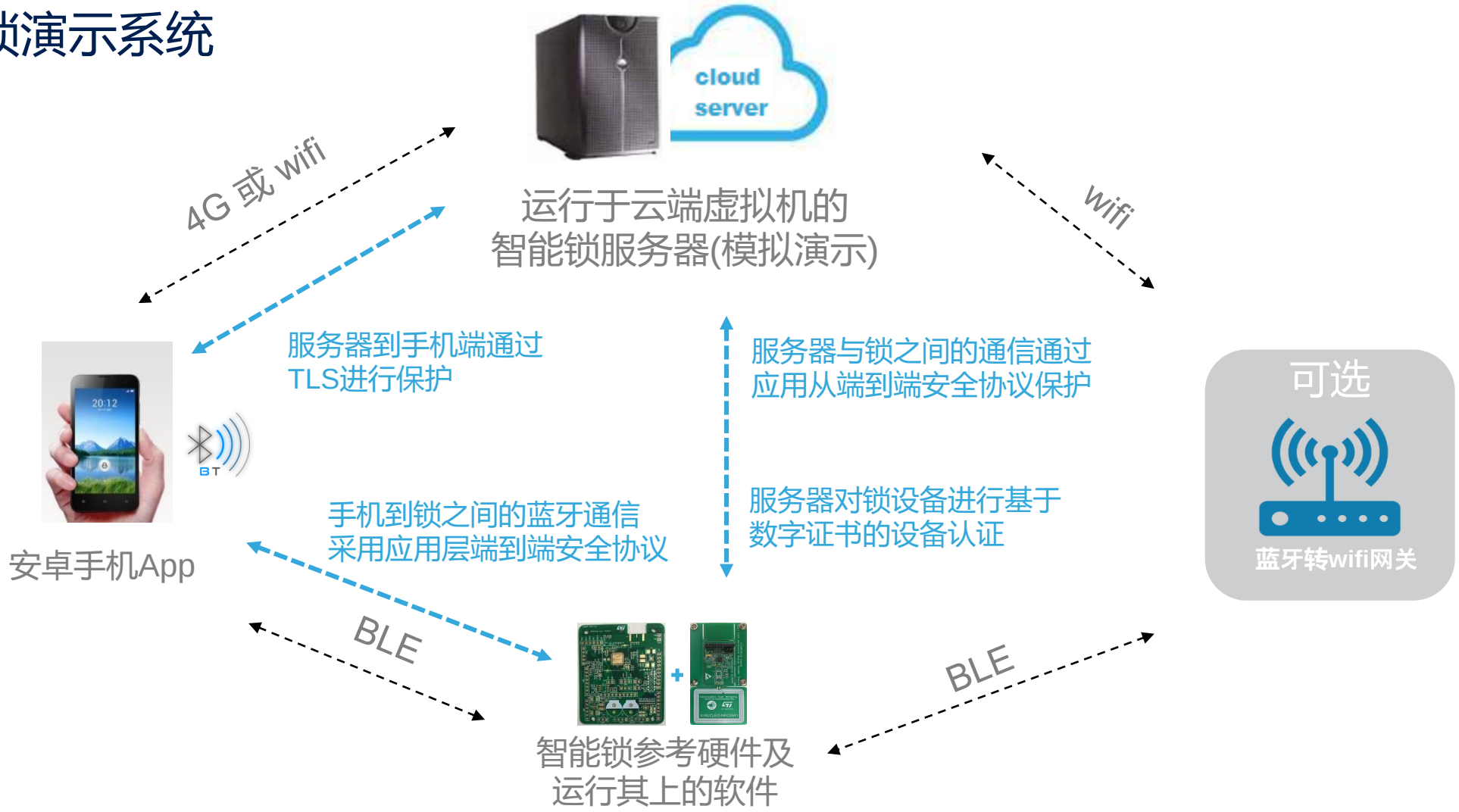
智能锁参考平台(2/3)

- 硬件构成框图



智能锁参考平台(3/3)

- 智能锁演示系统



家庭自动化

Central

Peripheral

Central

Home Controller (Router)

Light Controller

Peripherals

Peripherals

Lock Controller

Peripherals

Temperature Controller

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Multi P2P Demo(1/2)

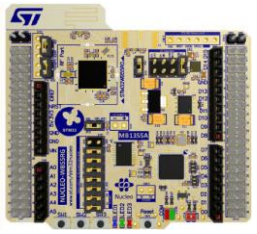
Notification

Command

P2P server 1
End Device 1
Adv Id = 0x83

Peripheral(S)
Server

Peripheral(S)
Server



Client
Central(M)

