2023 tech talks
WEBINAR SERIES

开箱：探索蓝牙新功能

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SILICON LABS

议程大纲

xG27简介

xG27差异化特性

开发套件硬件和软件

GitHub演示

Simplicity Studio演示

EFR32BG27和EFR32MG27目标应用

- **互联健康**
  - 携带式医疗设备
    - 连续血糖监测仪，脉搏血氧仪，医用贴片，心电图
  - 临床医疗仪器
  - 穿戴设备
- **智能家居**
  - 传感器，开关
  - 门锁
  - 暖通空调，恒温器
  - LED照明
  - 智能家电
- **工业和商业**
  - 楼宇自动化
  - 商用照明
  - 门禁系统
  - 资产跟踪，室内导航

xG27：适用于电池供电设备的多功能SoC

电池供电
超低功耗
多协议
安全

设备规格

高性能 2.4 GHz 射频
- Up to +8 dBm TX
- -98.9 dBm RX @ BLE 1 Mbps
- -106.7 dBm RX @ BLE 125 kbps

MCU内核
- ARM Cortex®-M33 (76.8 MHz with FPU & DSP)

内存
- Up to 64kB RAM
- Up to 768kB Flash

超低功耗
- 1.1 µA EM2 with 8 kB RAM retention
- 4.1 mA TX @ 0 dBm
- 3.6 mA RX (BLE 1 Mbps)

多协议支持
- Bluetooth 5.3 (1M/2M/LR), Bluetooth mesh
- Zigbee 3.0
- Proprietary 2.4 GHz

功能丰富的外设
- 16-bit ADC, USARTs, I2C, I2S, PDM, Timers

封装
- 2.3x2.6 WLCSP (19 GPIO) +85ºC
- 4x4 QFN32 (18 GPIO) +125ºC
- 5x5 QFN40 (26 GPIO) +125ºC

差异化特性

极小的外形尺寸
- 2.3 x 2.6 WLCSP package[1]

灵活的电池电源支持
- DCDC Buck/Boost
- Supports 1.7 to 3.6 volts
- Supports 0.8 to 1.7 volts

增强安全性
- Secure Vault™ Mid
- Tamper detect
- Customer Key Management w/PUF

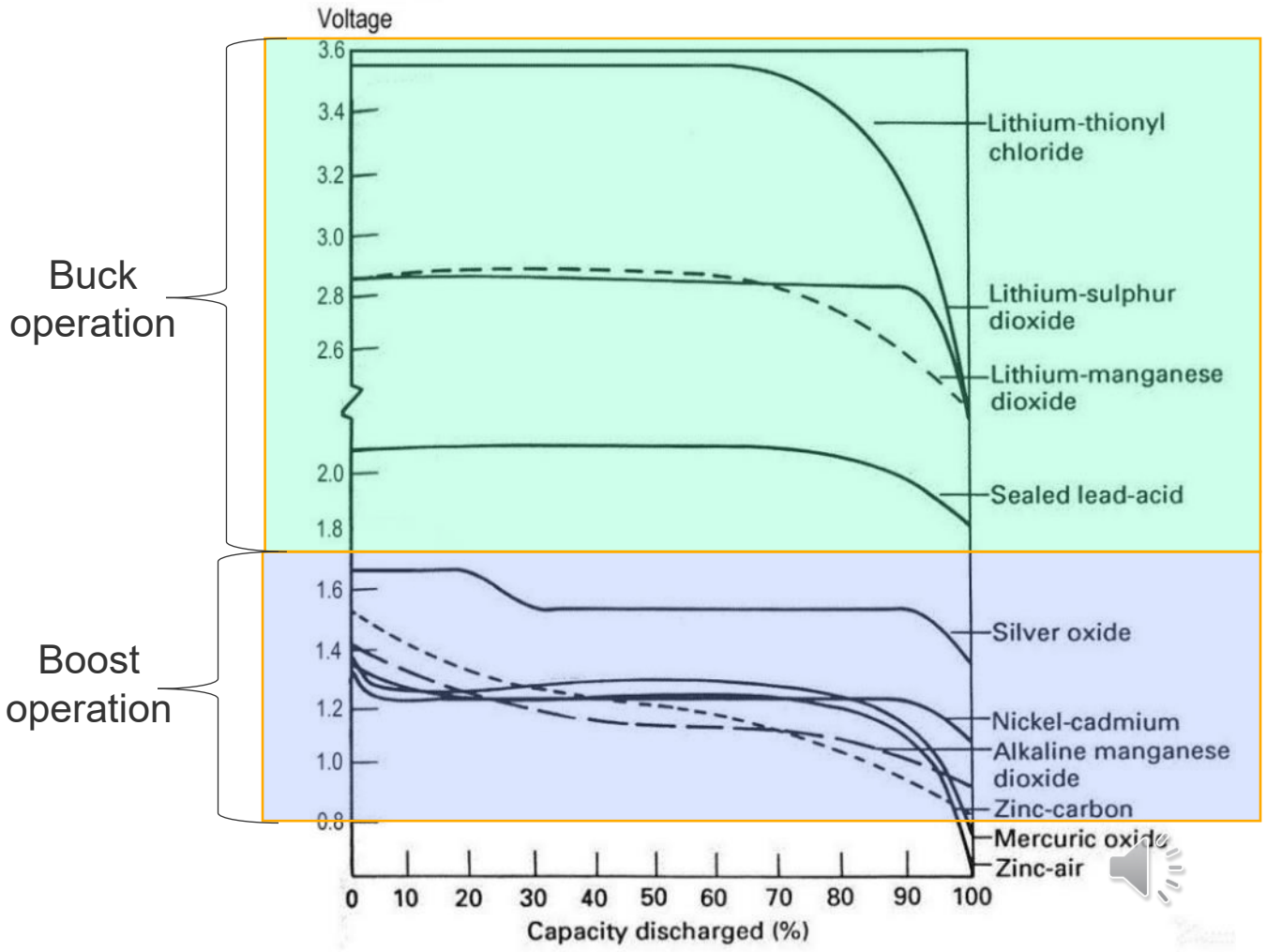
电池管理
- Coulomb counter

唤醒引脚 (BOOST_EN)
- Enables <20 nA for long-term storage
- Up to 10 years of shelf storage

差异化特性

DC-DC升压转换器

- **输入范围: 0.8 V ~ 1.7 V**
  - 增加对低电压电池的支持
  - Silver Oxide: ~1.2 to 1.65 V
  - 碱性电池 / 可充电的2A/3A电池: ~0.9 to 1.5 V
- **库仑计数器**
  - 实现准确的电池电量水平追踪
- **具有唤醒引脚的上架模式(Shelf Mode)**

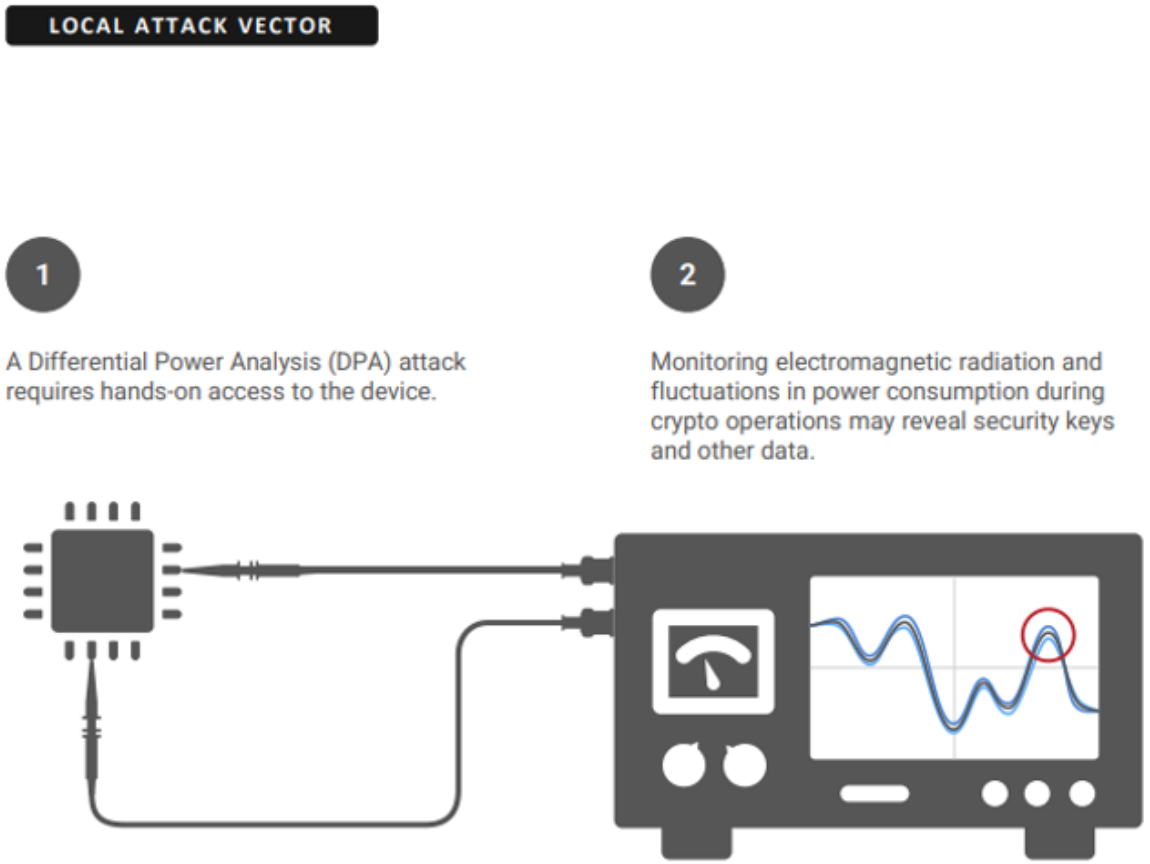


Secure Vault™ — 保护物联网设备

Base	Mid	High	Feature
✓	✓	✓	True Random Number Generator
✓	✓	✓	Crypto Engine
✓	✓	✓	Secure Application Boot
—	VSE/HSE	HSE	Secure Engine
—	✓	✓	Secure Boot with RTSL
—	✓	✓	Secure Debug with Lock/Unlock
—	HSE & xG27	✓	DPA Countermeasures
—	xG25, xG27	xG25	E-Tamper
—	xG27*	✓	PUF Support (Seed Key to AES)
—	—	✓	Anti-Tamper
—	—	✓	Secure Attestation
—	—	✓	Secure Key Management
—	—	✓	Advanced Crypto
	EFR32BG27 EFR32MG27		

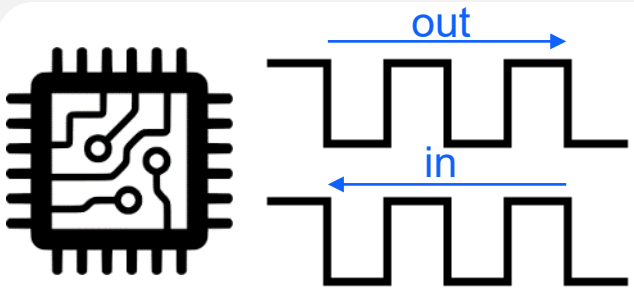
设计安全的物联网设备

增强安全性—DPA Countermeasures

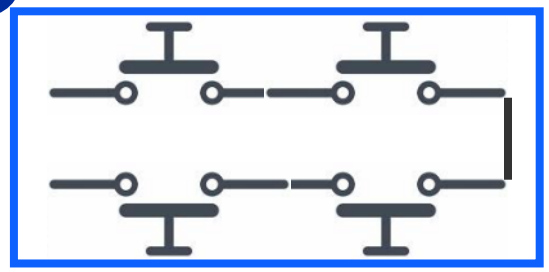


- **漏洞**
  - 观察给定内部操作期间的细微差异可以提供对加密函数的深入了解。
- **DPA Countermeasures**
  - 该解决方案为内部操作添加掩码(masks)和随机计时(random timings)，并扭曲DPA snooping

