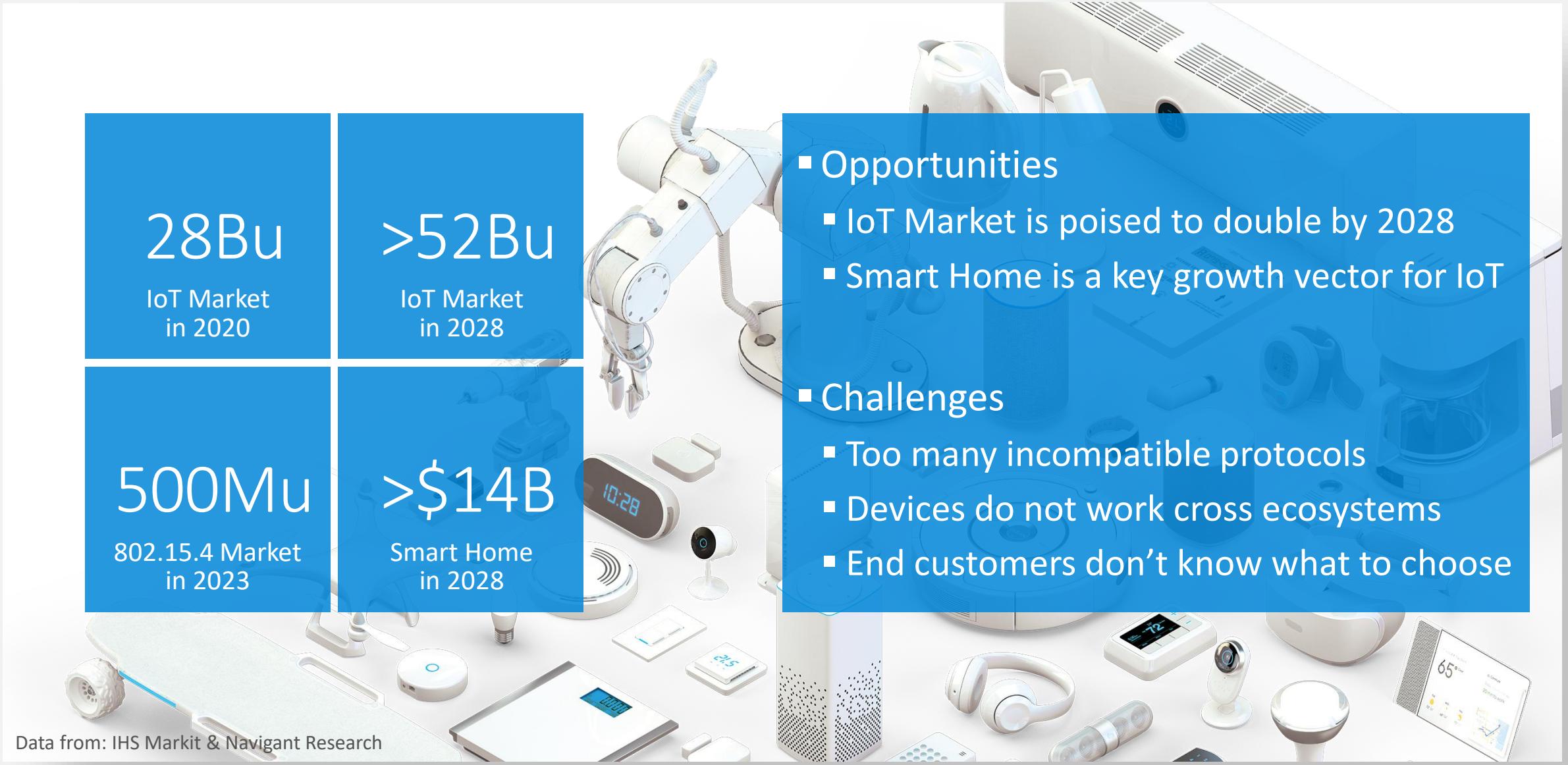
簡化開發無線整合多協定MCU打造下世代物聯網產品

黃金評/ANSON HUANG | SR FAE, SILICON LABS TAIWAN

IoT Market Opportunity & Challenges

28Bu IoT Market in 2020	>52Bu IoT Market in 2028
500Mu 802.15.4 Market in 2023	>$14B Smart Home in 2028



- Opportunities
  - IoT Market is poised to double by 2028
  - Smart Home is a key growth vector for IoT
- Challenges
  - Too many incompatible protocols
  - Devices do not work cross ecosystems
  - End customers don’t know what to choose

Data from: IHS Markit & Navigant Research

What Protocols fit in IoT Connectivity Landscape (ex: Smart Home) ?

