2023 tech talks WEBINAR SERIES

xG27 Unboxing and Development

Koichi Matsuo
Sr. FAE, Silicon Labs Japan

SILICON LABS

Agenda

xG27 Introduction

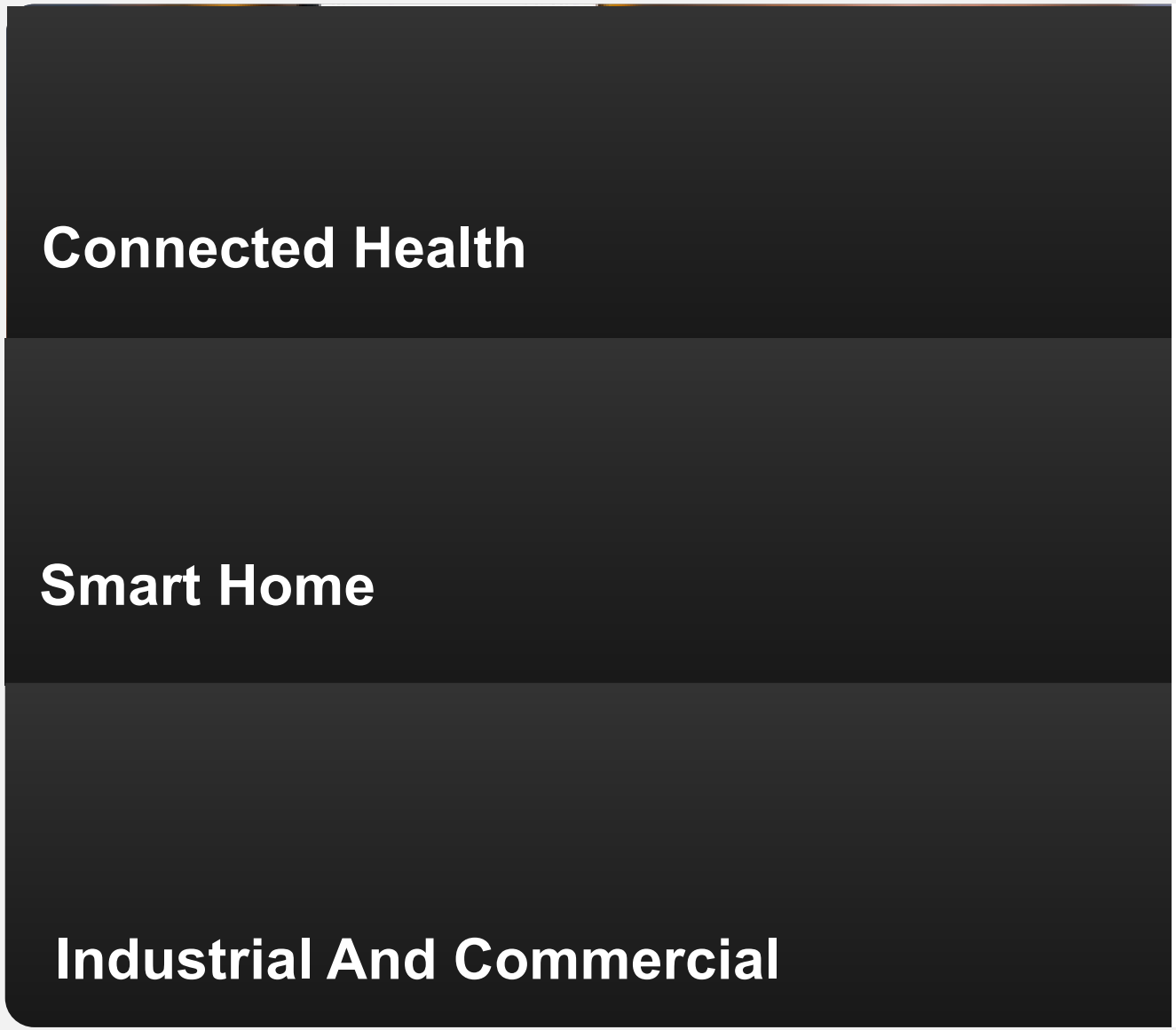
xG27 Differentiating Features

GitHub Demo

Simplicity Studio Demo

Summary and Q&A

EFR32BG27 and EFR32MG27 Target Applications



- **Connected Health**
  - Portable Medical Devices
    - Continuous glucose monitors, pulse oximeters, medical patches, electrocardiograms
  - Clinical Medical Devices
  - Wearables
- **Smart Home**
  - Sensors, Switches
  - Door Locks
  - HVAC, Thermostats
  - LED Lighting
  - Small Appliances
- **Industrial and Commercial**
  - Building Automation
  - Commercial Lighting
  - Access Control
  - Asset Tracking, Indoor RTLS

xG27: Most Battery Versatile Series-2 SoC

Battery Versatile

Ultra-Low Power

Multi-Protocol

Secure

DEVICE SPECIFICATIONS

High Performance 2.4 GHz Radio
- Up to +8 dBm TX
- -98.9 dBm RX @ BLE 1 Mbps
- -106.7 dBm RX @ BLE 125 kbps

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

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

Ultra Low Power
- 1.1 µA EM2 with 8 kB RAM retention
- 4.1 mA TX @ 0 dBm
- 3.6 mA RX (BLE 1 Mbps)

Multiple protocol support
- Bluetooth 5.3 (1M/2M/LR), Bluetooth mesh
- Zigbee 3.0
- Proprietary 2.4 GHz

Feature Rich peripherals
- 16-bit ADC, USARTs, I2C, I2S, PDM, Timers

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

DIFFERENTIATED FEATURES

Extremely small form-factor
- 2.3 x 2.6 WLCSP package[1]

Flexible battery support
- DCDC Buck/Boost
- Supports 1.7 to 3.8 volts
- Supports 0.8 to 1.7 volts

Enhanced security
- Secure Vault™ Mid
- Tamper detect
- Customer Key Management w/PUF

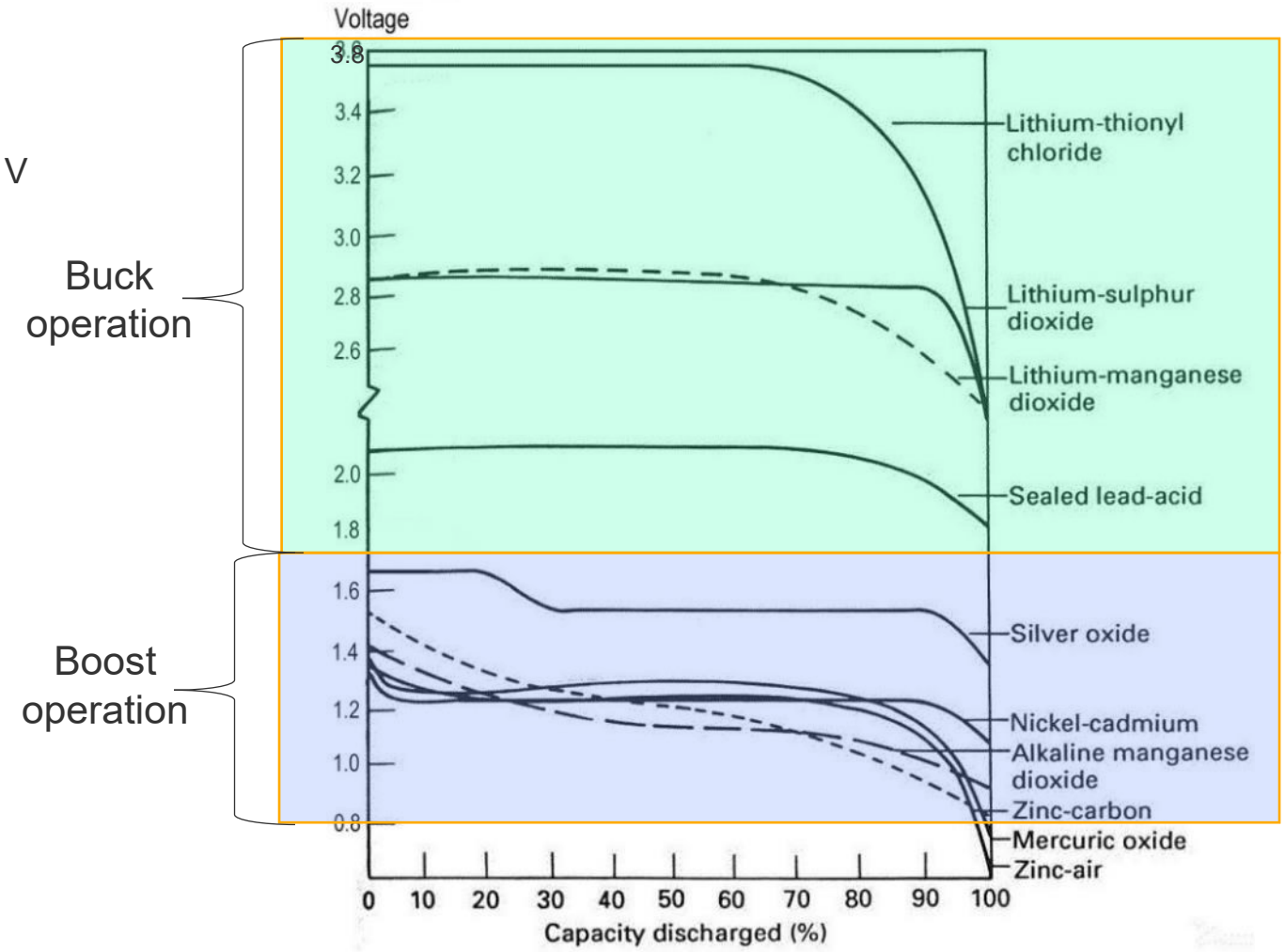
Battery management
- Coulomb counter

Wake-up pin (BOOST_EN)
- Enables <20 nA for long-term storage
- Up to 10 years of shelf storage

Differentiating Features

Boost DC-DC Converter

- **Input range: 0.8 V to ~1.7 V**
  - Adds support for lower voltage batteries
  - Silver Oxide: ~1.2 to 1.65 V
  - Alkaline / Rechargeable AA/AAA form: ~0.9 to 1.5 V
- **Coulomb counter**
  - Enables accurate battery level tracking
- **Shelf mode with a wake-up pin**