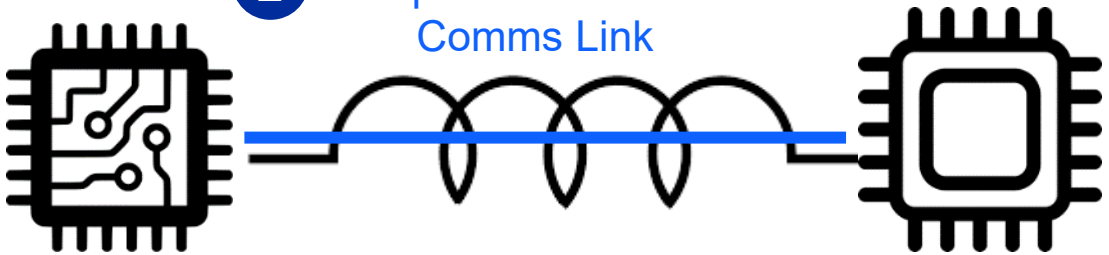
E-Tamper



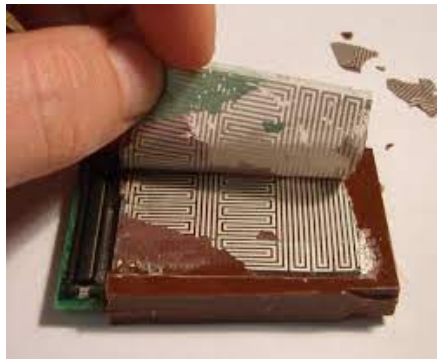
1 Tamper Pins on Case



2 Tamper Trace Around Comms Link

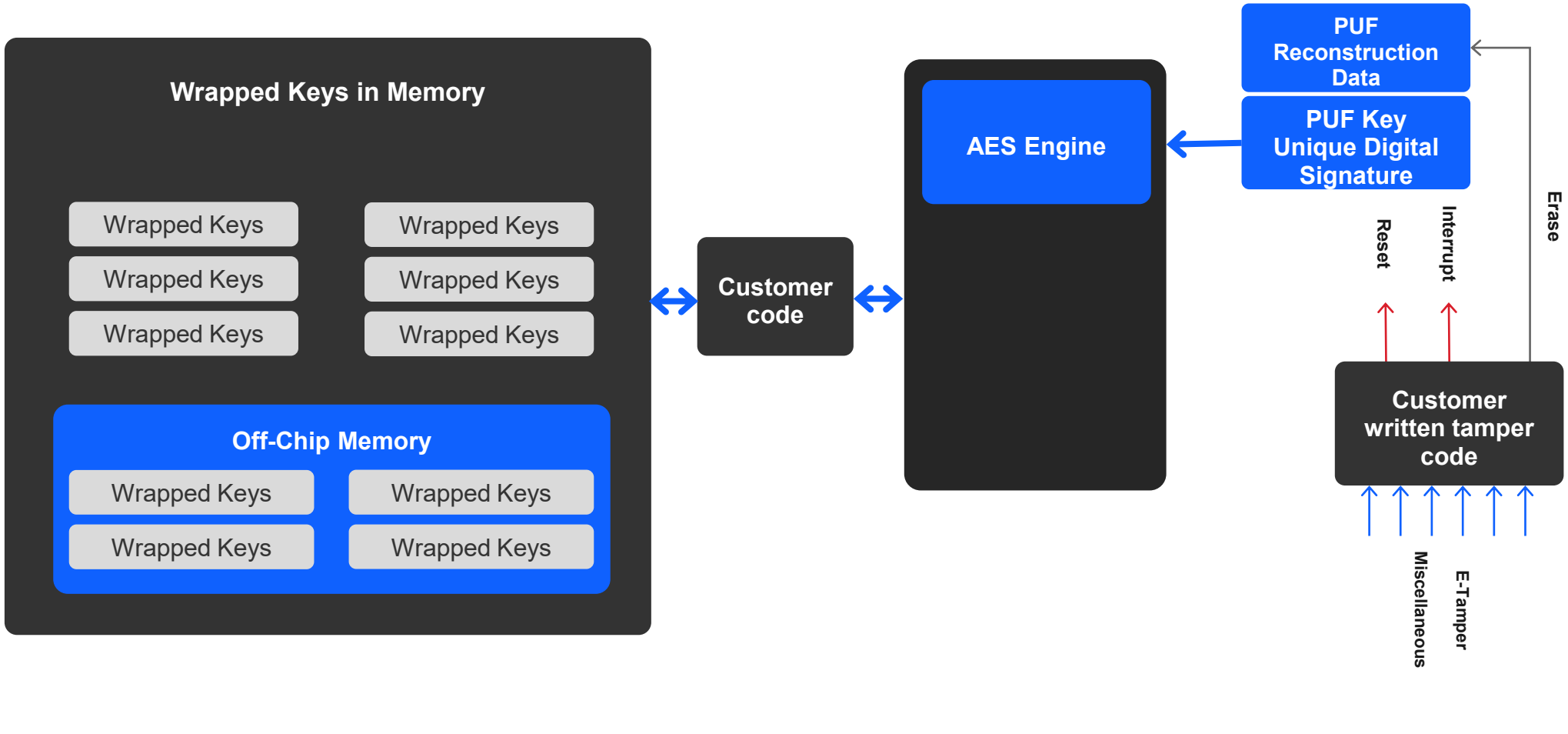


3 Purpose Built Tamper Shields

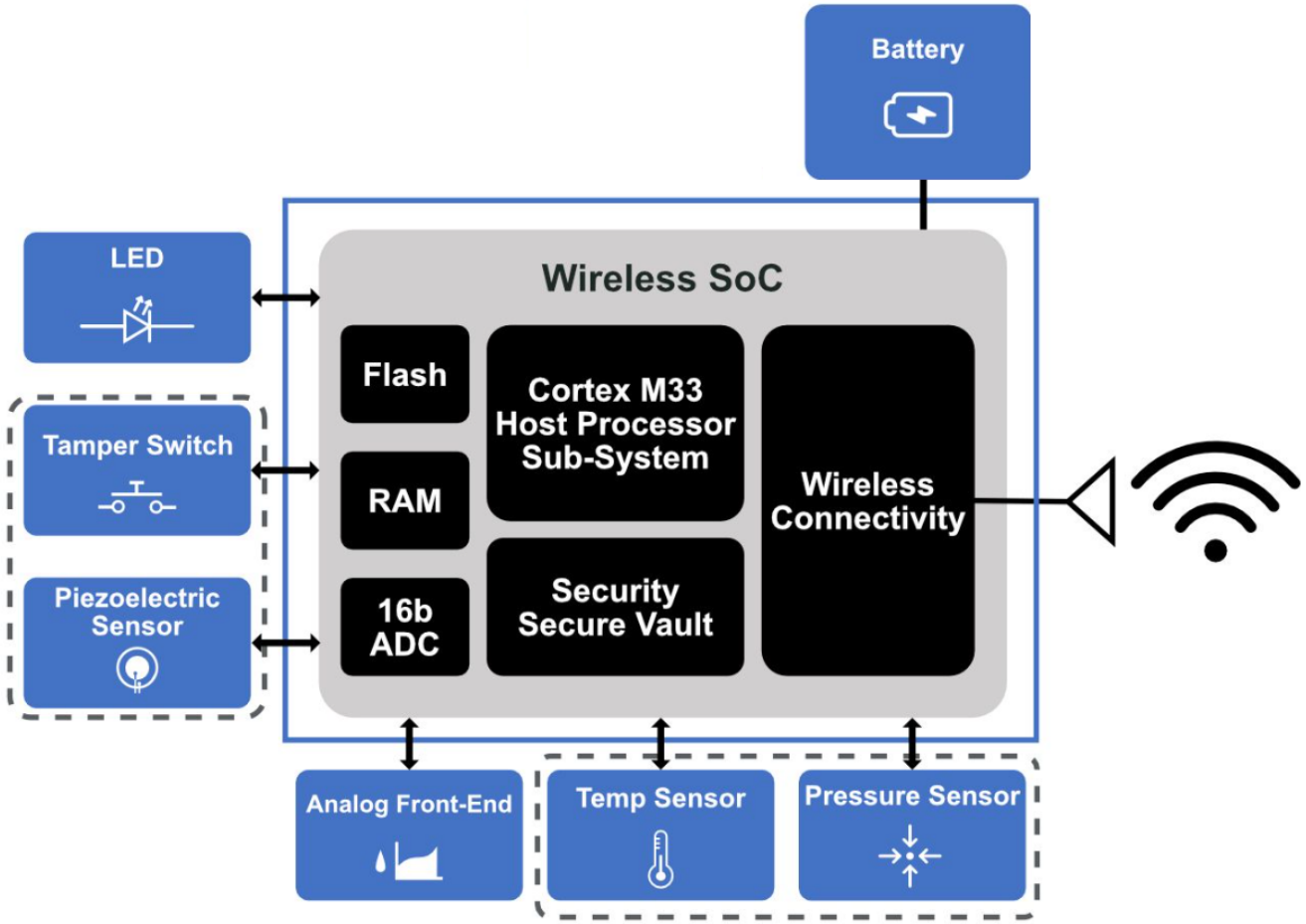


- 方波从一个引脚输出，而在另一个引脚输入时，断开的信号可以输入其他逻辑来采取篡改动作
- 应用案例:
  1) 在产品包装上连接篡改引脚，然后在包装打开时触发动作
  2) 在PC板上总线创建Wire trace，以保护两个组件之间的通信
  3) 为防篡改屏蔽供电以保护PCB上多个组件

增强安全性—用户密钥管理与PUF



微型医疗设备设计实例—连续血糖监测仪



- **基于BG27 SoC**
- **功能特点**
  - BG27 CSP 封装 / 尺寸
  - DCDC 降压 / 升压
  - 功耗优化
    - 低活动电流和睡眠电流
    - 上架模式 (Shelf Mode) (BOOST_EN)
  - Secure Vault
    - E-Tamper
  - 模拟/串行外围设备
    - 16-bit ADC
  - CGM示例应用

芯科科技2.4GHz SoC产品组合

	xG21	xG22	xG24	xG27
Protocols				
Frequency Bands	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz
Core	Cortex-M33 (80 MHz) Cortex-M0+ (Security)	Cortex-M33 (76.8 MHz) Cortex-M0+ (Radio)	Cortex-M33 (78 MHz) Cortex-M0+ (Radio) Cortex-M0+ (Security)	Cortex-M33 (76.8 MHz) Cortex-M0+ (Radio)
Max Flash	1024 kB	512 kB	1536 kB	768 kB
Max RAM	96 kB	32 kB	256 kB	64 kB
Security	Secure Vault Mid Secure Vault High	Secure Vault Mid	Secure Vault Mid Secure Vault High	Secure Vault Mid
Rx Sensitivity (15.4)	-104.5 dBm	-102.3 dBm	-105.4 dBm	-102.3 dBm
Rx Sensitivity (BLE 1Mbps)	-97.5 dBm	-98.9 dBm	-97.6 dBm	-98.9 dBm
Active Current	63.8 µA/MHz	26 µA/MHz	33.4 µA/MHz	29 µA/MHz
Sleep Current (EM2, 16 kB ret)	4.5 µA	1.2 µA (8 kB)	1.3 µA	1.6 µA (64 kB)
TX Current @ +0 dBm (2.4 GHz)	9.3 mA	4.1 mA	5.0 mA	4.1 mA
TX Current @ +10 dBm (2.4 GHz)	33.8 mA	8.2 mA @ +6 dBm	19.1 mA	11.3 mA @ +8 dBm
TX Current @ +20 dBm (2.4 GHz)	185 mA	N/A	156.8 mA	N/A
RX Current (802.15.4)	9.4 mA	3.9 mA	5.1 mA	3.9 mA
RX Current (BLE 1 Mbps)	8.8 mA	3.6 mA	4.4 mA	3.6 mA
Serial Peripherals	USART, I2C	USART, EUSART, I2C, PDM	USART, EUSART, I2C	USART, EUSART, I2C, I2S, PDM
Analog Peripherals	12-bit ADC, ACMP	16-bit ADC	20-bit ADC, ACMP, VDAC	16-bit ADC, ACMP, Coulomb Counter
Other	Die Temp Sensor	Die Temp Sensor	Die Temp Sensor	Temp Sensor, PLFRCO, Buck/Boost
Operating Voltage	1.71 V to 3.8 V	1.71 V to 3.8 V	1.71 V to 3.8 V	0.8 – 1.6 V 1.71 – 3.8 V
GPIO	20	18, 26	26, 28/32	26, 18, 19
Package	4x4 QFN32	4x4 QFN32 4x4 TQFN32 5x5 QFN40	5x5 QFN40 6x6 QFN48	5x5 QFN40 4x4 QFN32 2.3x.2.6 WLCSP