P2P Router
Adv Id = 0x85

Server
Peripheral

P2P Server 2
End Device 2
Adv Id = 0x84

Smart
Phone

Central(M)
Client

P2P Server 3,4,5,6 may be added

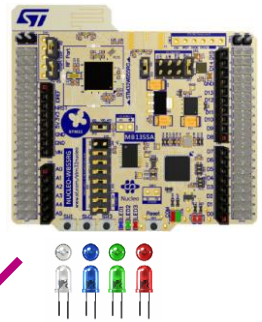
Multi P2P Demo(1/2)

产品快速上市

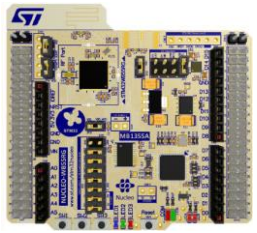
Notification

Command

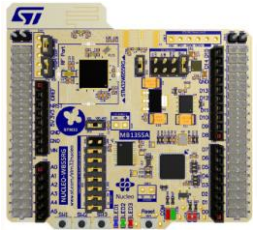
P2P server 1
End Device 1
Adv Id = 0x83



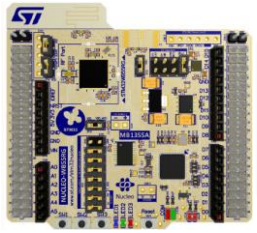
Peripheral(S)
Server



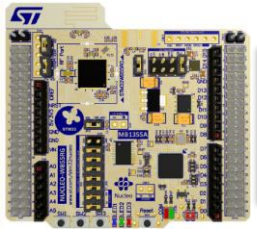
P2P Server 2
End Device 2
Adv Id = 0x84



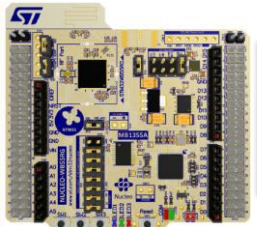
P2P Server 3
End Device 3
Adv Id = 0x87



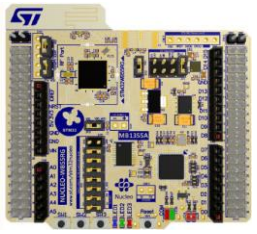
P2P Server 4
End Device 4
Adv Id = 0x88



P2P Server 5
End Device 5
Adv Id = 0x89



P2P Server 6
End Device 6
Adv Id = 0x8A



Client
Central(M)

Peripheral(S)
Server

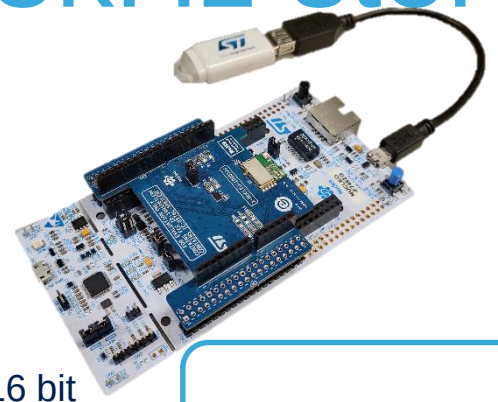
P2P Router
Adv Id = 0x85

Server
Peripheral

Smart
Phone

Central(M)
Client

Streaming 48kHz stereo music to STM32WB



BlueVoiceOpus service:
- Audio characteristic (notification)
- Control characteristic (notification)

USB Key – Wav file stereo 48kHz → PCM 16 bit, Stereo 48kHz → Opus encoding → Raw data → BlueVoiceOpus BLE custom Profile

Compressed audio divided in 20Byte BLE packet

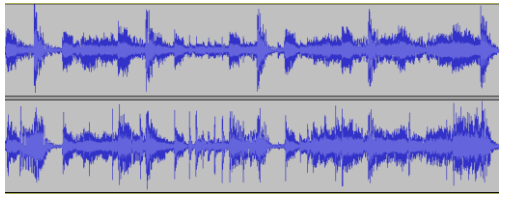
Bitrate: 56 kbps
(tested up to 72kbps)

Custom protocol used to recreate the complete compressed Opus frame

(it can be divided in more than one BLE packets)

BlueVoiceOpus BLE custom Profile → Raw data → Opus Decoding → PCM 16 bit, Stereo 48kHz → USB Audio Output

STM32WB is recognized as a standard recording device, audio can be acquired using audacity