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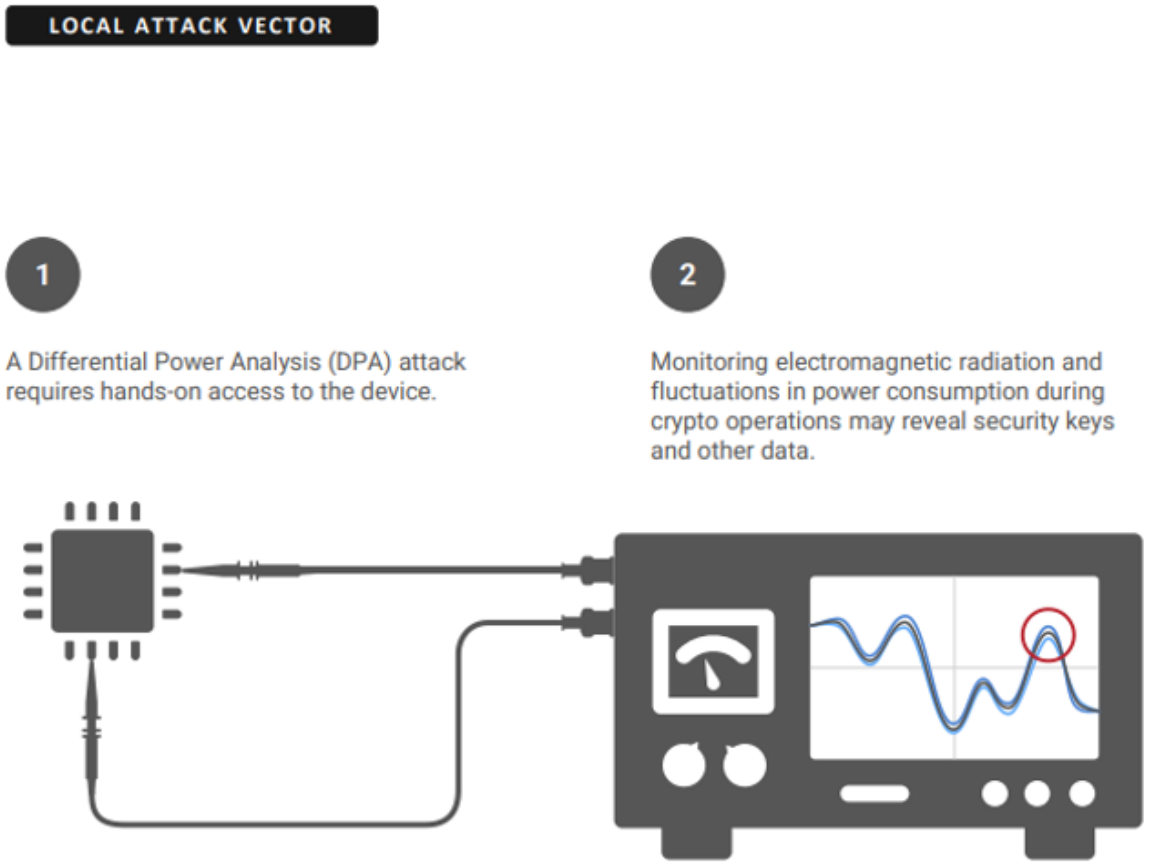
Secure Vault™ - Protecting the IoT Device

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		

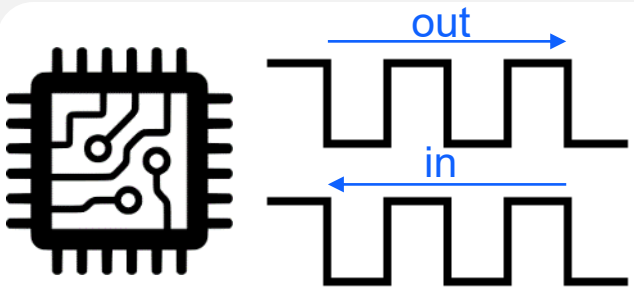
Designing Secure IoT Devices

Enhanced Security – DPA Countermeasures

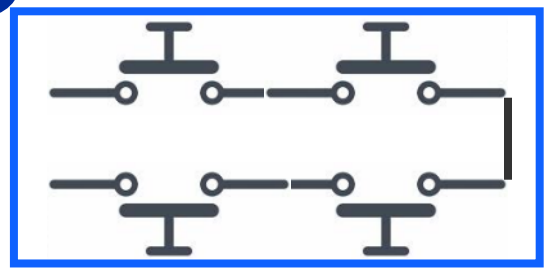


- **Vulnerabilities**
  - Observing subtle differences during given internal operations can provide insight into cryptographic functions
- **DPA Countermeasures**
  - Countermeasures add masks and random timings to internal operations and distorts DPA snooping

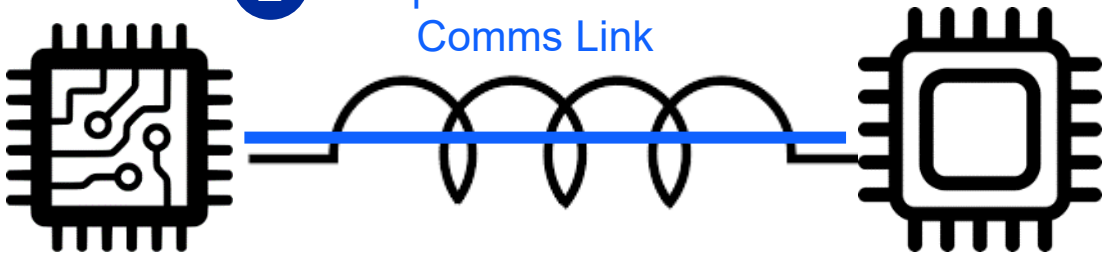
E-Tamper



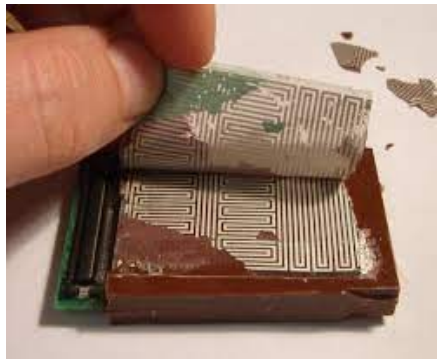
1 Tamper Pins on Case



2 Tamper Trace Around Comms Link

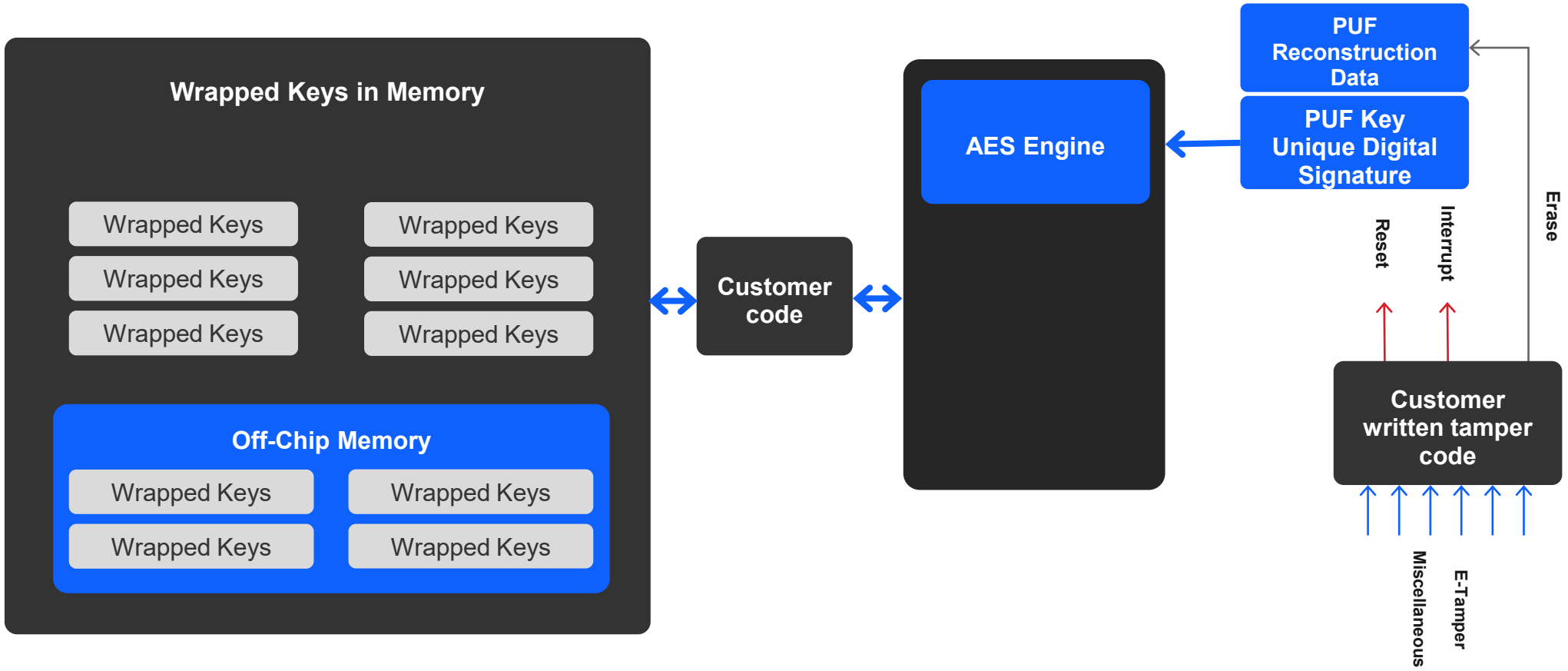


3 Purpose Built Tamper Shields

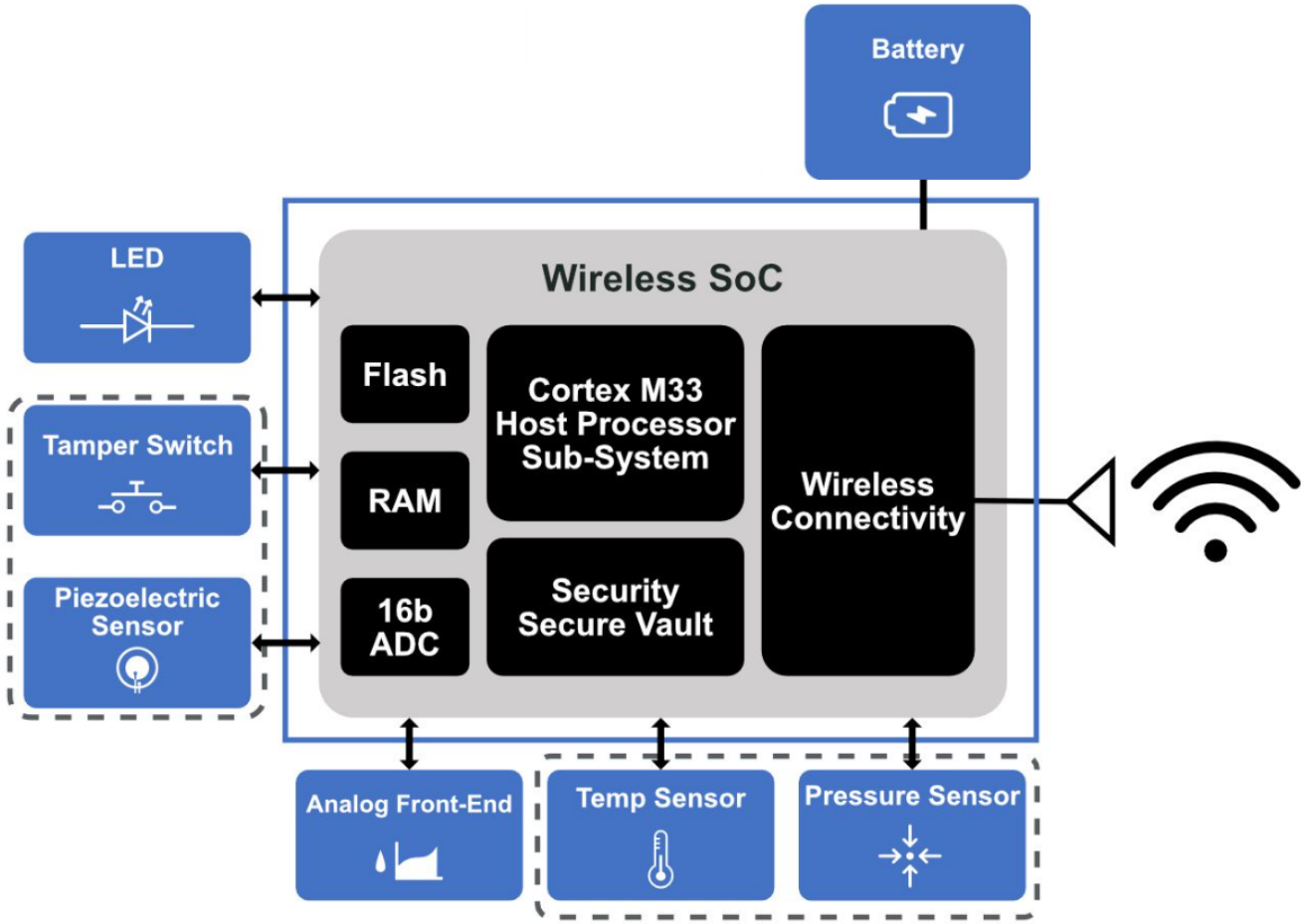


- **Square wave out one pin and in another – broken signal can be fed into other logic to take tamper action**
- **Uses Cases:**
  1) Connect Tamper Pins on a product case and then do trigger action when case opened
  2) Create Wire trace around bus in PC Board to protect communications between two components
  3) Power a tamper shield which can protect several components on a PCB