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蓝牙开发套件之硬件和软件综合导览与演示

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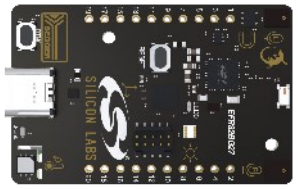
芯科科技高级现场应用工程师

SILICON LABS

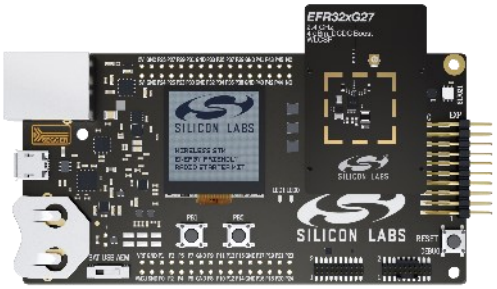
启用EFR32BG27和EFR32MG27 SoC

- 开发板
  - Low-cost development board
  - On-board debugger
  - Signal breakouts
  - On-board sensors
  - 16-bit ADC
- 内容物
  - 1x dev board



Part Number	Description
xG27-DK2602A	EFR32xG27 2.4 GHz +8 dBm dev board

- 高级套件
  - Modular development platform
  - Advanced development
  - RF measurements
  - Energy profiling
  - External device debug
  - Ethernet for large network test
- 内容物
  - 1 x WSTK main board
  - 1 x radio board

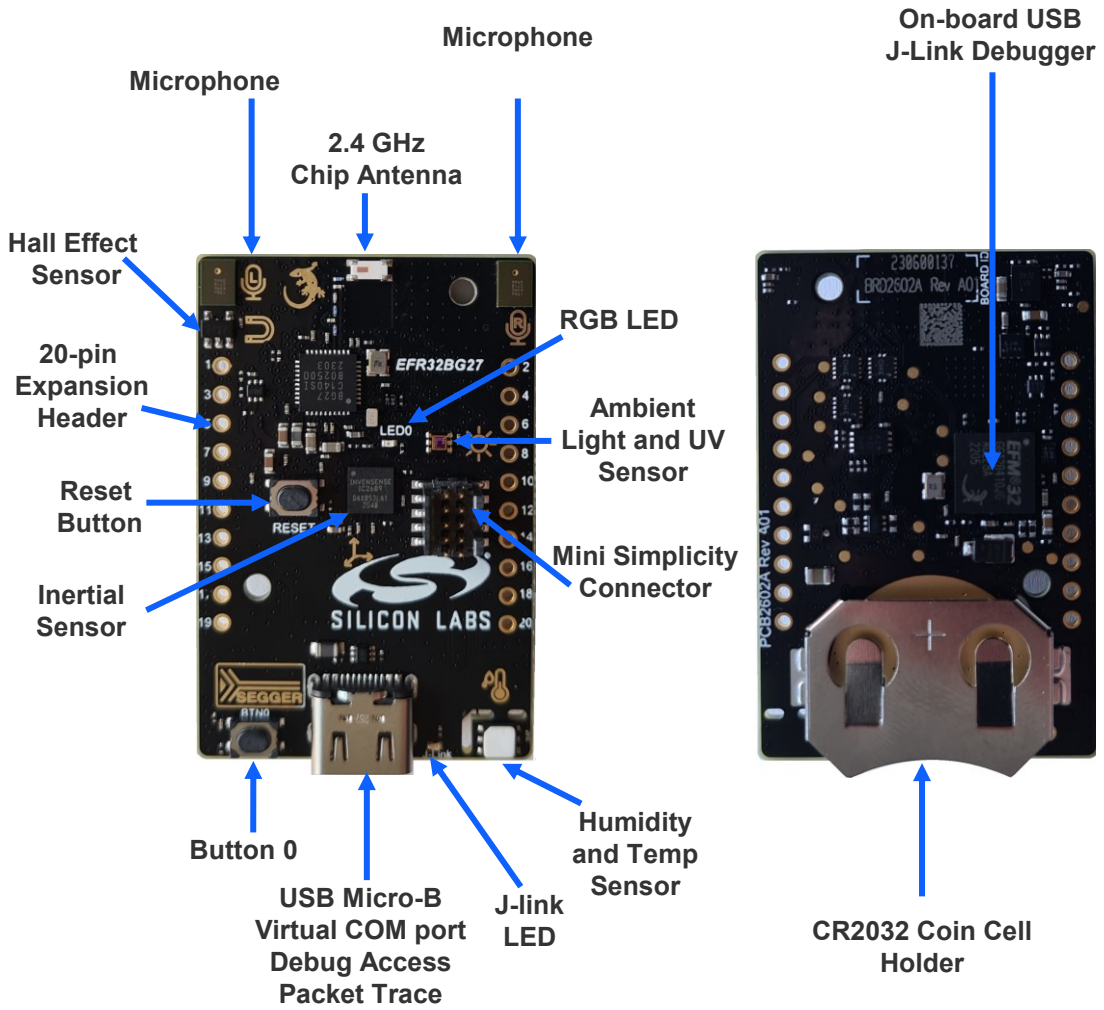


Part Number	Description
xG27-PK6017A	EFR32xG27 2.4 GHz +8 dBm Pro Kit (Buck)
xG27-PK6018A	EFR32xG27 2.4 GHz +4 dBm Pro Kit (Buck)
xG27-PK6019A	EFR32xG27 2.4 GHz +4 dBm Pro Kit (Boost)

- 无线开发套件
  - Uses existing WSTK boards
  - Uses existing software tools
- 内容物
  - 1x radio board

Part Number	Description
xG27-RB4194A	EFR32xG27 2.4 GHz +8 dBm Radio Board (Buck)
xG27-RB4110B	EFR32xG27 2.4 GHz +4 dBm Radio Board (Buck)
xG27-RB4111B	EFR32xG27 2.4 GHz +4 dBm Radio Board (Boost)

开发板功能特点



- 特性
  - EFR32BG27C140F768IM40 for +8 dBm Kit (Buck)
  - Wireless SoC with multi-protocol radio
  - Cortex-M33, 768 kB Flash and 64 kB RAM
  - Coulomb counter
- 广泛的传感器支持
  - 9-axis Inertial Sensor
  - 2 Digital Microphones
  - Pressure Sensor
  - Relative Humidity and Temperature Sensor
  - UV and Ambient Light Sensor
  - Hall-effect Sensor
- 扩展选项和用户界面
  - Breakout pads
  - Qwiic connector
  - LEDs and Push Buttons

射频开发板和主板功能特点

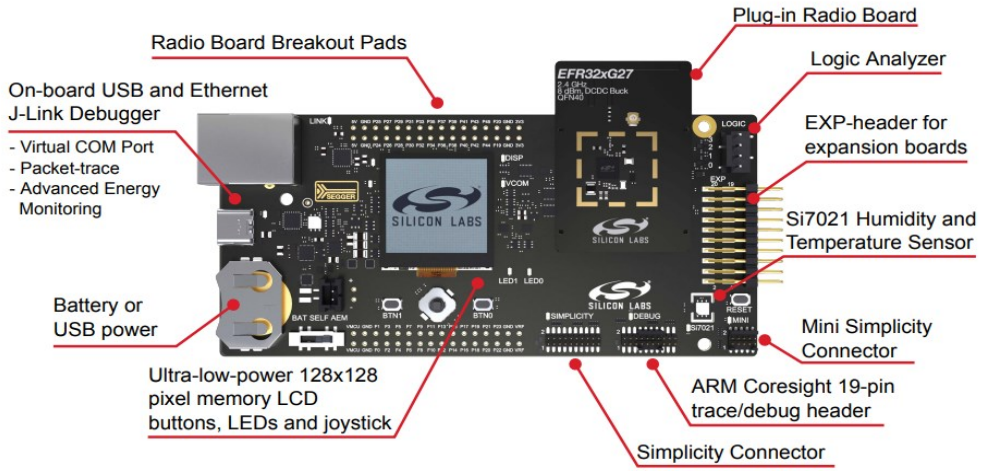
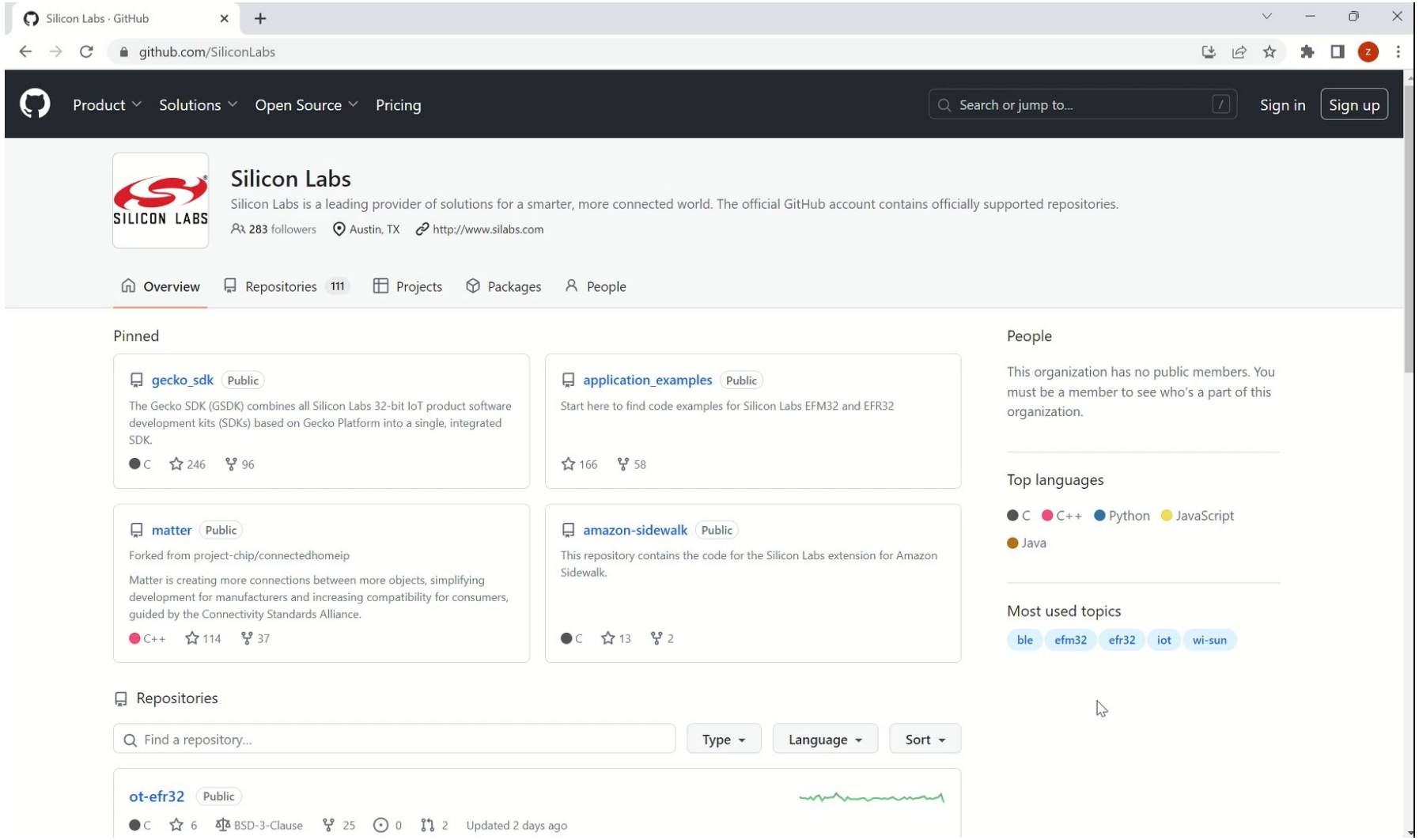