What Does the IoT Market Need to Grow?

Market expectations:

- **Simple** – Simplicity for end customers, developers and manufacturers
- **Secure** – Robust security from end devices to the cloud is essential
- **Inclusive and Open** – Products to work together and across ecosystems

The Industry is Making Big Investments in Ecosystems

Disruptors setting agenda

works with nest

Works with Apple HomeKit

WORKS WITH alexa

Critical Infrastructure

COMCAST

ROGERS

works with XFINITY Home

Bell

Bezeq

ADT

WORKS WITH ALARM.COM

signify

Friends of hue

ring

WORKS WITH ring

SAMSUNG

vodafone

WORKS WITH SmartThings

Voice

Smart User Interface

Touch

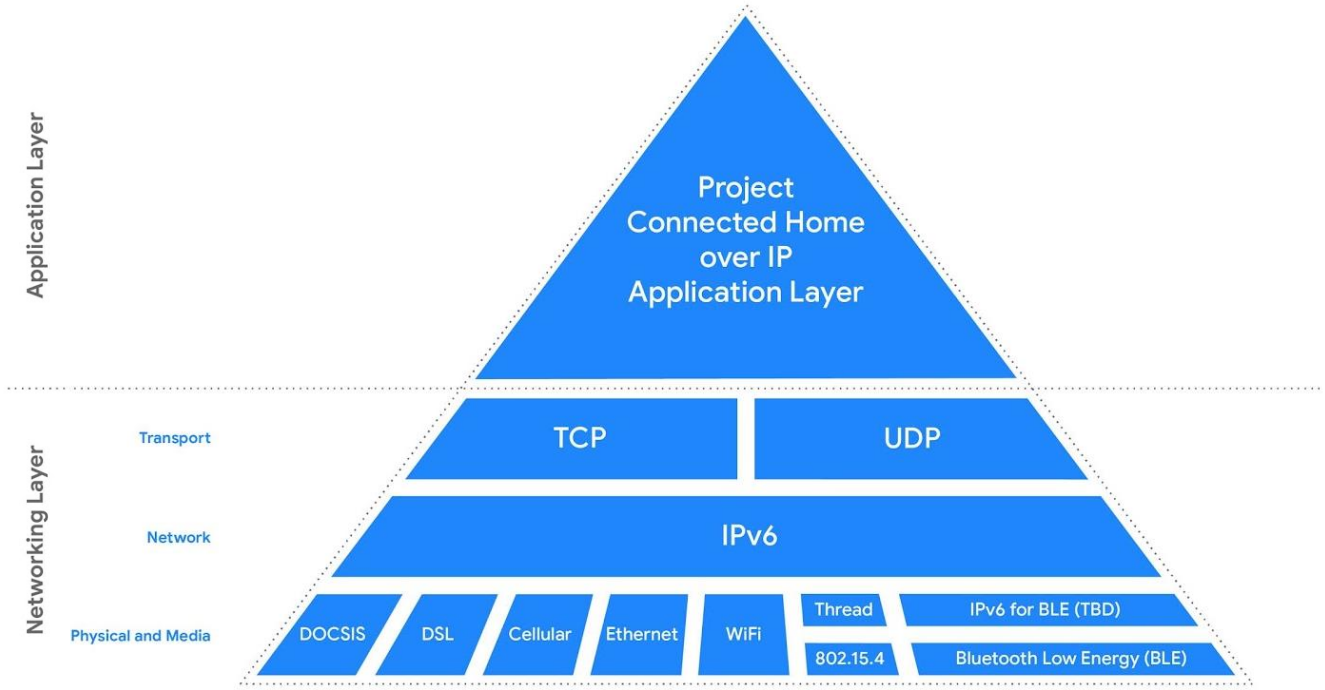
- Focus on consumer experience
- Ecosystems enable new “big data” revenue streams
- More devices equals more data about the consumer
- Focus on cloud & application, not hardware protocol