Enhanced Security - Customer Key Management with PUF



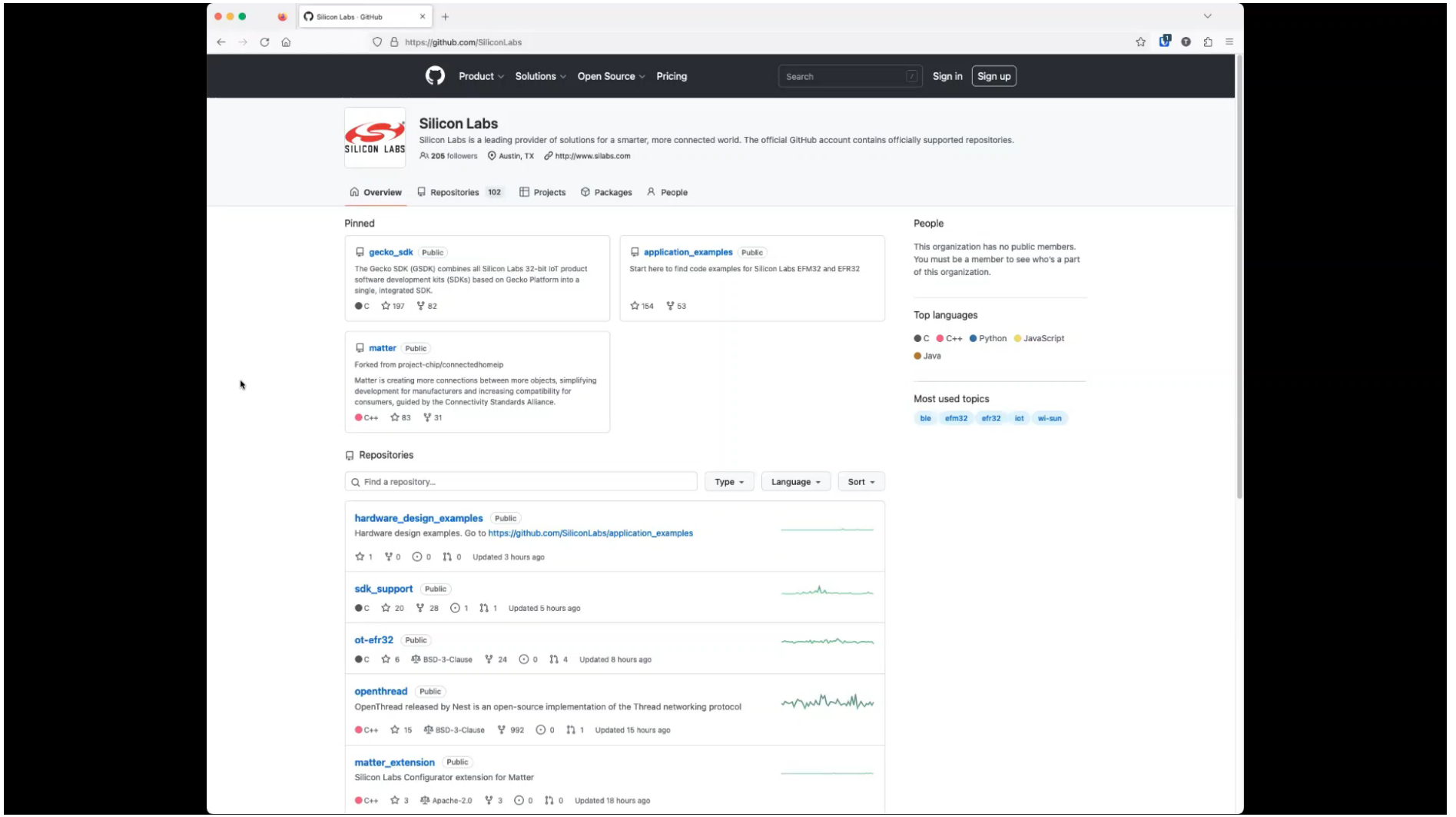
Example of Tiny Medical Device Design – Continuous Glucose Monitor



- **BG27 SoC Based**

- **Highlights**
  - BG27 CSP Package / Size
  - DCDC Buck/Boost
  - Power Optimization
    - Low active and sleep current
    - Shelf Mode (BOOST_EN)
  - Secure Vault
    - E-Tamper
  - Analog/Serial Peripherals
    - 16-bit ADC
  - CGM Sample Application

Github Demo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Projects
Packages
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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 197 82
application_examples Public
Start here to find code examples for Silicon Labs EFM32 and EFR32
154 53
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++ 83 31
People
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Hardware design examples. Go to https://github.com/SiliconLabs/application_examples
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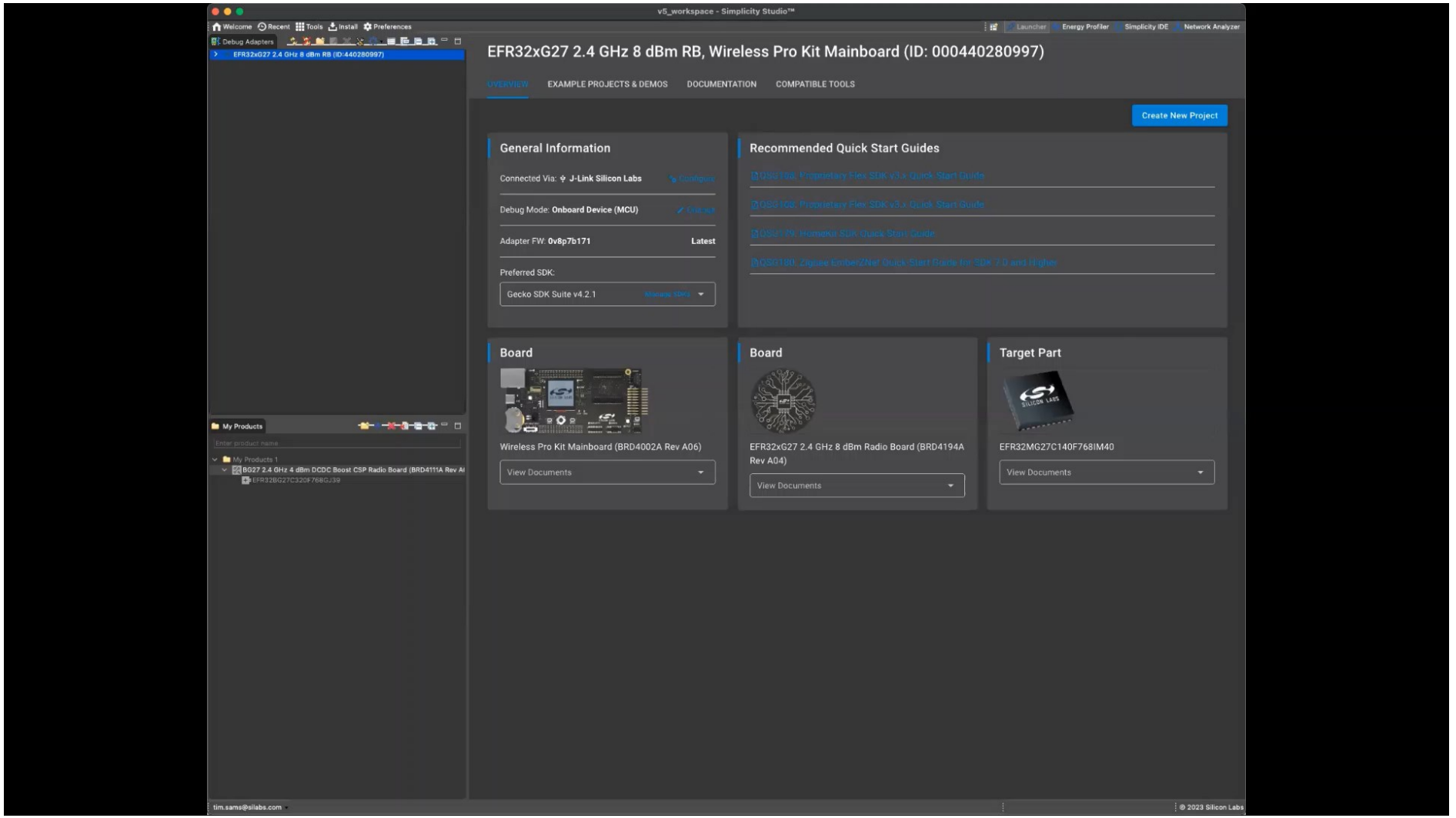
ot-efr32 Public
C 6 BSD-3-Clause 24 0 4 Updated 8 hours ago
openthread Public
OpenThread released by Nest is an open-source implementation of the Thread networking protocol
C++ 15 BSD-3-Clause 992 0 1 Updated 15 hours ago
matter_extension Public
Silicon Labs Configurator extension for Matter
C++ 3 Apache-2.0 3 0 0 Updated 18 hours ago