Figure 2.1. Hardware Layout With A Wireless Pro Kit Mainboard (BRD4002A)

- 射频开发板特性
  - EFR32MG27C140F768IM40 for +8 dBm Kit (Buck)
  - EFR32BG27C320F768GJ39 for +4 dBm Kit (Buck)
  - EFR32BG27C320F768GJ39 for +4 dBm Kit (Boost)
  - Cortex-M33, 768 kB Flash and 64 kB RAM
  - Secure Vault Mid
  - U.FL for RF Measurements
- 主板特性
  - LEDs and Push Buttons
  - Ethernet and USB connectivity
  - Advanced Energy Monitor
  - Packet Trace Interface
  - Breakout pads and expansion header
  - External debug support
  - Si7021 Relative Humidity and Temperature sensor
  - Low Power 128x128 pixel Memory LCD
  - USB, CR2032, and battery pack options for power

Github演示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Austin, TX
http://www.silabs.com
Overview
Repositories 111
Projects
Packages
People
Pinned
gecko_sdk Public
The Gecko SDK (GSDK) combines all Silicon Labs 32-bit IoT product software development kits (SDKs) based on Gecko Platform into a single, integrated SDK.
C 246 96
application_examples Public
Start here to find code examples for Silicon Labs EFM32 and EFR32
166 58
matter Public
Forked from project-chip/connectedhomeip
Matter is creating more connections between more objects, simplifying development for manufacturers and increasing compatibility for consumers, guided by the Connectivity Standards Alliance.
C++ 114 37
amazon-sidewalk Public
This repository contains the code for the Silicon Labs extension for Amazon Sidewalk.
C 13 2
Repositories
Find a repository...
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Language
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ot-efr32 Public
C 6 BSD-3-Clause 25 0 2 Updated 2 days ago
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This organization has no public members. You must be a member to see who's a part of this organization.
Top languages
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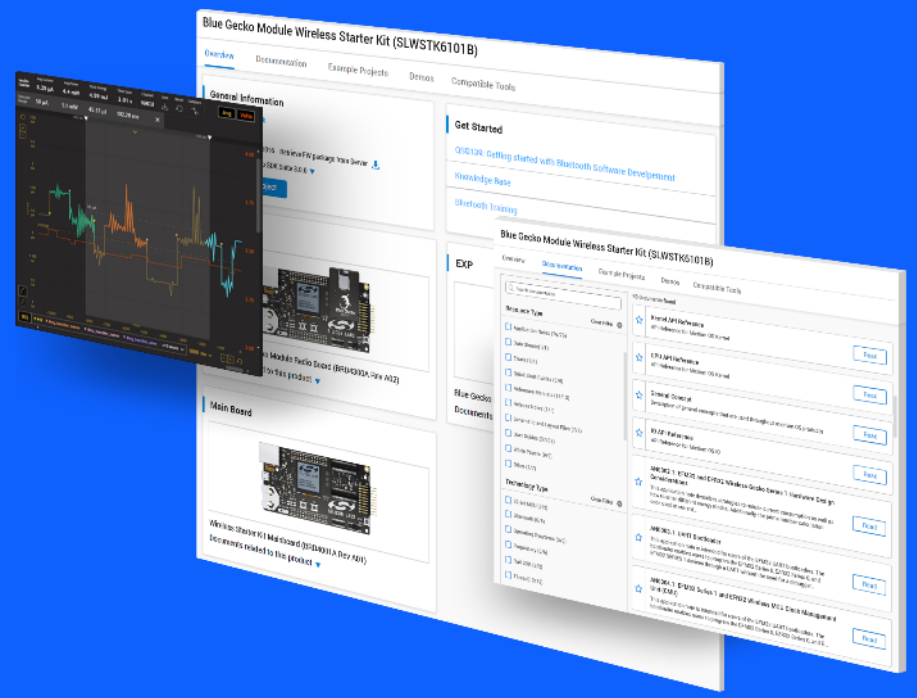
Most used topics
ble efm32 efr32 iot wi-sun

简化开发人员体验

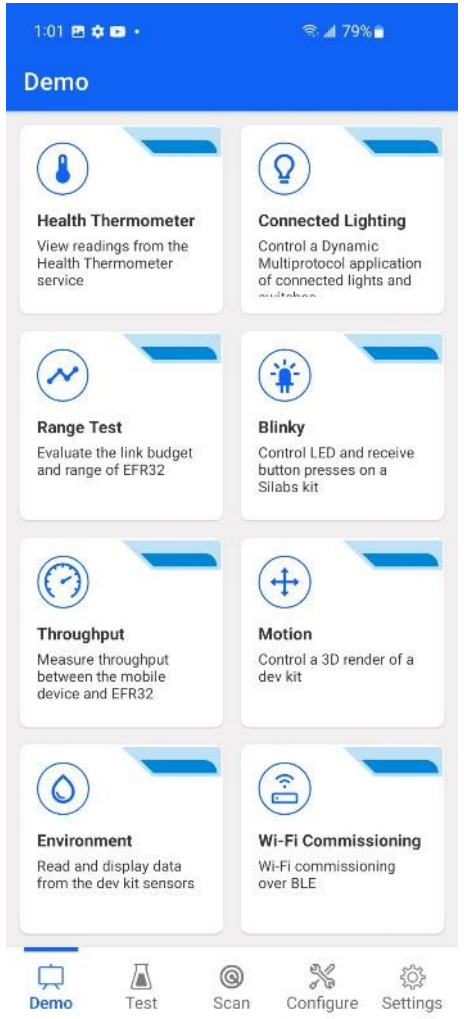


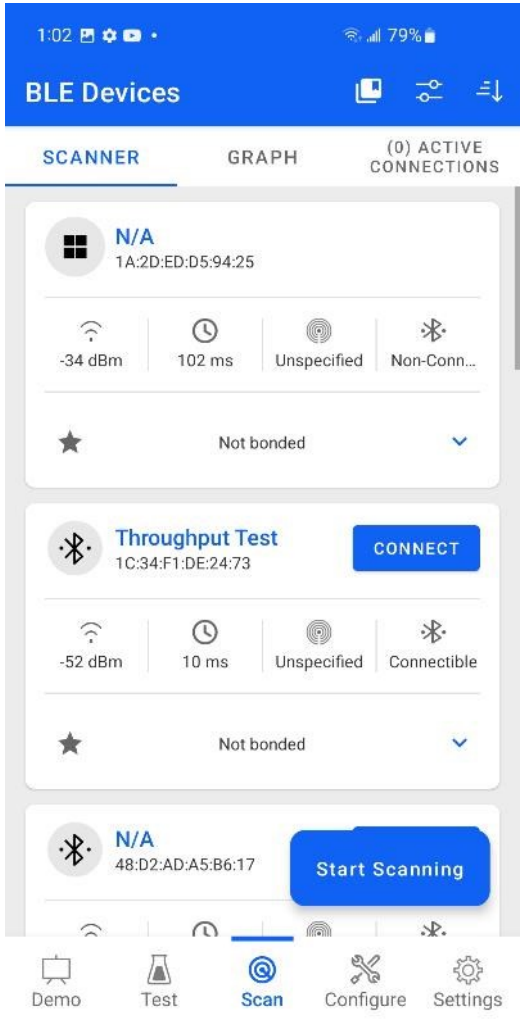
Simplicity Studio 5

Simplicity Studio 5

- 界面
  - Fresh, new & simplified
  - Intuitive out-of-the-box experience
  - Fast access to developer resources
  - Linux, Mac & Windows
- 工具
  - Configuration utilities
  - Compiler
  - Error & validation
  - IDE & command line support
  - Graphical hardware configurator
  - Energy Profiler – visual energy analysis
  - Network Analyzer – packet capture & decode

EFR Connect – 演示



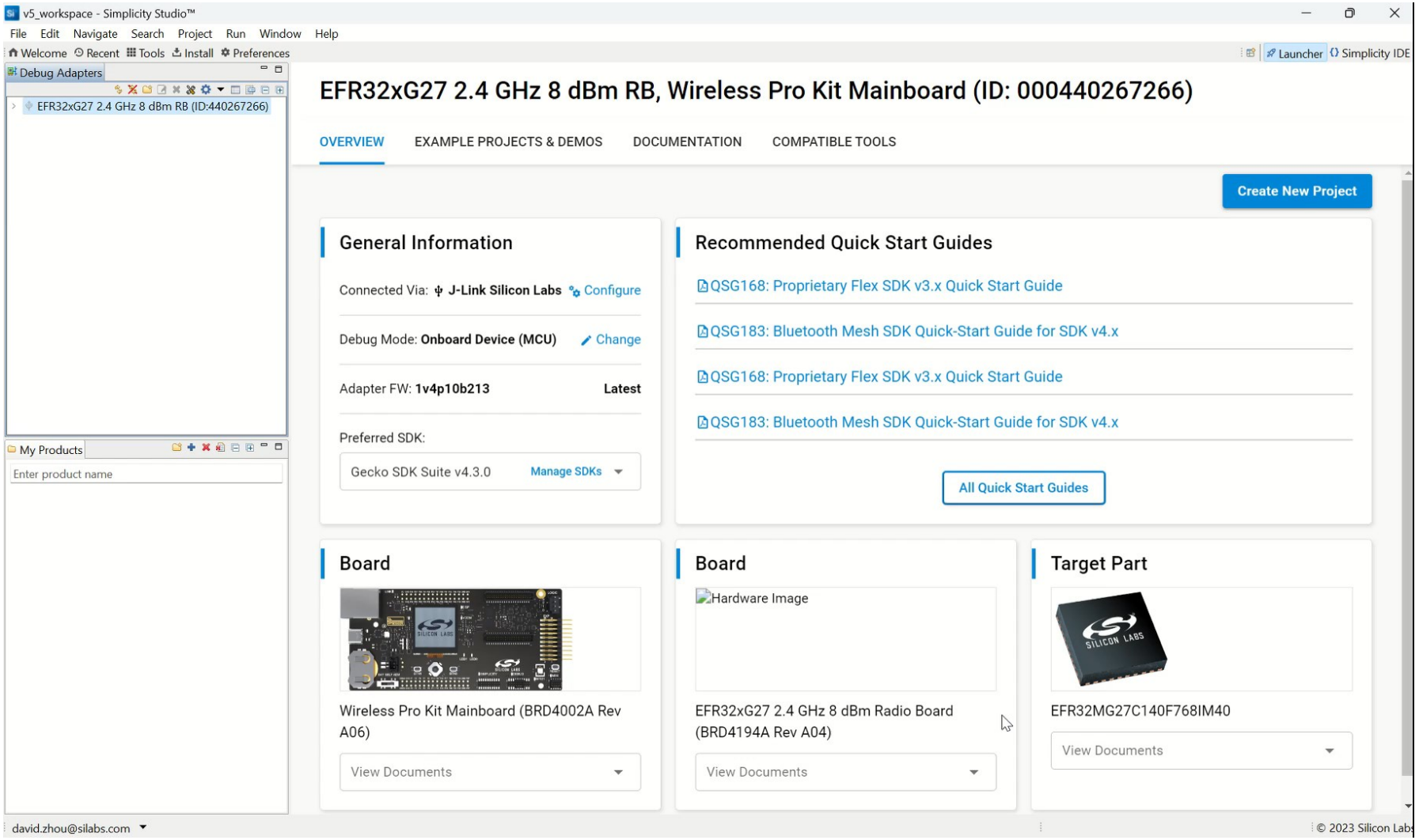


- **EFR Connect将最流畅的开箱即用体验与最先进的低功耗蓝牙开发功能结合在一个移动应用程序中**

- **带有不同用途视图的主导航栏**
  - Demo: 在GSDK上预编译了许多工具包，包括现成的演示与匹配的样例应用程序
  - Scan: 用于搜索、连接和与远程设备交互
  - Configure:为移动设备提供本地广播和GATT配置
  - Test: (IOP)评估针对Silicon Labs的蓝牙软件和硬件的行为
  - Settings: 用于系统配置和应用程序信息

xG27和Simplicity Studio演示

Simplicity Studio实际操作演示



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资源和链接

BG27产品网页

- https://www.silabs.com/bg27

MG27产品网页

- https://www.silabs.com/mg27

Simplicity Studio 5

- https://www.silabs.com/developers/simplicity-studio

EFR Connect

- https://www.silabs.com/developers/efr-connect-mobile-app

GitHub

- https://github.com/siliconlabs

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蓝牙产品介绍：BLE 5.4 的新特点和芯科科技对此的支持