Ecosystem

- Retail brands are betting on sticky IoT Services
- Home security scope includes lifestyle & comfort
- Wants to create better experience to add value
- Sell more devices and better touch with consumers

Scales through ‘Works With’ Programs

Project Connected Home over IP - Introduction



zigbee Zigbee Alliance Dotdot Data Models

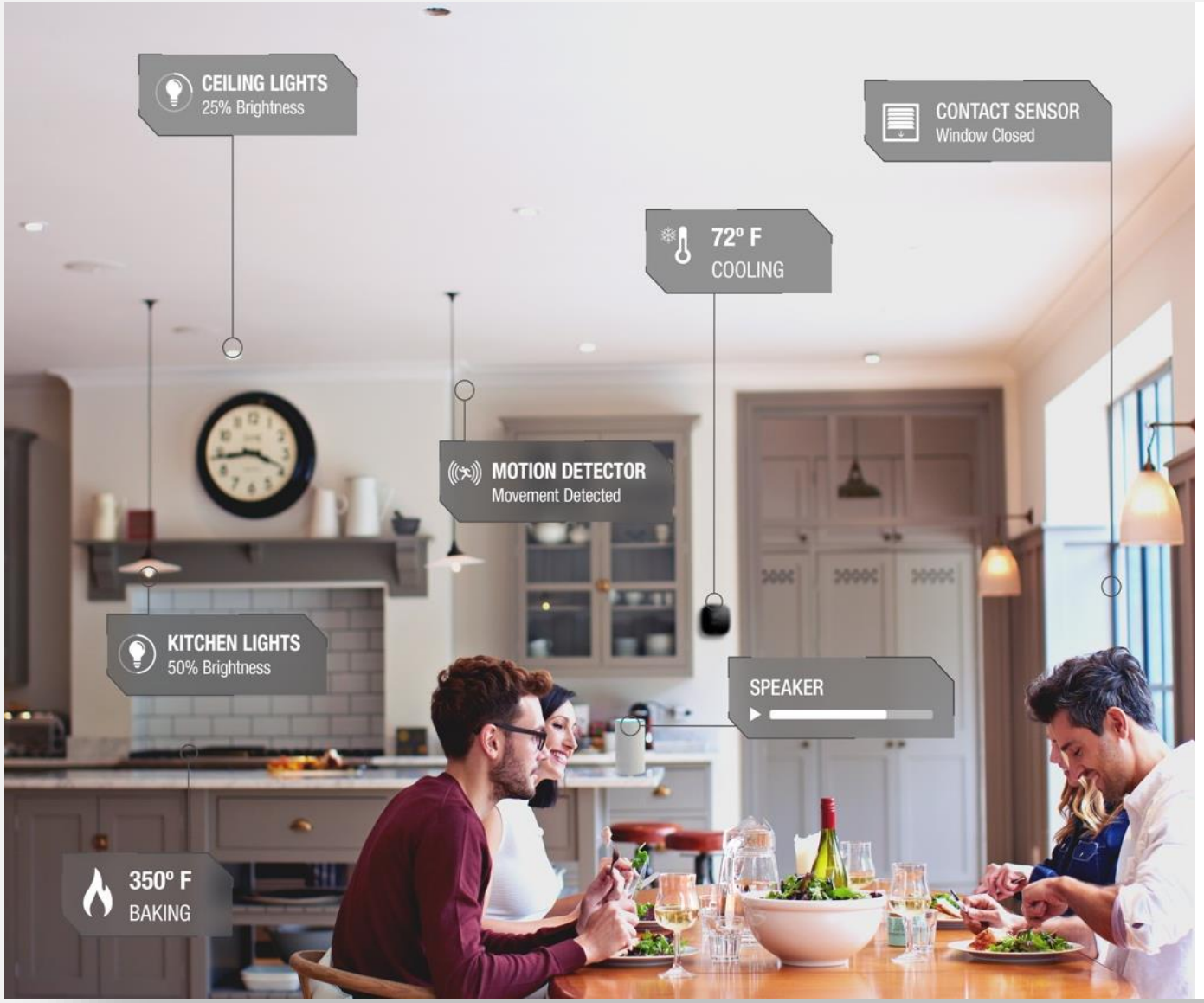
WEAVE Google Weave

Apple HomeKit

Amazon Alexa's Smart Home

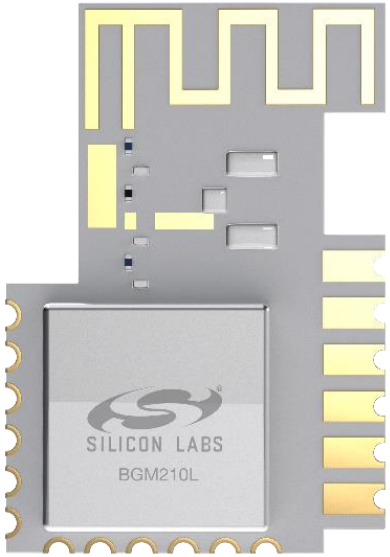
- Project Connected Home over IP is a Working Group within the Zigbee Alliance that plans to develop and promote the adoption of a new, royalty-free connectivity standard to increase compatibility among smart home products, with security as a fundamental design tenet.
- Amazon, Apple, Google, and the Zigbee Alliance joined together to promote the formation of the Working Group. Silicon Labs is fully endorsing this project and actively engaged
- Goals
  - Simplify development for manufacturers and increase compatibility for consumers
  - Enable communication across smart home devices, mobile apps, and cloud services

Project Connected Home Over IP – Key Takeaways