xG27 and Simplicity Studio Demonstration

Simplicity Studio Demo



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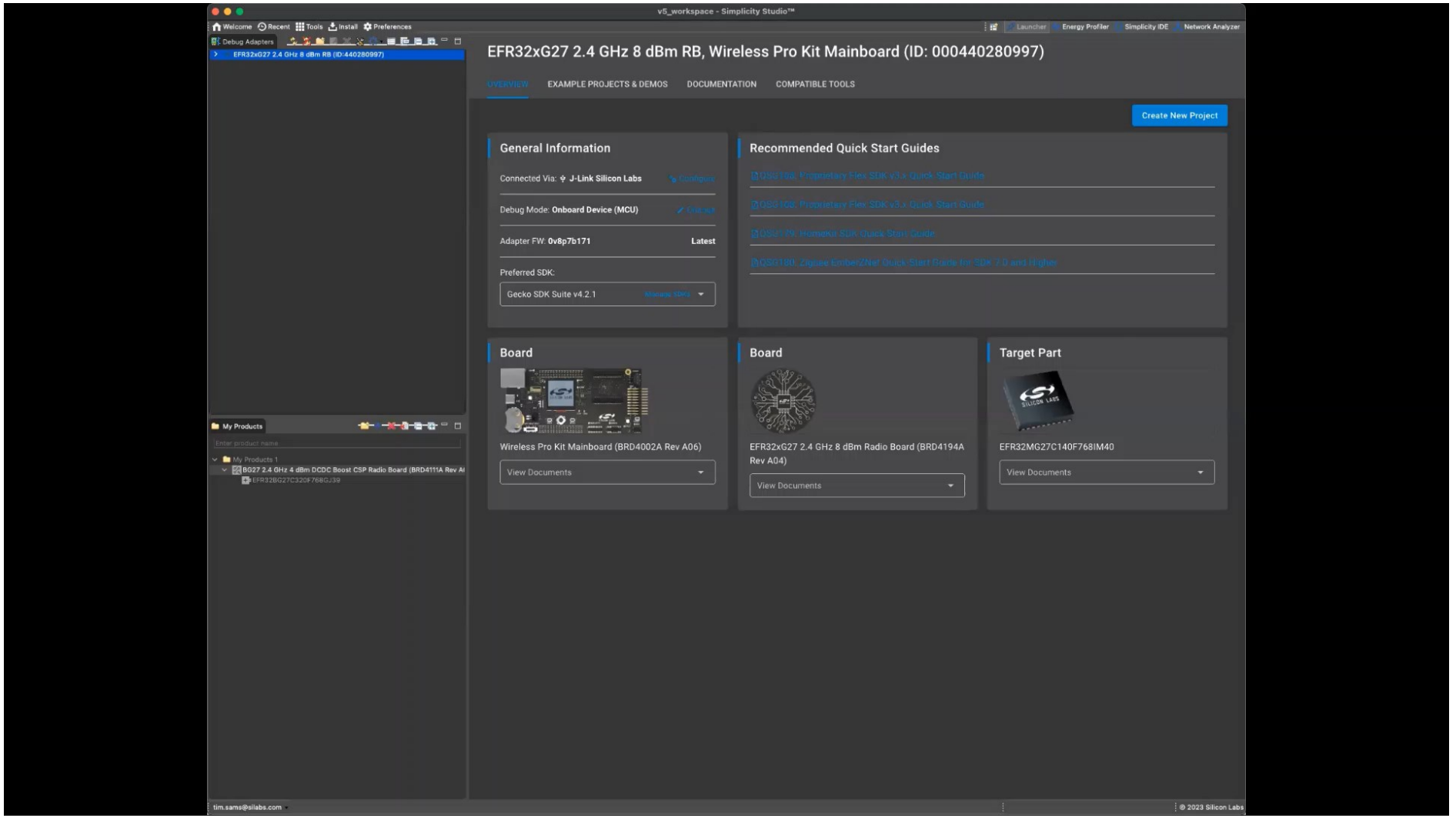
Summary

BG27 and MG27: Smallest, and most battery versatile SoCs for the Edge

- **Smaller devices without compromising power, performance, or security**
  - Ultra-compact 2.3mm x 2.6mm WLCSP package
  - DCDC Buck/Boost allowing operation down to 0.8 volts
  - Secure Vault™ Mid
    - Tamper detect
    - Secure Key Management w/PUF
  - 16-Bit ADC for highly accurate analog sensing
- **Worry-free battery-life expectancy**
  - Coulomb counter for enhanced battery monitoring
- **Reliable Wireless**
  - Multiprotocol 2.4 GHz wireless SoC with High-Performance RF
    - Bluetooth, Bluetooth mesh, and Zigbee
- **Unleash Your Innovation and Extend your Product Lifetime!**
  - Enough memory facilitating more features and OTA updates

xG27 and Simplicity Studio Demonstration

Simplicity Studio Demo



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Q&A

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Bluetooth® Portfolio: What's Right For Your Application

Koichi Matsuo
Sr. FAE, Silicon Labs Japan

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Agenda

Why Bluetooth® 5.4?

What's new with Bluetooth® 5.4

Bluetooth® Portfolio

Bluetooth Selector Guide

Summary and Q&A

Bluetooth® 5.4

Why Bluetooth 5.4?

- **Need for standardized large scale star networks**
  - Capability to host thousands of nodes
  - Encrypted data traffic
  - Ultra-low power consumption
  - Driven by electronic shelf label (ESL) market
- **Enhancements**
  - Optimizing access to secure data
  - Better control for LE Coded PHY for extended advertising

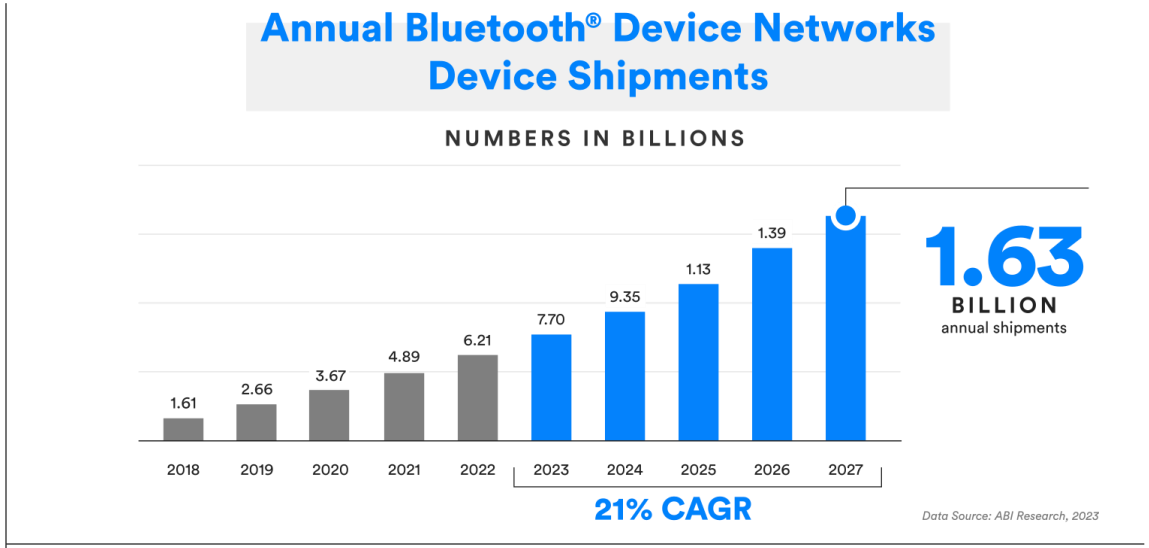
Bluetooth 5.4 – Target Markets & Use Cases

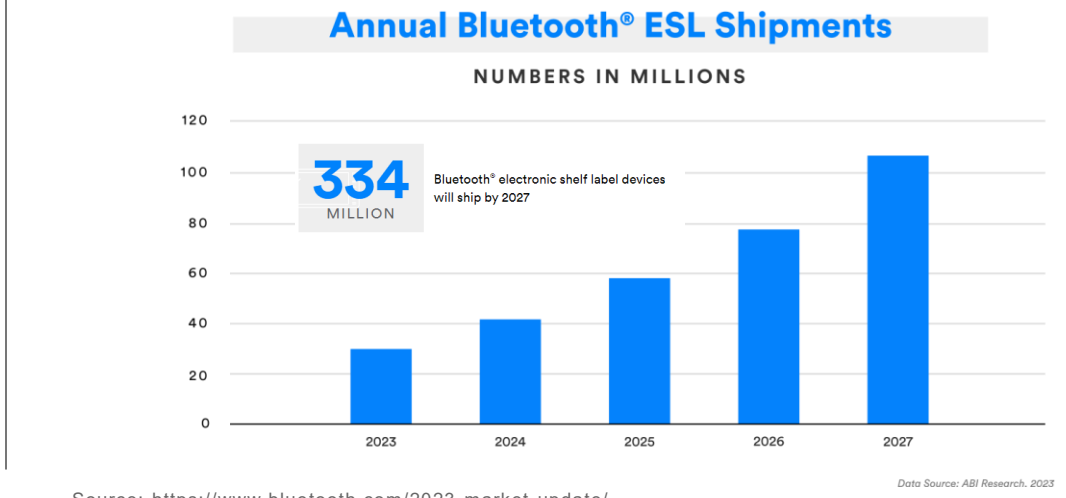
SMART RETAIL

- Electronics Shelf Labels
- Shelf Sensors

INDUSTRIAL

- Manufacturing & Logistics
- Digital Signage
- Asset monitoring





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

Bluetooth 5.4 New Features

Periodic Advertising with Responses (PAwR)

Provides energy efficient, large-scale, and bi-directional one-to-many communication topology

Encrypted Advertising Data (EAD)

Feature to the secure broadcasting of data in advertising packets

LE GATT Security Levels Characteristic

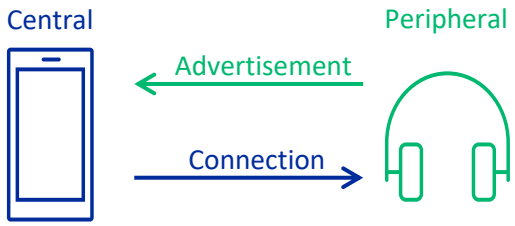
Devices can indicate the security mode and level required for all their GATT functionality to be available

Advertising Coding Selection

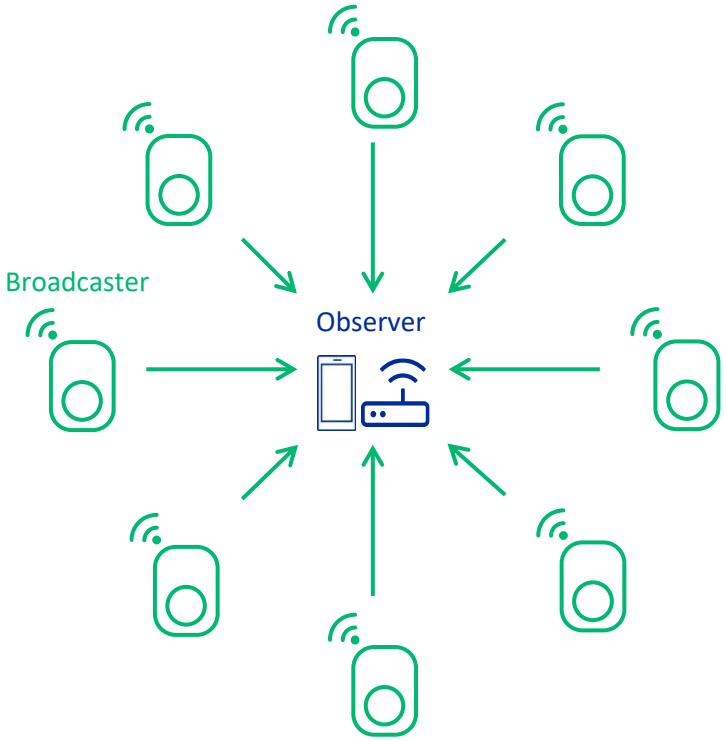
The Host can specify which of two supported long range coding options are used with LE extended advertising