方恒坚(Kevin Fang)
芯科科技高级现场应用工程师

SILICON LABS

议程大纲

为何需要Bluetooth® 5.4?

Bluetooth® 5.4的新功能及特性

Bluetooth® 5.4

为何需要Bluetooth 5.4?

- **需要标准化的大规模星型网络**
  - 承载数千个节点的能力
  - 加密数据流量
  - 超低功耗
  - 受电子货架标签(ESL)市场的推动
- **增强特性**
  - 优化对安全数据的访问
  - 为扩展广告(extended advertising)的LE编码PHY提供更好地控制

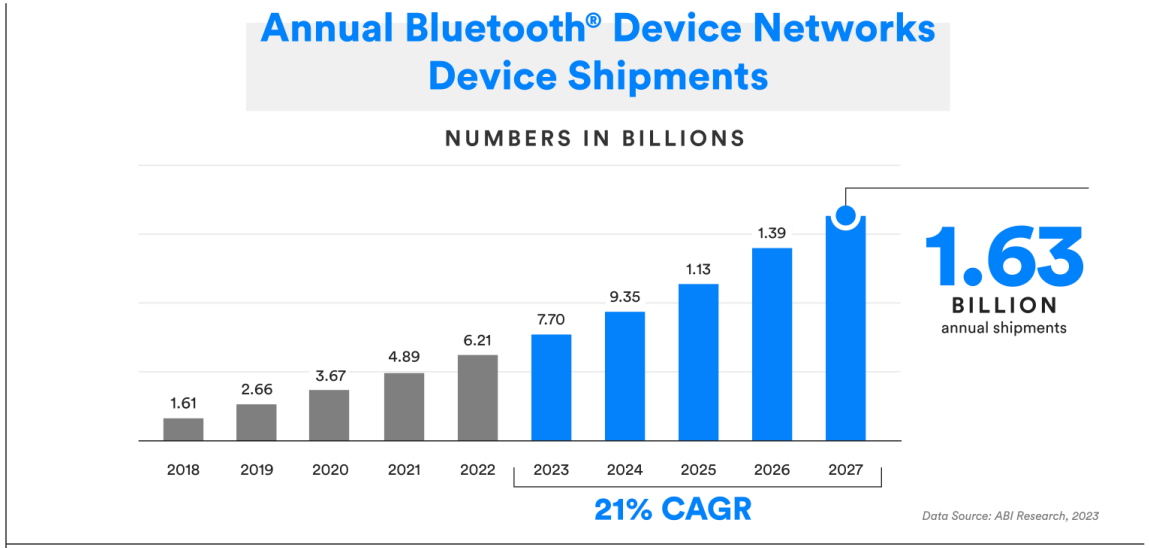
Bluetooth 5.4 – 目标市场和应用案例

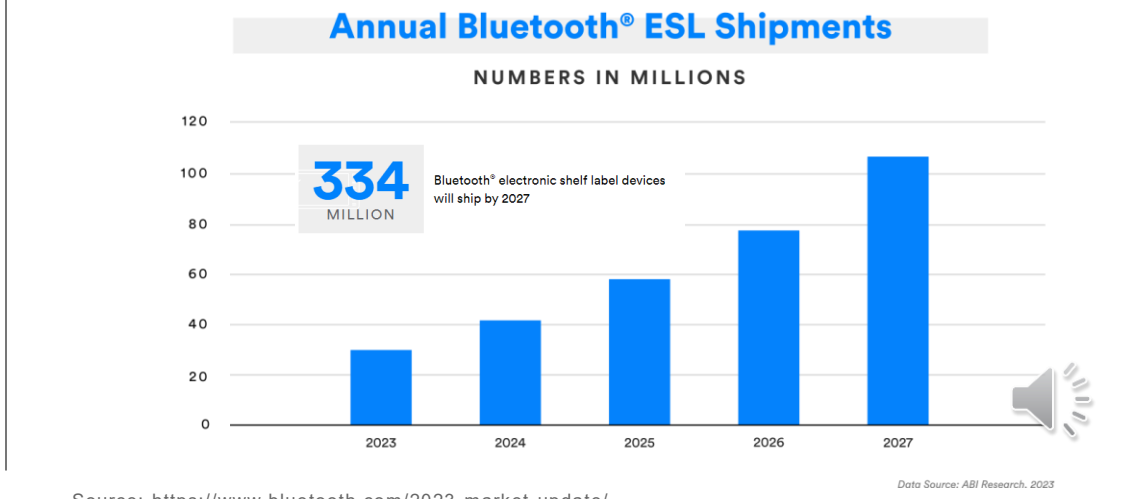
智能零售

- 电子货架标签
- 架上的传感器

工业

- 制造和物流
- 数字标记
- 资产监控





Source: https://www.bluetooth.com/2023-market-update/

Bluetooth 5.4新特性

同步广告响应 (PAwR)

提供节能、大规模、双向的一对多通信拓扑

加密广播数据 (EAD)

具有在广告包中安全地广播数据的特点

LE GATT 安全级别

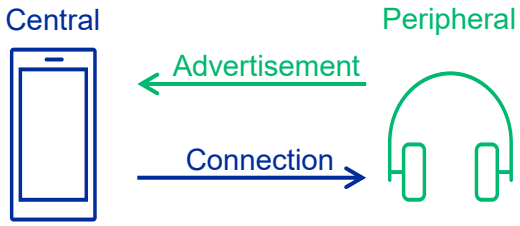
设备可以指示所有GATT功能应用所需的安全模式和级别

广播编码选择

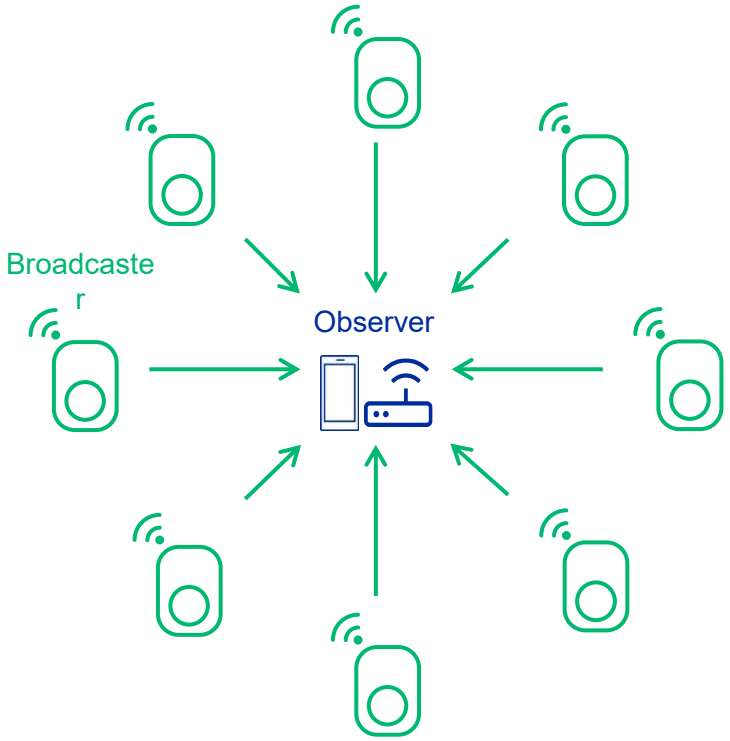
主机可指定LE扩展广告使用两个支持的远程编码选项中的其一

蓝牙5.4中的广播模式

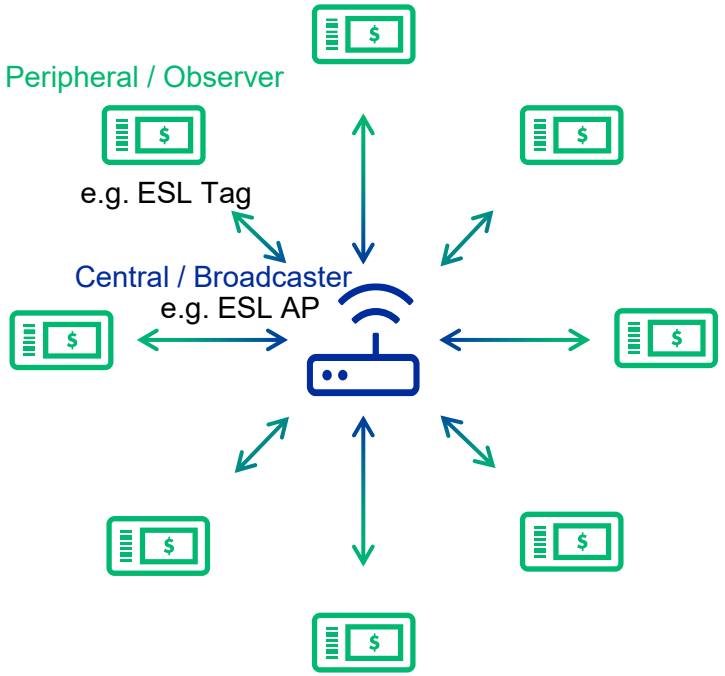
针对连接的广告
(不定期, 单向)



单向的 “Beaconing”
(定期, 单向)



同步广播响应(PAwR)
(定期, 双向)