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Streaming 16kHz voice from STM32WB to Android Device

BlueVoiceOpus service:
- Audio characteristic (notification)
- Control characteristic (notification)

X-NUCLEO-CCA02M1

NUCLEO-WB55

Mic acquisition (SAI) → PDM → PDM to PCM conversion in SW → PCM 16 bit, 16kHz mono → Opus encoding → Raw data → BlueVoiceOpus BLE custom Profile

Compressed audio divided in 20Byte BLE packets

Bitrate: 16kbps
(can be modified)

BlueST-SDK

Custom protocol used to recreate the complete compressed Opus frame

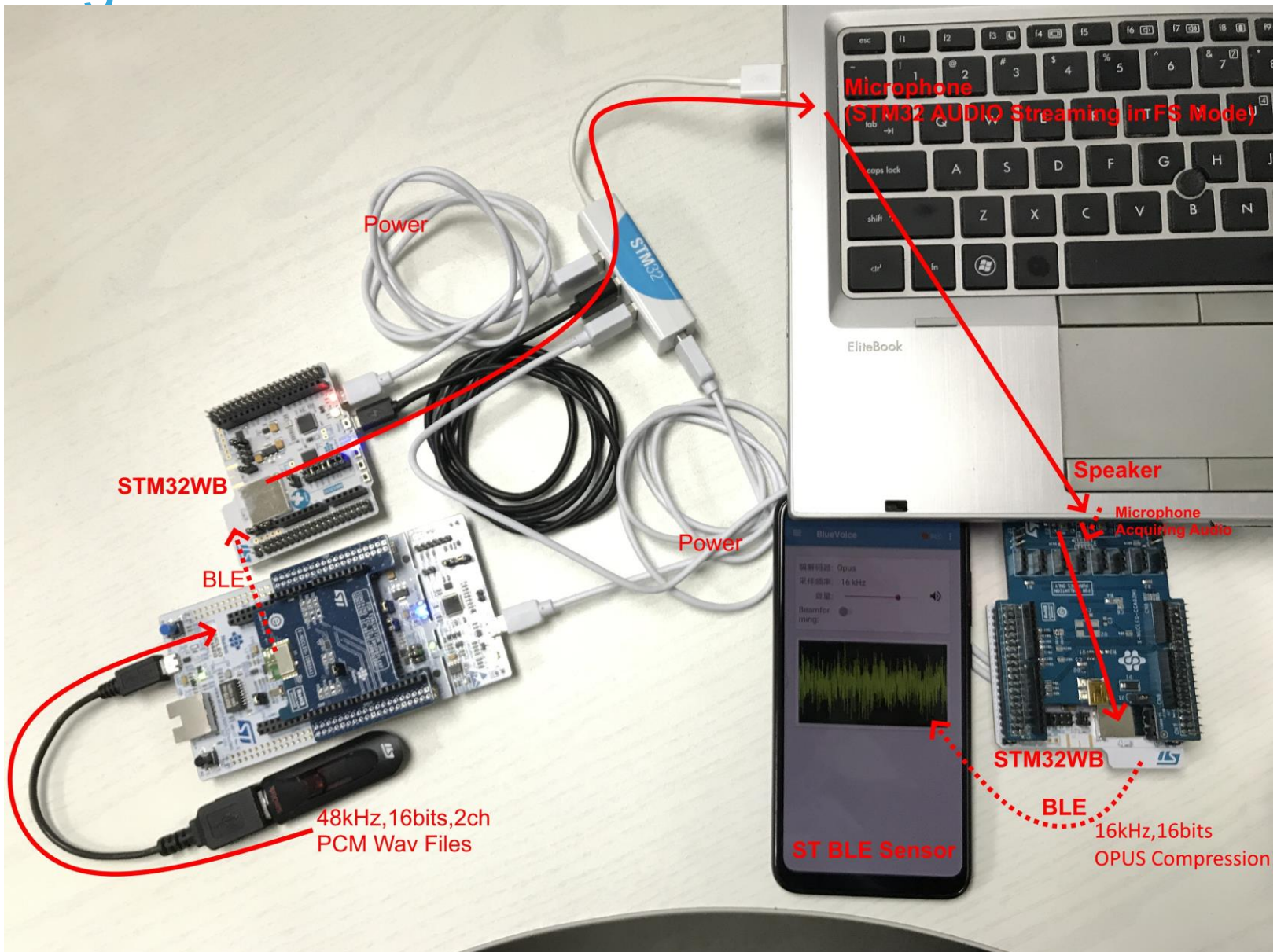
(it can be divided in more than one BLE packets)