Advertising Modes in Bluetooth 5.4

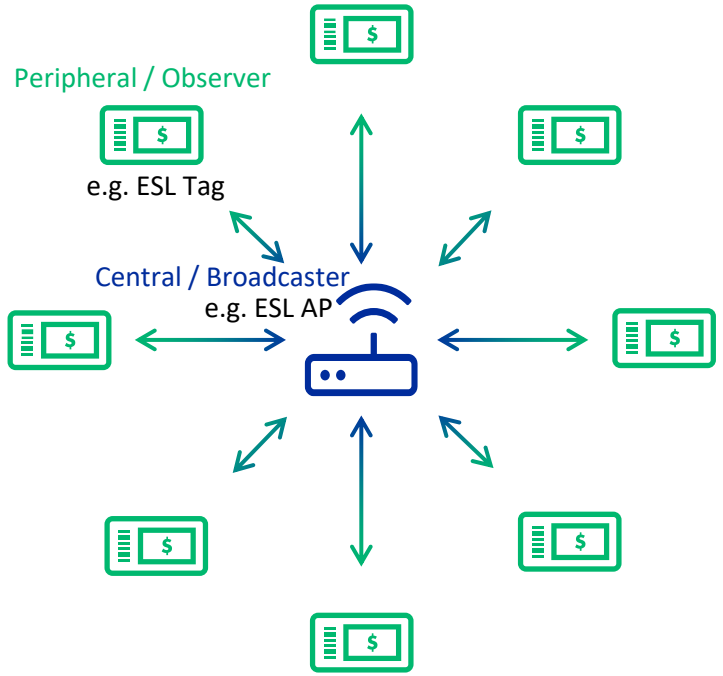
Advertising for Connection
(irregular, unidirectional)



One-way “Beaconing”
(regular, unidirectional)



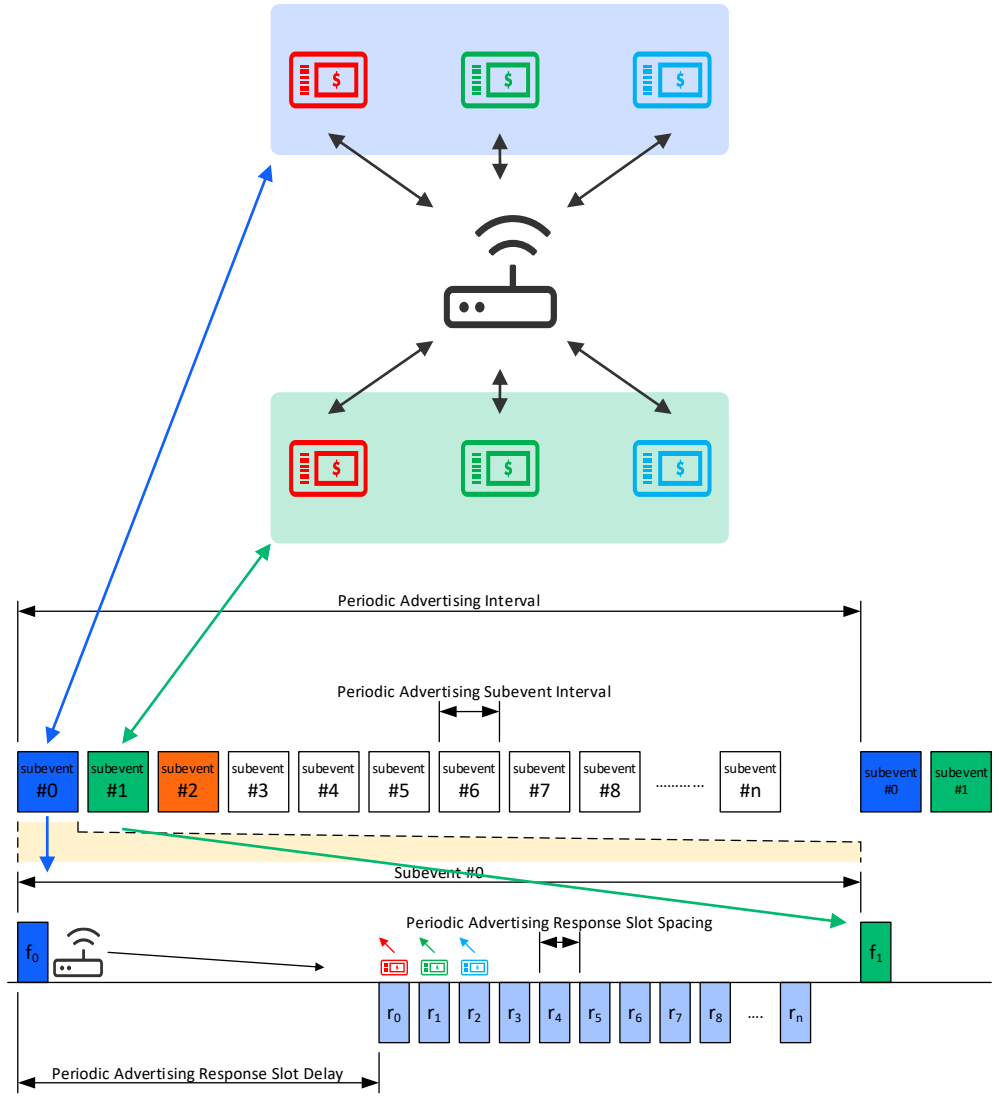
Periodic Advertising with Responses
(regular, bidirectional)



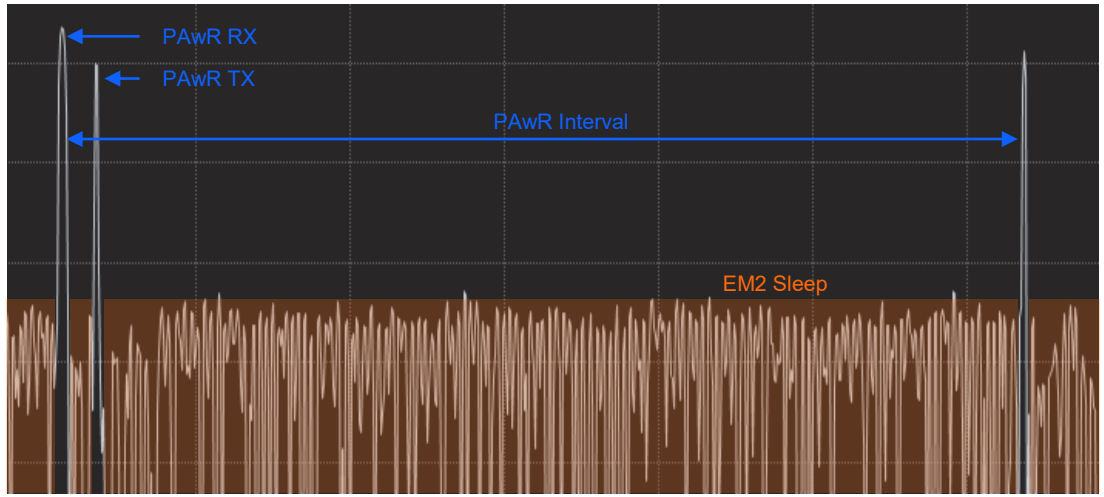
New mode enabling “Synchronized” mode network. Used by BT ESL.

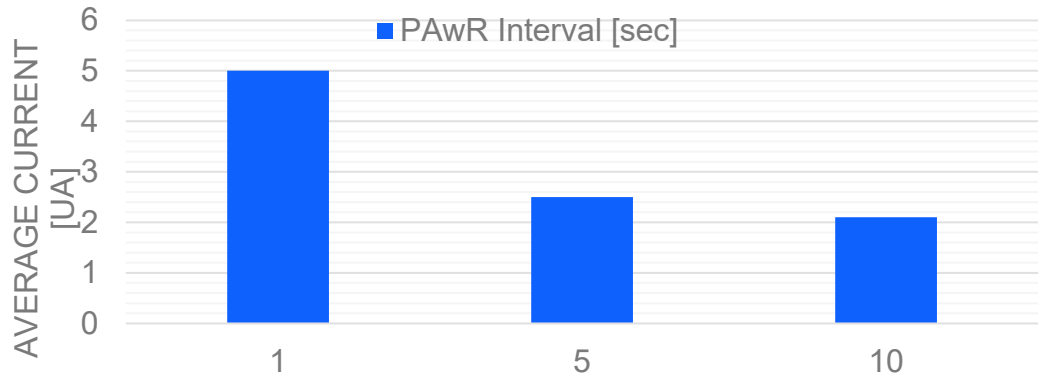
Periodic Advertisement with Responses (PAwR) Explained

- **PAwR train setup**
  - Sets timing parameters
  - Configure number of Subevents and Response Slots
- **Subevents**
  - Each Peripheral (ESL) belongs to one Subevent
  - Maximum 128 Subevents (ESL Group)
  - 255 unique ESLs in one ESL Group
  - Total max 32,640 Peripherals in the network
- **Inside a Subevent**
  - All Peripherals in one Subevent receive the Central Device transmission (downlink)
    - Keeps up the synchronization to the PAwR train
    - Transmits downlink payload data
  - Each Peripheral has its own Response Slot to reply (uplink)



Example of PAwR Current Consumption





- **Peripheral device use case**
  - Receives Central Device downlink transmission at given Subevent time slot
  - Responses uplink at given Response Slot
  - Remains in sleep mode rest of time

- **Measurement condition**
  - MG22 Radio Board
  - Vinput 3.0V, DC/DC in use
  - SoC Current only
  - TX 0dBm
  - LFXO accuracy 50ppm

Bluetooth® Portfolio

The Portfolio of SoCs and Modules

Increasing Features

BG22 SoC

BGM220S SiP & PCB Modules

Industry-leading energy efficient SoC

- Lowest power Bluetooth LE
- Direction Finding
- Bluetooth mesh LPNs
- SoC, PCB Module and SIP
- Balance of features, size, power, cost
- Support in SoC mode BT 5.4 stack and ESL application

Q2 2023

BG27 SoC

Most Battery Versatile SoC for Connected Health, Smart Home, Portable Products

- Supports button cells
- DCDC Buck and Boost
- Coulomb counting
- Small form factor WLCSP
- Wake-up pin (BOOST_EN)
- Support in SoC mode BT 5.4 stack and ESL application
- Bluetooth mesh Relay, Proxy, LPNs

BG21 SoC

BGM210L & PCB Module

Optimized for LED lighting, Gateway/Hub, and Bluetooth mesh applications

- Highest output power in Industry
- Line-powered devices
- Secure Vault High, PSA L3
- Bluetooth mesh
- Bluetooth 5.4 gateway devices

BG24 SoC

BGM240S SiP & PCB Modules

Feature rich device with Highest integration

- Largest Flash/RAM
- High I/O pin count
- AI/ML hardware accelerator
- High sensing ADC
- Secure Vault High, PSA L3
- Bluetooth mesh
- Bluetooth 5.4 gateway devices
- SoC mode for micro gateways

Increasing Flash/RAM

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Home & Life - Bluetooth Positioning

Home Automation

LED Lighting

BG21
- Line Powered
- Long Range +20dBm Tx
- High Temp +125ºC
- CA Title 20
- Secure Vault High (Sesip L3 / PSA L3)

BG24
- Battery Powered
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator

BGM210L
- Line Powered
- High Temp +125ºC
- CA Title 20
- Long Range +12.5dBm Tx
- Antenna and RF Certifications
- Flexible mountability (vertical / horizontal)

Gateways

BG22
- Battery Powered
- High Temp +125ºC
- CA Title 20
- Ultra-Low Power
- Secure Vault Mid

BG27
- Battery Powered
- Battery Life tracking (Coulomb Counter)
- DC-DC Converter
- Ultra-Low Power
- Secure Vault Mid