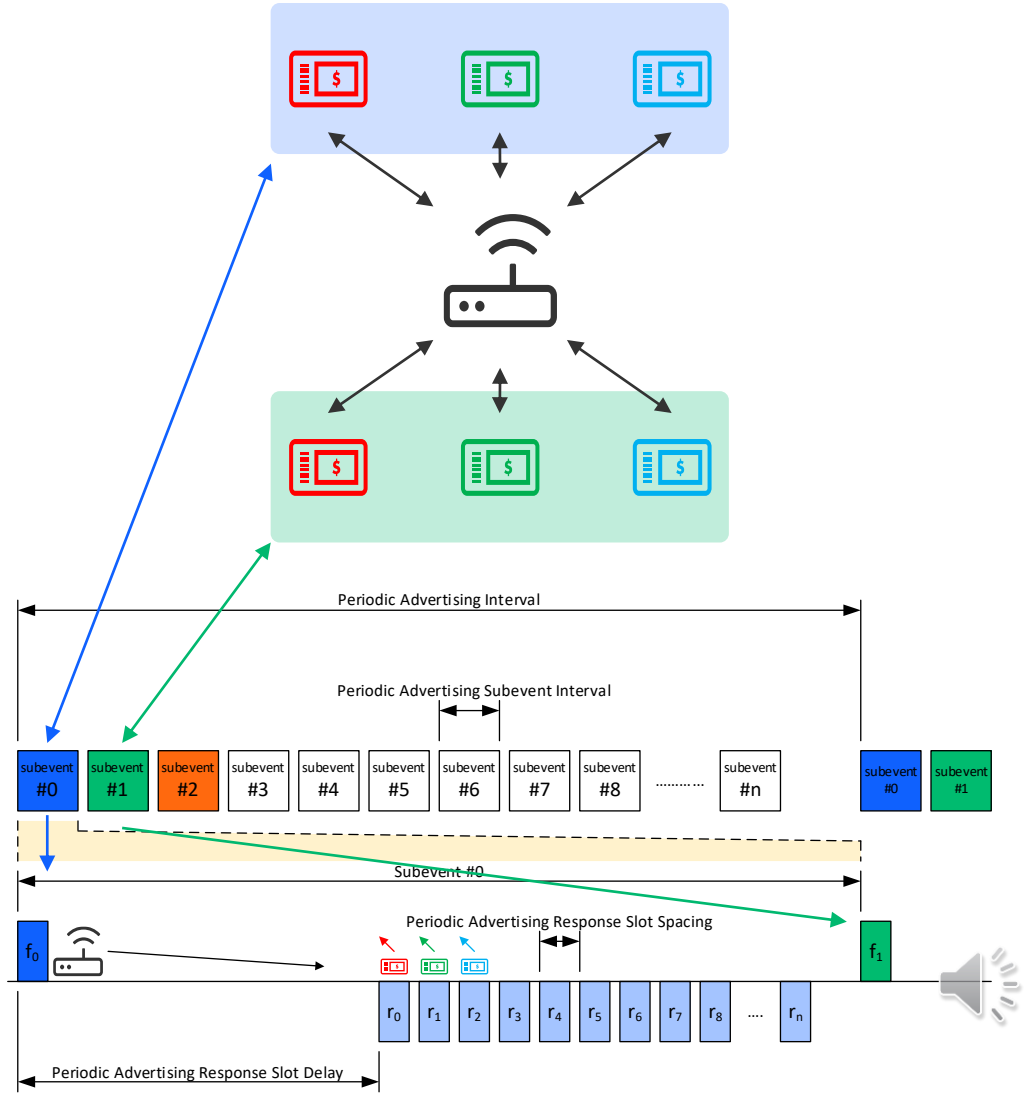


启用“同步”模式网络的新模式
用于蓝牙ESL

SILICON LABS

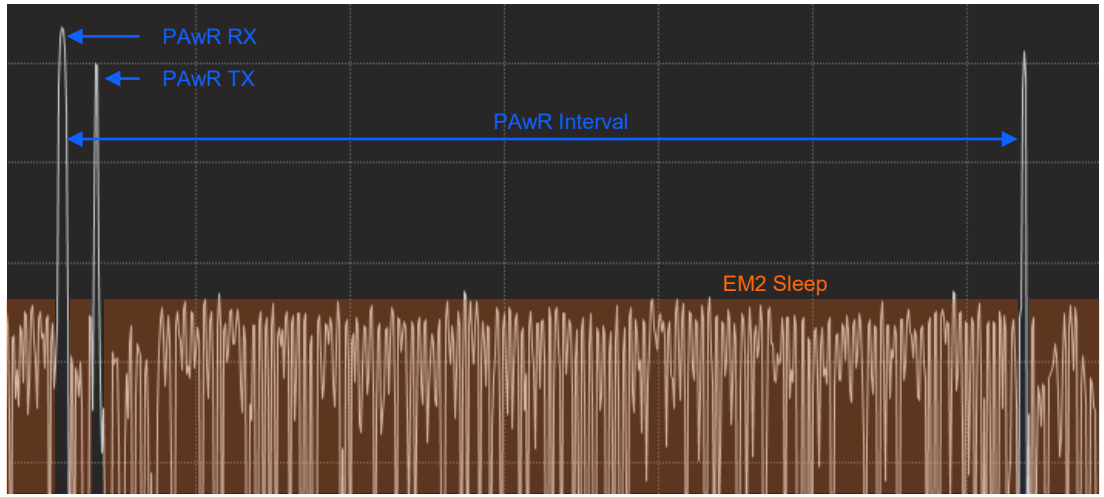
同步广播响应(PAwR)的说明

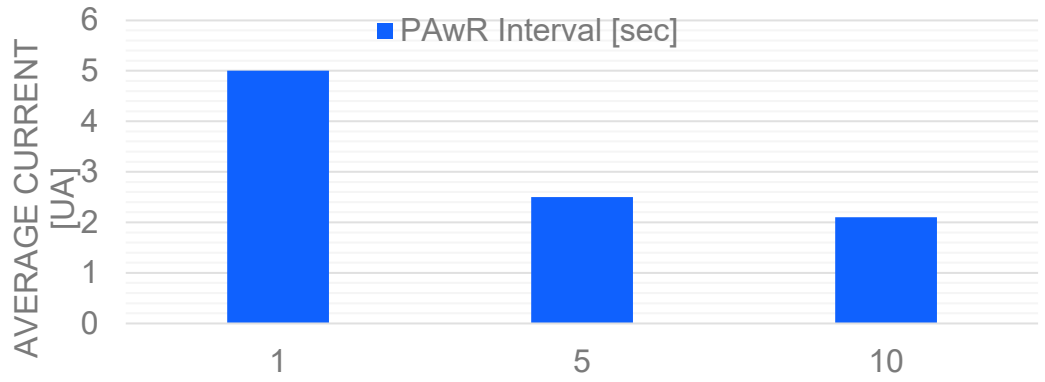
- **PAwR设置**
  - 设置定时参数
  - 配置子事件数和响应槽数
- **子事件(Subevents)**
  - 每个外设(ESL)属于一个子事件
  - 最多128个子事件(ESL Group)
  - 一个ESL Group中有255个专属的ESL
  - 网络中最多有32,640个外设
- **在子事件中**
  - 一个子事件中的所有外设接收中心设备传输(下行链路)
    - 保持与PAwR序列的同步
    - 传输下行负载数据
  - 每个外设都有自己的响应槽来应答(上行链路)



SILICON LABS

PAwR电流消耗示例



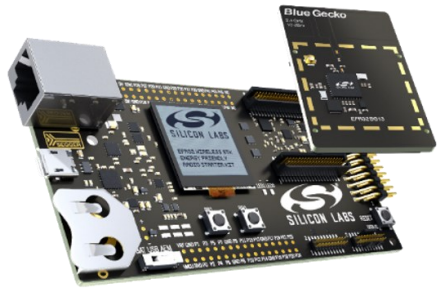


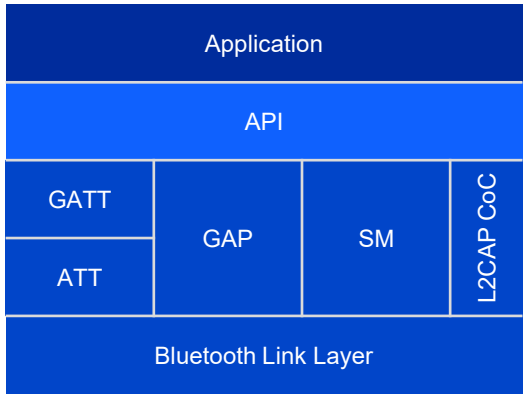
- **外围设备用例**
  - 在给定子事件时隙接收中央设备下行传输
  - 响应给定响应槽的上行链路
  - 其余时间保持睡眠模式
- **测量条件**
  - MG22射频开发板
  - Vinput 3.0V, DC/DC in use
  - SoC Current only
  - TX 0dBm
  - LFXO accuracy 50ppm

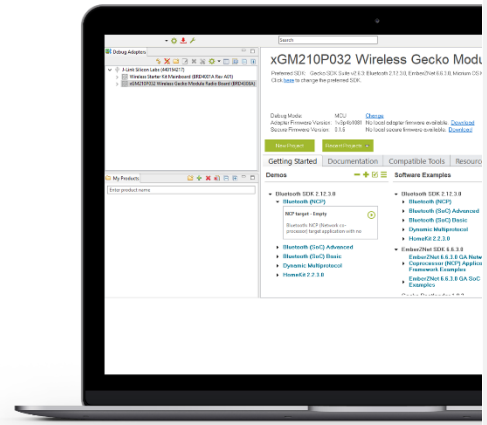
SILICON LABS

完整的Bluetooth 5.4开发解决方案

公开的GSDK版本已于6月发布







SOC，模块，开发套件

Multiple physical interfaces to support advanced development and debugging

UART, Ethernet, USB

LCD, LED, buttons

软件协议栈

In-house developed stack

Bluetooth 5.4

Support for PAwR, EAD, PAST, CoC, BT ESL Service and Profile

All security features supported

ESL接入点演示

Python based ESL AP

ESL Library (GATT, OTS & NCP Events)

EFR32 radio with NCP

开发工具

Simplicity Studio

BT 5.4 NCP and SoC

BT ESL Example

Energy Profiler

2023 tech talks
WEBINAR SERIES

基于低功耗蓝牙的高精度距离测量(HADM)最新技术

黄良军(Bruce Huang)
芯科科技主任现场应用工程师

BLUETOOTH SERIES

高精度距离测量(HADM)应用

目标市场和应用

家居

寻物(Item Finding)

无钥匙进入(Keyless Entry)

宠物跟踪(Pat Tracking)

商业

门禁控制(Access Control)

库存管理(Inventory management)

资产跟踪(Asset Tracking)

对改进距离测量的需求－超越RSSI

精确性和可靠性

RSSI对室内多径环境过于敏感

简单易用

实现低成本器件的设计
单天线设计
减少系统资源

安全性

攻击者可通过射频信号放大来操纵RSSI

互操作性

基于标准化的特性

HADM和信道探测

LOCATION SERVICES

Drivers for Tomorrow

Bluetooth® high-accuracy distance measurement will set a new bar for performance of location services solutions

Bluetooth® technology will soon add high-accuracy distance measurement (HADM), enabling item finding solutions to provide greater precision as users get closer to an item being located, allowing passive keyless entry solutions to add another layer of authentication and accuracy, and improving the performance of real-time locating systems.