BlueVoiceOpus BLE custom Profile → Raw data → Opus Decoding → PCM 16 bit, 16kHz mono → Audio Out

PCM Audio can be played or sent to the cloud for SpeechToText service

life.augmented

Streaming 48kHz stereo music to STM32WB
Streaming 16kHz voice from STM32WB to Android Device



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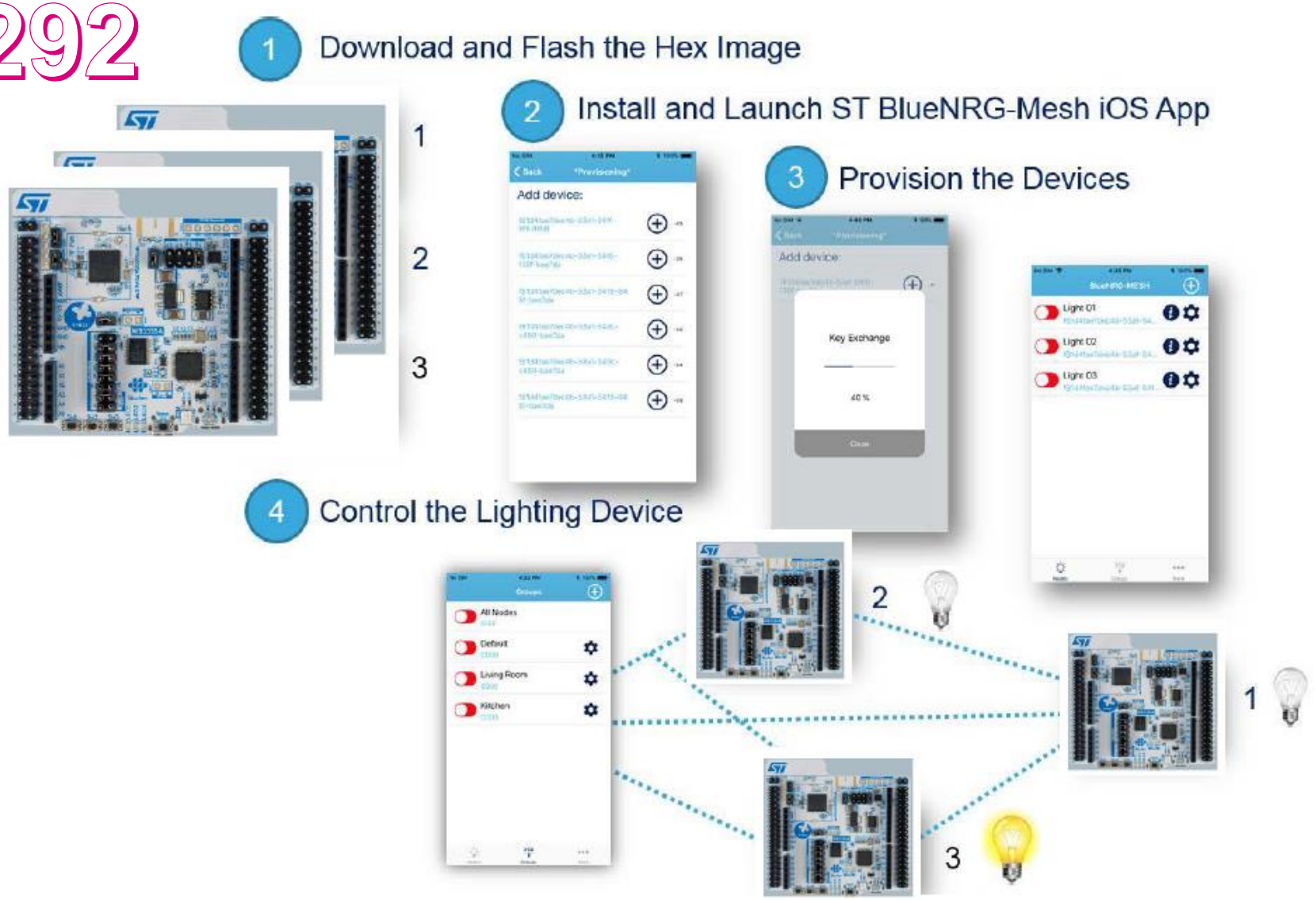
Mesh网格网络

STM32Cube_FW_WB_Vx.x.x\Projects\P-NUCLEO-WB55.Nucleo\Applications\BLE\BLE_MeshLightingDemo

AN 5292



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