BGM240P/S
- Battery Powered
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- Antenna and RF Certifications
- 7x7mm SIP, 12.9x15mm PCB

BGM220P/S
- Battery Powered
- Ultra-Low Power
- Secure Vault Mid
- Antenna and RF Certifications

Outdoor Living

BG22
- Battery Powered
- High Temp +125ºC
- CA Title 20
- Ultra-Low Power
- Secure Vault Mid

BG24
- Battery Powered
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator

BGM210L
- Line Powered
- High Temp +125ºC
- CA Title 20
- Long Range +12.5dBm Tx
- Antenna and RF Certifications
- Flexible mountability (vertical / horizontal)

Switches

BG22
- Battery Powered
- High Temp +125ºC
- CA Title 20
- Ultra-Low Power
- Secure Vault Mid

BG24
- Battery Powered
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator

BGM210L
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- High Temp +125ºC
- CA Title 20
- Long Range +12.5dBm Tx
- Antenna and RF Certifications
- Flexible mountability (vertical / horizontal)

Sensors

BG22
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- Ultra-Low Power
- Secure Vault Mid

BG27
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- Battery Life tracking (Coulomb Counter)
- DC-DC Converter
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BGM240P/S
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- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- Antenna and RF Certifications
- 7x7mm SIP, 12.9x15mm PCB

BGM220P/S
- Battery Powered
- Ultra-Low Power
- Secure Vault Mid
- Antenna and RF Certifications

Locks

BG22
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- High Temp +125ºC
- CA Title 20
- Ultra-Low Power
- Secure Vault Mid

BG24
- Battery Powered
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator

BGM210L
- Line Powered
- High Temp +125ºC
- CA Title 20
- Long Range +12.5dBm Tx
- Antenna and RF Certifications
- Flexible mountability (vertical / horizontal)

HVAC

BG22
- Battery Powered
- High Temp +125ºC
- CA Title 20
- Ultra-Low Power
- Secure Vault Mid

BG24
- Battery Powered
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator

BGM210L
- Line Powered
- High Temp +125ºC
- CA Title 20
- Long Range +12.5dBm Tx
- Antenna and RF Certifications
- Flexible mountability (vertical / horizontal)

Shades Blinds

BG22
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- High Temp +125ºC
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- Ultra-Low Power
- Secure Vault Mid

BG24
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- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
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BGM210L
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- Antenna and RF Certifications
- Flexible mountability (vertical / horizontal)

Home Security

Cameras

BG22
- Battery Powered
- High Temp +125ºC
- CA Title 20
- Ultra-Low Power
- Secure Vault Mid

BG24
- Battery Powered
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator for tiny edge processing

BG27
- Battery Powered Devices
- Battery Life tracking (Coulomb Counter)
- DC-DC Converter
- Ultra-Low Power
- Secure Vault Mid

BGM220S
- Battery Powered
- Ultra-Low Power
- Secure Vault Mid
- Antenna and RF Certifications

BGM240P/S
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Control Panels

BG22
- Battery Powered
- High Temp +125ºC
- CA Title 20
- Ultra-Low Power
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- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
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- Battery Powered
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- Antenna and RF Certifications

Appliances

Whitegoods

BG24
- Battery Powered
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator

BG27
- Battery Powered Devices
- Battery Life tracking (Coulomb Counter)
- DC-DC Converter
- Ultra-Low Power
- Secure Vault Mid

BGM220P
- Battery Powered
- Ultra-Low Power
- Secure Vault Mid
- Antenna and RF Certifications

BGM240P
- Energy Efficient
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- Antenna and RF Certifications

Countertop

BG24
- Battery Powered
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator

BG27
- Battery Powered Devices
- Battery Life tracking (Coulomb Counter)
- DC-DC Converter
- Ultra-Low Power
- Secure Vault Mid

BGM220P
- Battery Powered
- Ultra-Low Power
- Secure Vault Mid
- Antenna and RF Certifications

BGM240P
- Energy Efficient
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- Antenna and RF Certifications

Robot Vacuums

BG24
- Battery Powered
- Long Range – Low Power
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- AI/ML accelerator

BG27
- Battery Powered Devices
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- DC-DC Converter
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- Secure Vault Mid
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BGM240P
- Energy Efficient
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- Antenna and RF Certifications

Entertainment

AR/VR

BG22
- 4.1mA Tx current @0dBm
- Secure Vault Mid
- -98.9dBm Rx Sensitivity
- 4x4 mm

BG24
- 5.0mA Tx current @0dBm
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator for tiny edge processing
- -97.6dBm Rx Sensitivity
- 5x5 mm

BG27 CSP
- Ultra small form-factor 2.3x2.6mm
- -98.9dBm Rx Sensitivity
- 4.1mA Tx current @0dBm
- Battery Life Tracking (Coulomb Counter)
- DC-DC Converter
- Wakeup Pin
- Secure Vault Mid

BGM220P/S
- Battery Powered
- Ultra-Low Power
- Secure Vault Mid
- Antenna and RF Certifications

BGM240S
- Battery Powered
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- Antenna and RF Certifications
- 7x7mm SIP

Toys

BG22
- 4.1mA Tx current @0dBm
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- -98.9dBm Rx Sensitivity
- 4x4 mm

BG24
- 5.0mA Tx current @0dBm
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator for tiny edge processing
- -97.6dBm Rx Sensitivity
- 5x5 mm

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- Ultra small form-factor 2.3x2.6mm
- -98.9dBm Rx Sensitivity
- 4.1mA Tx current @0dBm
- Battery Life Tracking (Coulomb Counter)
- DC-DC Converter
- Wakeup Pin
- Secure Vault Mid

BGM220P/S
- Battery Powered
- Ultra-Low Power
- Secure Vault Mid
- Antenna and RF Certifications

BGM240S
- Battery Powered
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- Antenna and RF Certifications
- 7x7mm SIP

Medical & Wearables

Portable Medical

BG22
- 4.1mA Tx current @0dBm
- Secure Vault Mid
- -98.9dBm Rx Sensitivity
- 4x4 mm

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- 4.1mA Tx current @0dBm
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- Wakeup Pin
- Secure Vault Mid

BGM220P/S
- Battery Powered
- Ultra-Low Power
- Secure Vault Mid
- Antenna and RF Certifications

BGM240S
- Battery Powered
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- Antenna and RF Certifications
- 7x7mm SIP

Wearables

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- 4.1mA Tx current @0dBm
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- 4x4 mm

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- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator for tiny edge processing
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Industrial & Commercial - Bluetooth Selector Guide

Smart Cities

Smart Agriculture

BG27 CSP

- Ultra small form-factor 2.3x2.6mm
- -98.9dBm Rx Sensitivity
- 4.1mA Tx current @0dBm
- Battery Life Tracking (Coulomb Counter)
- DC-DC Converter
- Wakeup Pin
- Secure Vault Mid

BG22

- Battery Powered Devices
- Ultra-Low Power
- Secure Vault Mid

BG24

- 5.0mA Tx current @0dBm
- Long Range – Low Power
- Secure Vault High
- -97.6dBm Rx Sensitivity
- 5x5 mm

BGM240S

- Battery Powered Devices
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- Antenna and RF Certifications

BGM220 P/S

- Battery Powered Devices
- Ultra-Low Power
- Secure Vault Mid
- Antenna and RF Certifications

EV Charging

BG24

- 5.0mA Tx current @0dBm
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator
- -97.6dBm Rx Sensitivity
- 5x5 mm

BG22

- Battery Powered Devices
- Ultra-Low Power
- Secure Vault Mid

BG21

- Line Powered
- Long Range +20dBm Tx
- High Temp +125ºC
- CA Title 20
- Secure Vault High (Sesip L3 / PSA L3)

Industrial IoT

Predictive Maintenance

BG22

- Battery Powered Devices
- Ultra-Low Power
- Secure Vault Mid

BG24

- 5.0mA Tx current @0dBm
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator
- -97.6dBm Rx Sensitivity
- 5x5 mm

BGM240S

- Battery Powered Devices
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- Antenna and RF Certifications

BGM220 P/S

- Battery Powered Devices
- Ultra-Low Power
- Secure Vault Mid
- Antenna and RF Certifications

Asset Monitoring

BG27

- Battery Powered Devices
- Battery Life tracking (Coulomb Counter)
- DC-DC Converter
- Ultra-Low Power
- Secure Vault Mid

Power Tools

Smart Buildings

Access Control

BG22

- Battery Powered Devices
- Ultra-Low Power
- Secure Vault Mid

BG24

- 5.0mA Tx current @0dBm
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator
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BGM220 P/S

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BGM240S

- Battery Powered Devices
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- Antenna and RF Certifications

Smart HVAC

Commercial

Commercial Lighting

BG22

- Battery Powered Devices
- Ultra-Low Power
- Secure Vault Mid

BG24

- 5.0mA Tx current @0dBm
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator
- -97.6dBm Rx Sensitivity
- 5x5 mm

BG21

- Line Powered
- Long Range +20dBm Tx
- High Temp +125ºC
- CA Title 20
- Secure Vault High (Sesip L3 / PSA L3)

BGM210L

- Line Powered
- High Temp +125ºC
- CA Title 20
- Long Range +12.5dBm Tx
- Antenna and RF Certifications
- Flexible mountability (vertical / horizontal)

Enterprise APs

BG21

- Line Powered Devices
- Long Range +20dBm Tx
- Secure Vault High (Sesip L3 / PSA L3)

Clinical Medical

Portable Medical

BG27 CSP

- Ultra small form-factor 2.3x2.6mm
- -98.9dBm Rx Sensitivity
- 4.1mA Tx current @0dBm
- Battery Life Tracking (Coulomb Counter)
- DC-DC Converter
- Wakeup Pin
- Secure Vault Mid

Retail

ESL

RTLS

BG22

- Battery Powered Devices
- Ultra-Low Power
- Secure Vault Mid

BG24

- 5.0mA Tx current @0dBm
- Long Range – Low Power
- Secure Vault High (Sesip L3 / PSA L3)
- Large Memory
- AI/ML accelerator
- -97.6dBm Rx Sensitivity
- 5x5 mm