260 MILLION — Bluetooth® asset tracking devices will ship in 2027

338 THOUSAND — Bluetooth® RTLS implementations by 2027

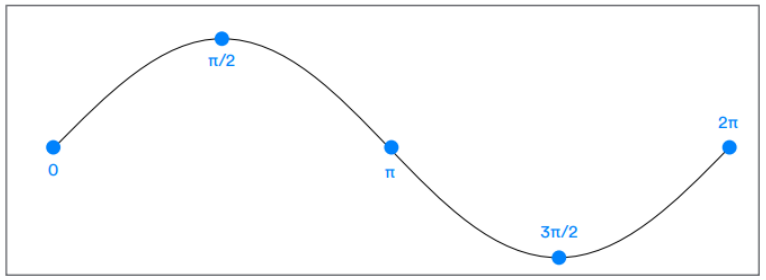
Bluetooth®

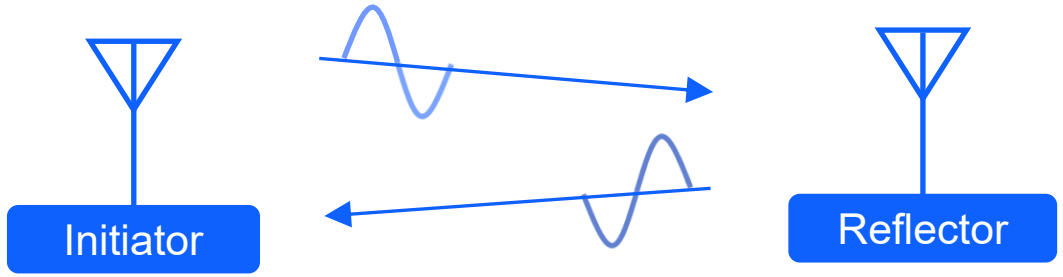
信道探测(CS)是启用HADM的蓝牙功能

- CS目前正在由蓝牙技术联盟(Bluetooth SIG)定义
- 规范草案可通过下方链接查找:
  https://www.bluetooth.com/specifications/specs/channel-sounding/
- 定义对基于相位的测距(PBR)音调交换和/或往返路程时间(RTT)包交换的支持
- 还定义了过程、事件、子事件等，以实现距离估算

相位测距(PBR)

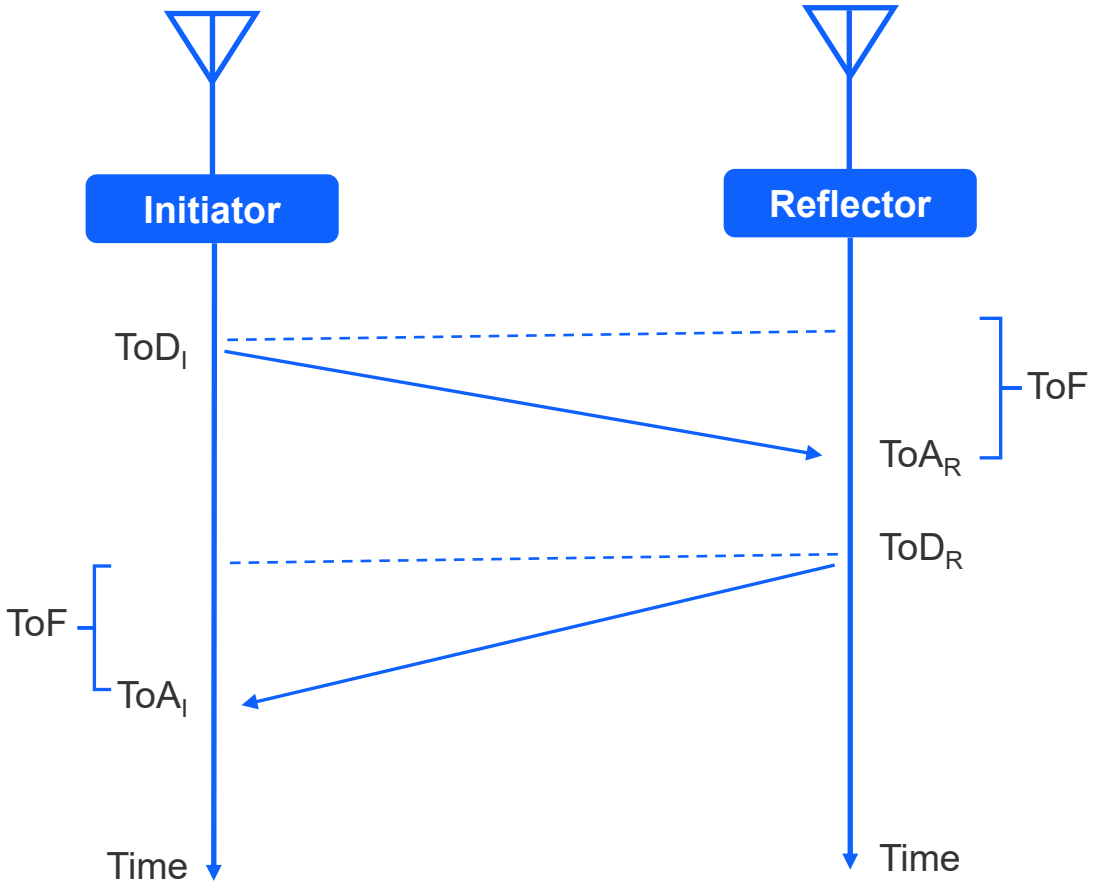
Phase
A specific point in a wave cycle, perhaps measured as the wave passes over an antenna, is known as its *phase*. Phase is measured as an angle from 0 at the start of the wave cycle to 360 degrees or 2π radians at the end of the wave cycle. Figure 8 illustrates the concept of phase.





- **两个设备间的音调交换**
- **射频信号的相位是载波频率和传输距离的函数**
  - 由于空间传播确定的相位旋转
  - 在多个射频频率进行测量，以解决距离模糊的问题
- **距离是用发射和接收信号之间的相位差来计算的**
- **安全性**
  - 相位的操作比RSSI更为复杂
  - IQ样本质量
- **相较于RSSI更为精确**
- **关键考量**
  - Antenna radiation patterns
  - 电路板设计特定校准

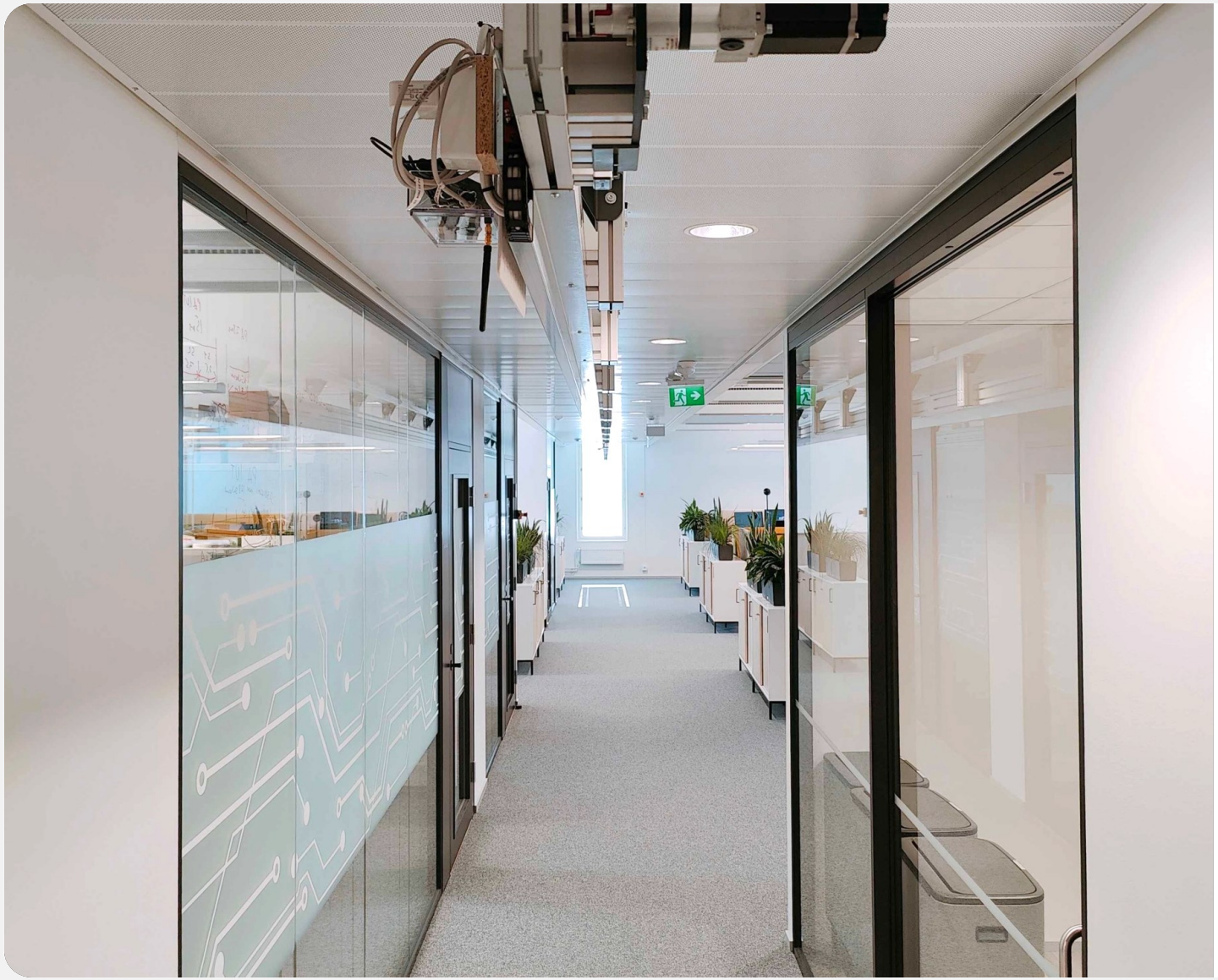
往返时间(RTT)



$$RTT = 2\,ToF = (ToA_I - ToD_I) - (ToD_R - ToA_R)$$

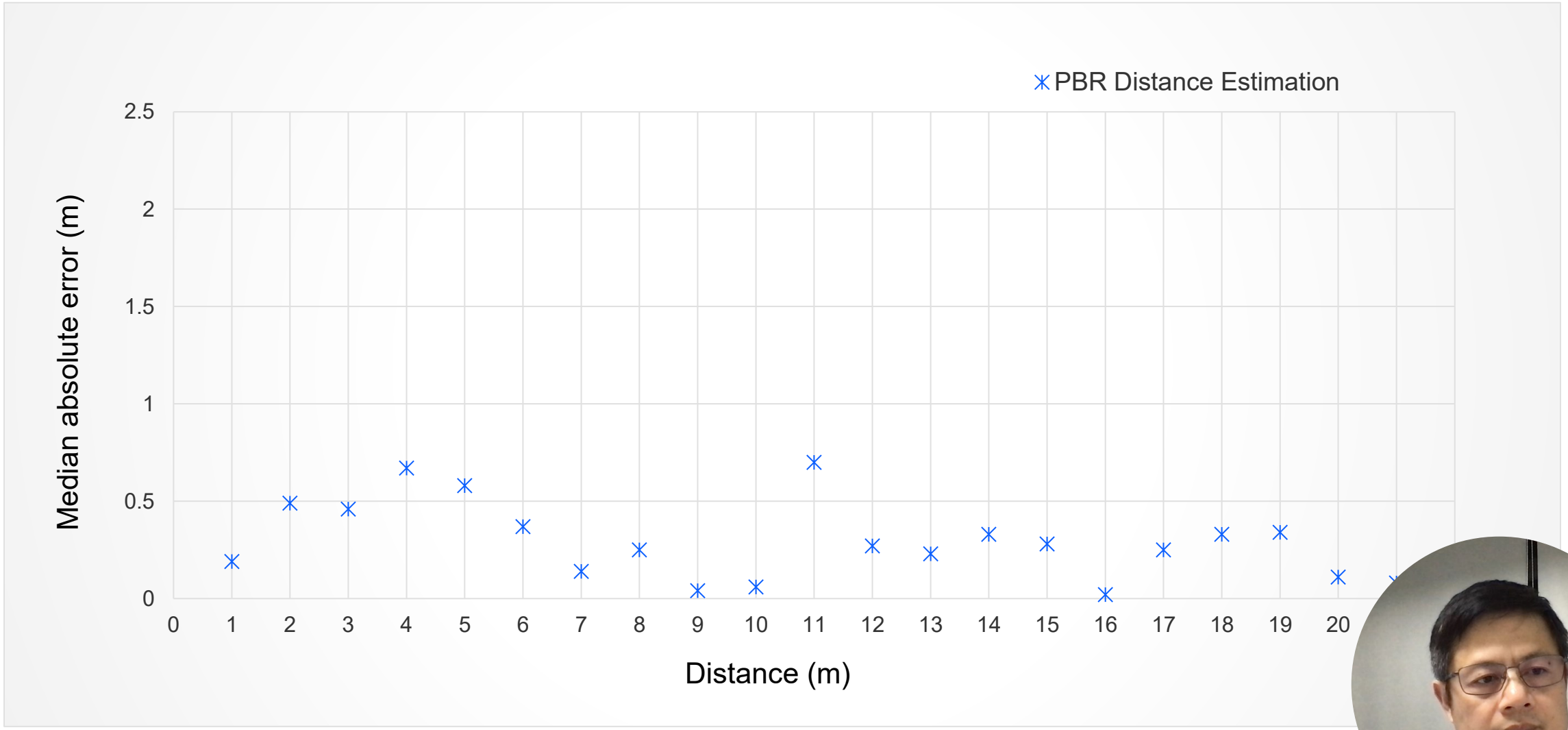
- **数据包传输时间(ToF)是用到达时间(ToA)和离开时间(ToD)在发起方和反射方测量的**
  - 在多个信道上交换的调制数据包，以确定ToF和估计距离
  - 使用小数分频来解决采样不确定性和提高分辨率
- **时间不能倒转 -> RTT有助于提高安全性**
- **相较于PBR较不准确**