SILICON LABS

Q&A

2023 tech talks WEBINAR SERIES

The Latest in HADM using Bluetooth LE

Koichi Matsuo
Sr. FAE, Silicon Labs Japan

SILICON LABS

Agenda

01 Target Markets and Applications

02 HADM – Beyond RSSI

03 Channel Sounding

04 Performance Results

05 Early Access & Sample Applications

06 Next Steps

High Accuracy Distance Measurement (HADM) Applications

Target Markets & Use Cases

HOME

Item Finding

Keyless Entry

Pet Tracking

COMMERCIAL

Access Control

Inventory management

Asset Tracking

Demand for Improved Distance Measurement – Beyond RSSI

Accuracy & Reliability

RSSI is sensitive to indoor multipath environment

Simplicity

Enable design of low-cost devices
Single antenna design
Reduce system resources

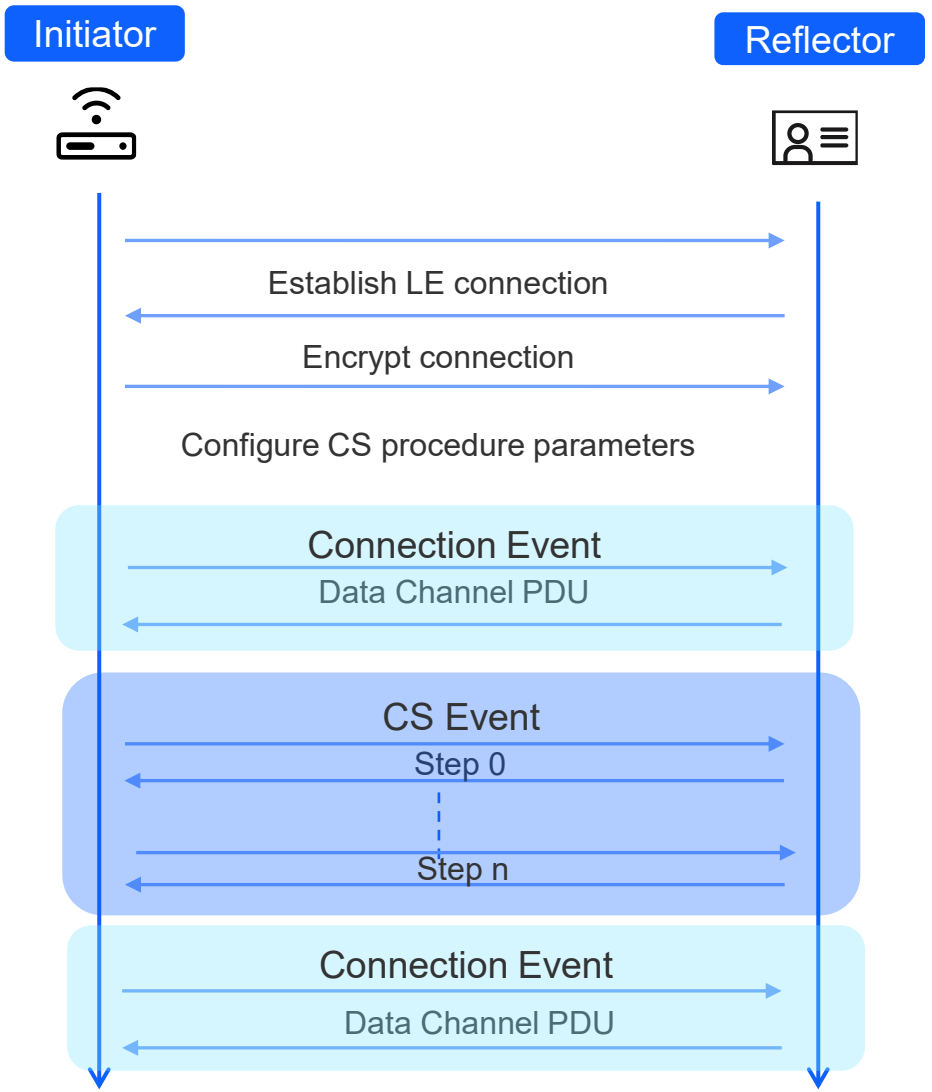
Security

Attacker manipulation of RSSI via RF signal amplification

Interoperability

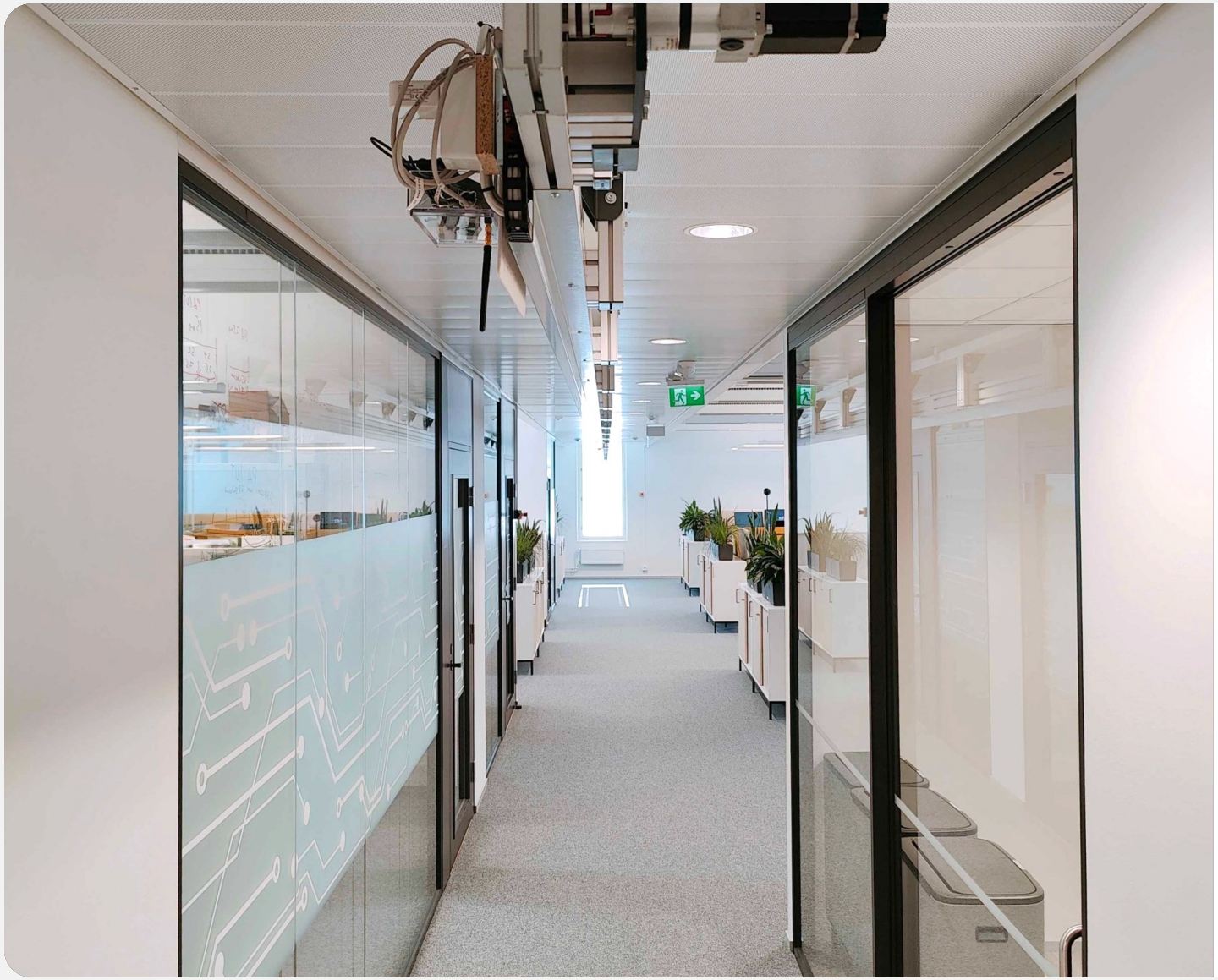
Standards Based Feature

Measurement Procedure Explained



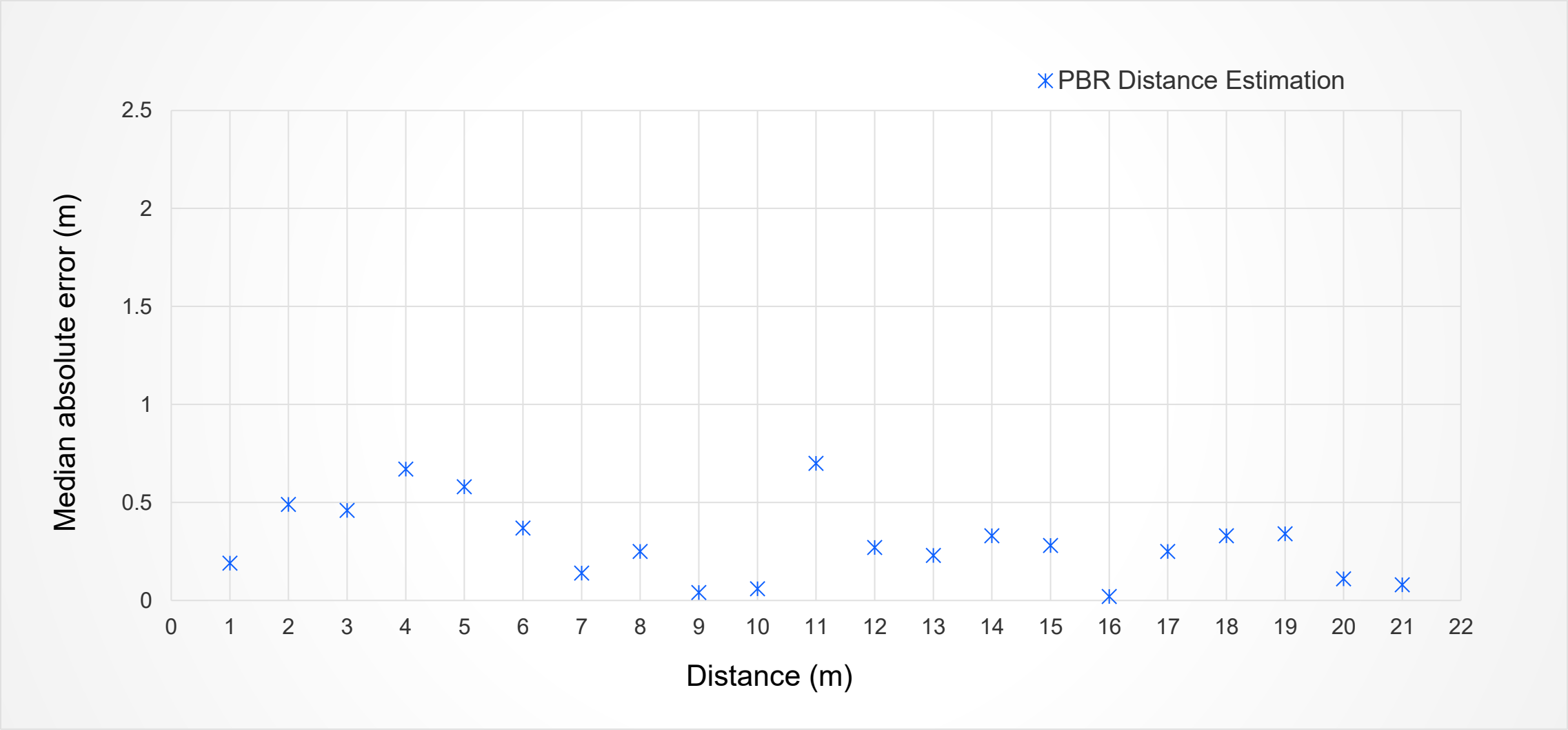
- **Connection-based 2-way ranging with encrypted Bluetooth LE connection events and secure CS events**
  - Reflector sends received signal info via GATT indications during connection events
- **Interchangeable device roles (central, peripheral) and CS roles (initiator, reflector)**
- **Initiator configures CS procedure parameters**
  - Number of channels, channel map(randomized), TX power
  - Allowed duration of connection interval, CS event
  - Measurement modes – RSSI, PBR, RTT
  - Trade-offs between accuracy, duration, and power
- **CS Event**
  - Calibration – frequency offset
  - Modulated packets or tones exchanged over multiple channels
  - Channel mapping is randomized to prevent attackers
- **Distance Estimation**
  - Initiator parses the measured data - IQ samples, time
  - Signal processing – averaging, filtering outliers, detecting multipath, etc.