应用于室内办公环境的操作性能



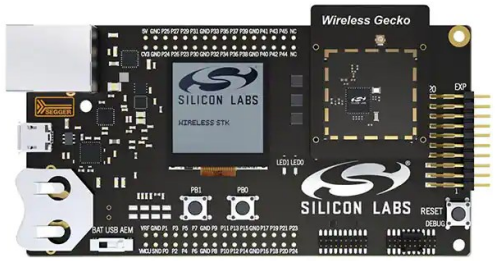
- **天花板轨道基础设施**
  - 内部测试环境
  - 多个固定的EFR32设备放置在不同的位置
  - 用于控制测量的移动EFR32装置(可重复性)
- **挑战－在室内办公室环境有复杂的多径问题**
  - 视距(LOS), 非视距(NLOS)
  - 非视距情况下的不同实体障碍 (金属，塑料，玻璃等)
- **统计分析**
  - 静态测量在多个距离可达30
  - 每距离进行数百次测量，
    大，平均值，中位数，标

室内办公室HADM性能测试结果



早期评估版本和应用开发

早期评估版本已经集成在最新的GSDK版本中



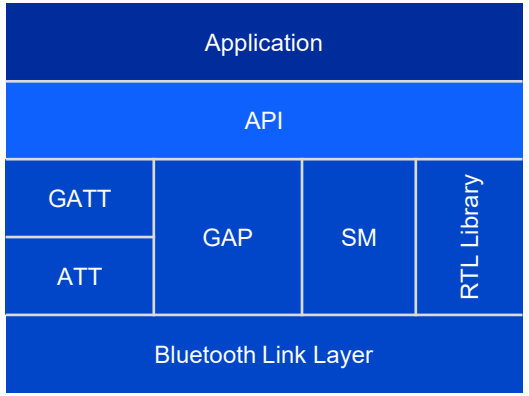
SOC,开发板

2x BRD4198A

2x Dipole Antennas

Wireless Pro Kit

EFR32MG24 + 10dBm OPN



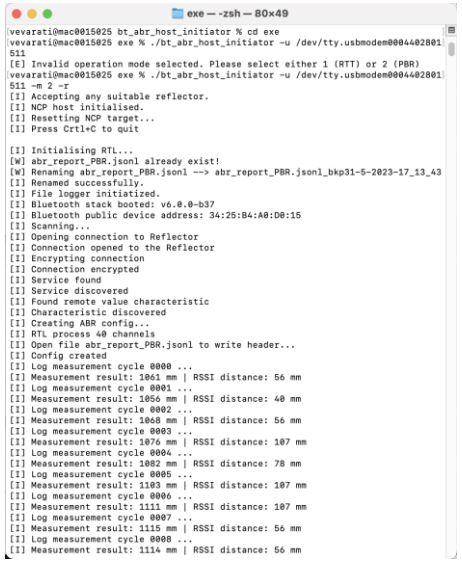
软件协议栈

In-house developed stack

Supports Bluetooth 5.4 features

All security features supported

New and improved Ranging features



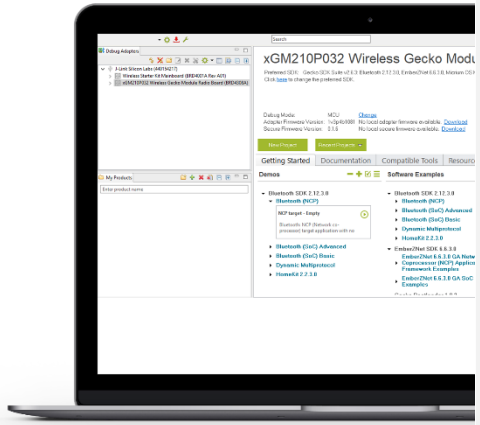
HADM演示

Python based Visualization tool

RTL Library
(GATT, IQ reporting)

EFR32xG24 NCP/SoC

RSSI, PBR, RTT modes



开发工具

Simplic

Initiator & F

Energy Profil

Appl

Salesfo

BG24和BGM241S: 面向蓝牙定位服务的2.4 GHz SoC理想选择

SOC和模块

BG24 SoC

BGM241S SiP Module

SOC设备规格

高性能射频
- Up to +19.5 dBm TX
- -97.6 dBm RX @ LE 1 Mbps
- -105.7 dBm RX @ Bluetooth LE 125 kbps

高效ARM® Cortex®-M33
- 78 MHz
- 1536kB Flash, 256kB RAM

低功耗
- 33.4 µA/MHz
- 5.0 mA TX @ 0 dBm
- 5.1 mA RX (802.15.4)
- 4.4 mA RX (LE 1 Mbps)
- 1.3 µA EM2 sleep

多协议支持
- Bluetooth (1M/2M/LR)
- Bluetooth mesh
- Proprietary 2.4 GHz

SoC和模块
- 5x5 QFN40
- 6x6 QFN48
- 7x7 SiP Module
- 12.9x15.0 PCB Module

差异化特性

+20 dBm输出功率
- Eliminates need for external power amplify

高精度距离测量(HADM)
- Measures distance between connected LE devices w/ sub-meter accuracy

AI/ML加速器
- Accelerates inferencing while reducing power consumption

Secure Vault高级
- Protects data and devices from local and remote attacks

20-bit ADC
- 16-bit ENOB for advanced sensing

天线分集
- Provides 6-8 dBm better link budget

优化无线共存
- Ideal for gateways and hubs

PLFRCO
- Eliminates need for 32 KHz xtal

细分市场及应用

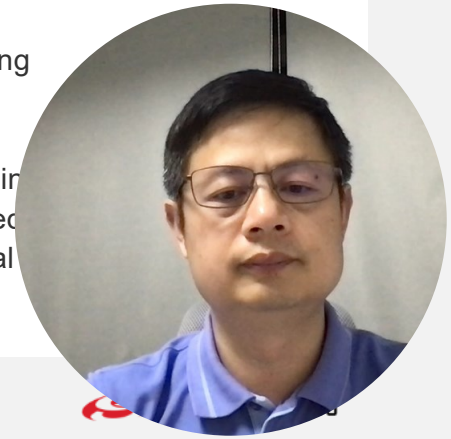
智能家居
- HVAC
- Locks
- LED Lighting
- Switches
- Sensors
- Gateways, Hubs and Panels

互联健康
- Portable Medical

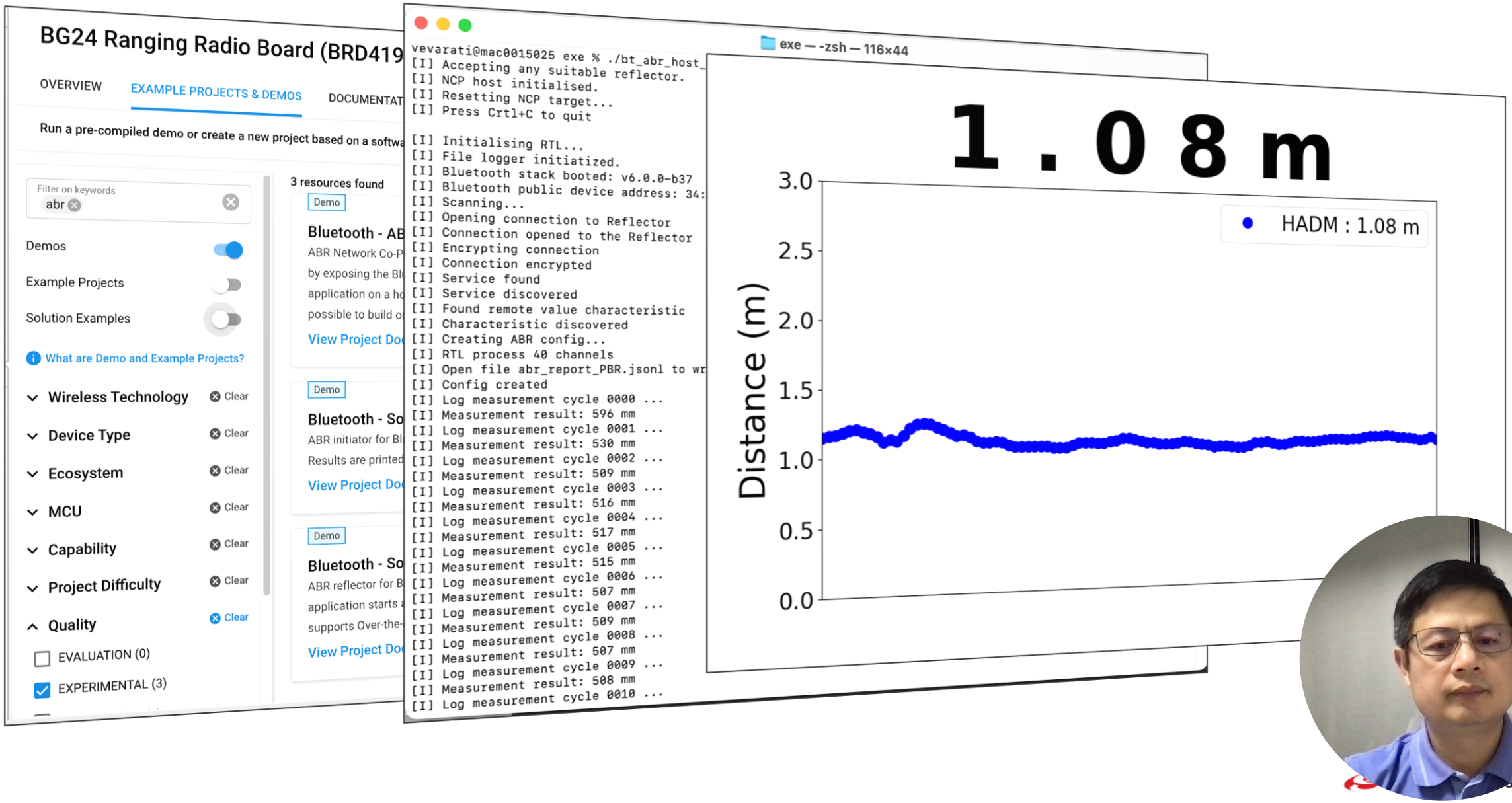
工业和智能建筑
- Access Control
- HVAC
- Predictive Maintenance
- Asset Tracking

智慧城市
- EV Charging

商业应用
- Lighting
- Access Poi
- Clinical Me
- Indoor Real



示例应用–开箱即用的体验



反射器功耗示例

- 测量条件
  - BRD4198 w/ WSTK
  - SoC mode
  - TX power: 0 dBm
  - Avg current consumption: ~792 uA
  - Connection interval : 20 ms
  - Distance estimation procedure duration : ~360 ms

下一步进展

Works With 2023

- 又一个关于HADM的专题会议

联系销售人员

- 与芯科科技销售人员以获取硬件

资源下载

- 下载Simplicity Studio 5

HADM In Action

- 探索我们集精准、可靠和简单易用等特性的HADM解决方案

2023 tech talks
WEBINAR SERIES

Thank You

BLUETOOTH SERIES

Watch ON DEMAND

Q&A

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