Performance in Indoor Office Environment



- **Ceiling rail infrastructure**
  - Internal test environment
  - Multiple stationary EFR32 devices placed at different locations
  - Mobile EFR32 device for controlled measurements (repeatability)
- **Challenges - heavy multi-path in an indoor office setting**
  - Line of Sight (LOS), Non-Line of Sight (NLOS)
  - Physical obstacles (metal, plastic, glass, etc.) in NLOS configurations
- **Statistical analysis**
  - Static measurements at multiple distances up to 30 meters
  - Hundreds of measurements per distance to determine min/max, mean, median, std, absolute error

Indoor Office Performance Results



BG24 and BGM240: 2.4 GHz SoC Ideal for Bluetooth Location Services

SOCS AND MODULES

BG24 SoC

BGM241S SiP Module

SOC DEVICE SPECIFICATIONS

High-Performance Radio
- Up to +19.5 dBm TX
- -97.6 dBm RX @ LE 1 Mbps
- -105.7 dBm RX @ Bluetooth LE 125 kbps

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

Low Power
- 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

Multiple protocol support
- Bluetooth (1M/2M/LR)
- Bluetooth mesh
- Proprietary 2.4 GHz

SoCs and Modules
- 5x5 QFN40
- 6x6 QFN48
- 7x7 SiP Module
- 12.9x15.0 PCB Module

DIFFERENTIATED FEATURES

+20 dBm output power
- Eliminates need for external power amplify

High Accuracy Distance Measurement
- Measures distance between connected LE devices w/ sub-meter accuracy

AI/ML accelerator
- Accelerates inferencing while reducing power consumption

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

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

Antenna Diversity
- Provides 6-8 dBm better link budget

Improved Coexistence
- Ideal for gateways and hubs

PLFRCO
- Eliminates need for 32 KHz xtal

SEGMENTS AND APPLICATIONS

Smart Home
- HVAC
- Locks
- LED Lighting
- Switches
- Sensors
- Gateways, Hubs and Panels

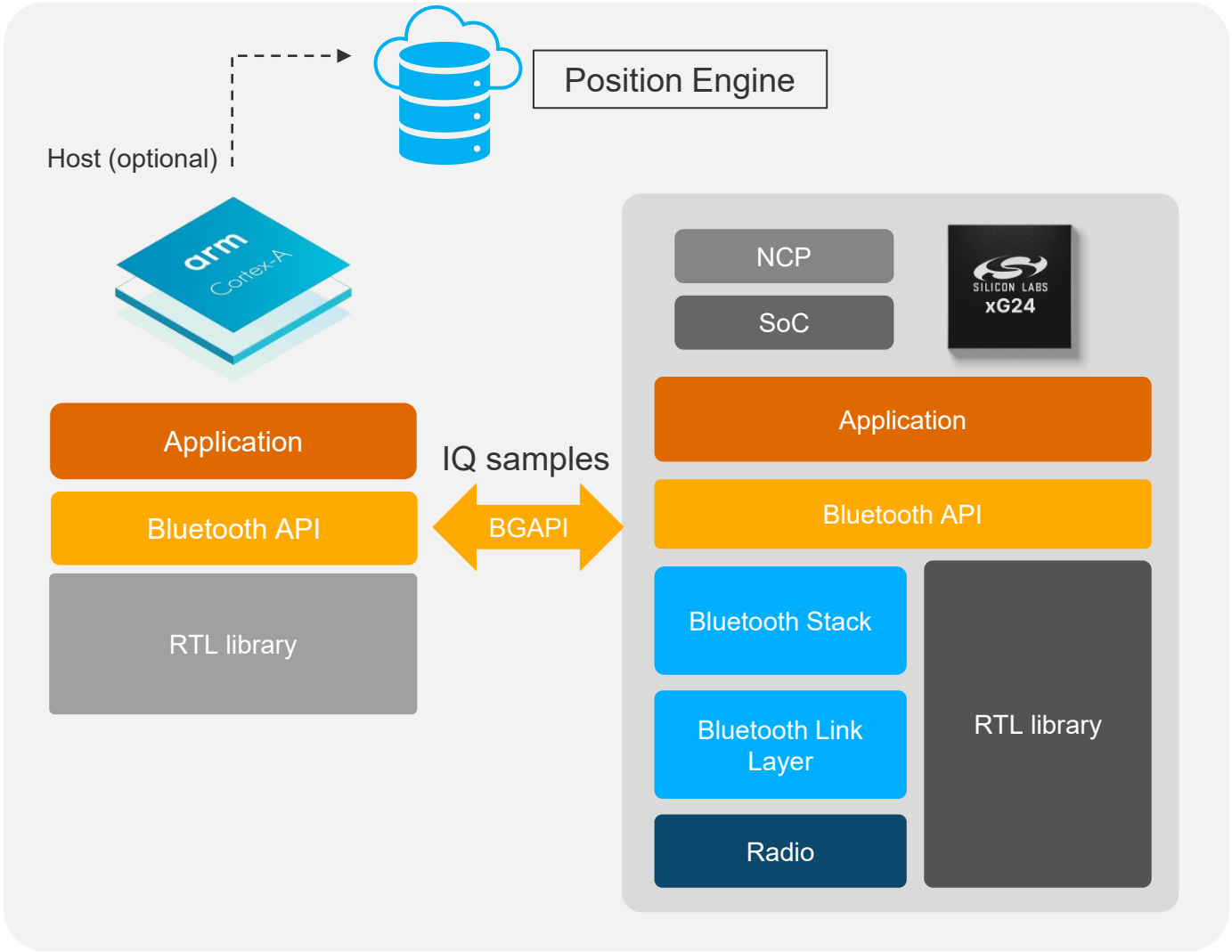
Connected Health
- Portable Medical

Industrial and Smart Buildings
- Access Control
- HVAC
- Predictive Maintenance
- Asset Tracking

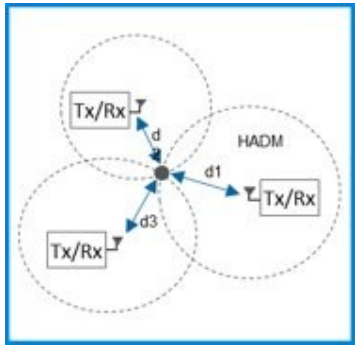
Smart Cities
- EV Charging

Commercial
- Lighting
- Access Points
- Clinical Medical
- Indoor Real Time Location Services

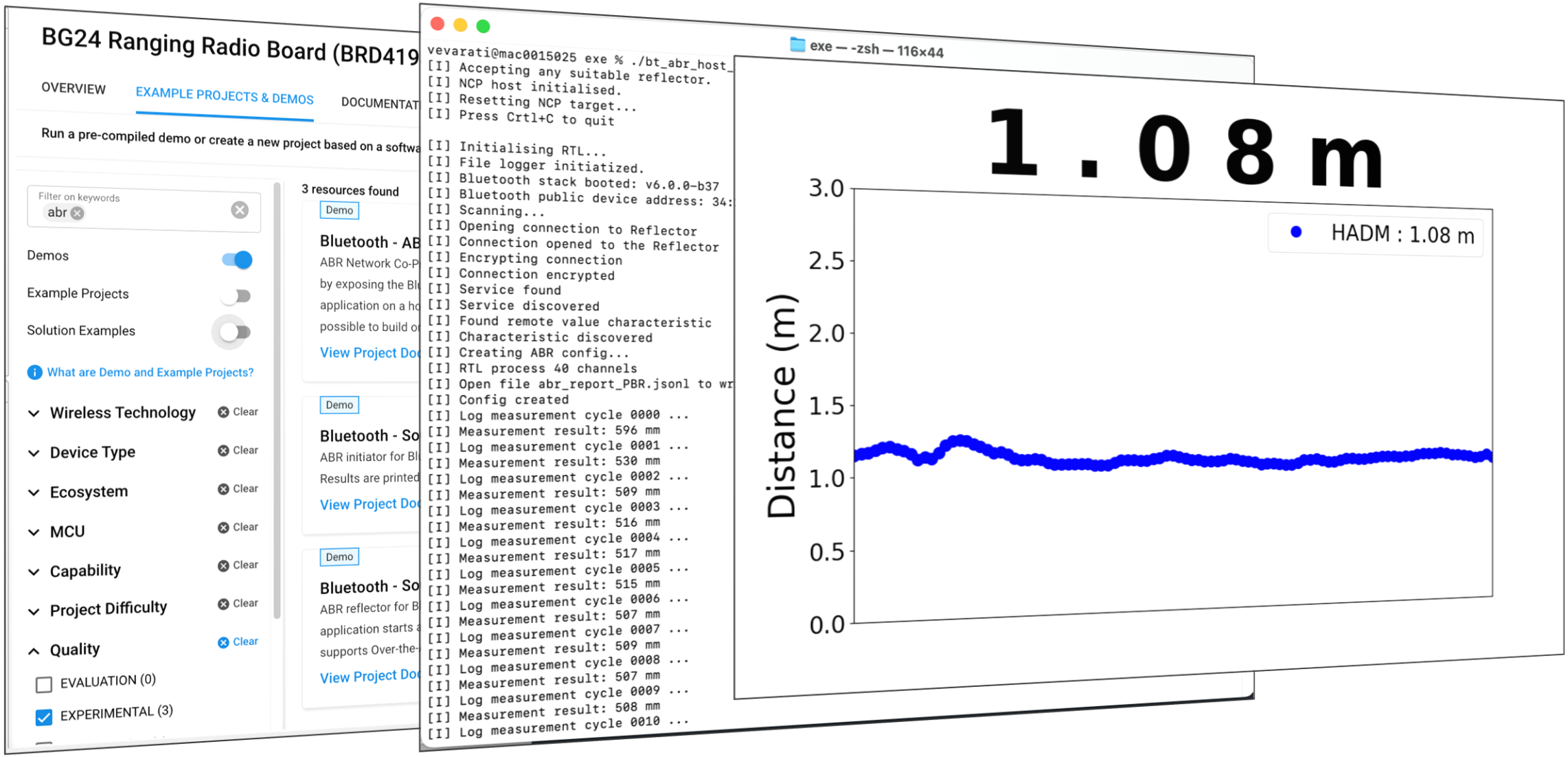
Software Stack Architecture



- **Flexible mode of operation**
  - Host-NCP mode – RTL library runs on host
  - SoC mode - RTL Library runs on xG24
  - Supported host platforms - Windows x64, Ubuntu x64, Raspbian (Cortex A), Darwin x64
- **GATT Ranging Service**
  - Measurement results sent via GATT indications
- **Extend ranging application to other location services via trilateration**



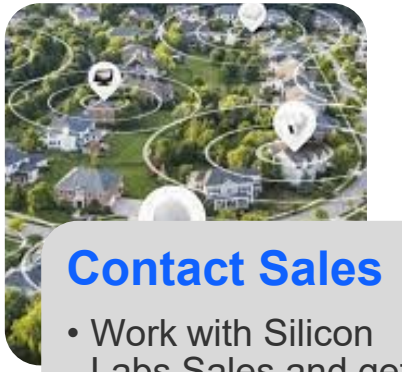
Sample Applications – Out-of-Box Experience



What's Next?

Works With 2023 – BT-202

- Another exciting session on HADM



Contact Sales

- Work with Silicon Labs Sales and get access to hardware

Download

- Download Simplicity Studio 5

HADM In Action

- See our accurate, reliable and simple distance estimating solution in action !

2023 tech talks
WEBINAR SERIES

Thank You

Watch ON DEMAND

Q&A