- New application layer based on market-tested technologies running on multiple network protocols like Wi-Fi, Bluetooth and 802.15.4
- Aims to improve customer experience by creating a protocol widely adopted across ecosystems and assistants
- Initial emphasis in the Smart Home which could be later expanded to other applications areas
- Removes barriers for Smart Home Ecosystems Providers and IoT Product Manufacturers
- Rapid pace development based on open source

Silicon Labs: Advancing What's Possible in the IoT



- **Expertise**: 20+ years providing RF solutions with more than 1 billion deployed wireless nodes worldwide
- **Platform**: Simplifying IoT product design with highly-integrated devices, reusable software and advanced development tools
- **Security**: Providing enhanced security features to help developers increase consumer trust in connected products

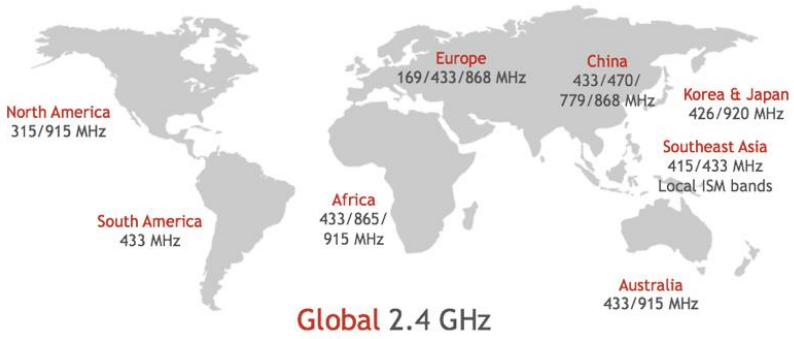
Bluetooth Proprietary THREAD Wi Fi zigbee Z-WAVE

Series 1 Wireless MCUs

	Z-Wave	ZigBee	Thread	Bluetooth	Proprietary wireless	
Zen Gecko	✓					256 – 512 kB Flash Up to 13 dBm Sub-GHz QFN32, LGA64
Mighty Gecko		✓	✓	✓	✓	256 – 1024 kB Flash Up to 19.5 dBm Sub-GHz + 2.4 GHz QFN32, QFN48, BGA125
Blue Gecko				✓	✓	128-1024 kB Flash Up to 19.5 dBm 2.4 GHz and Sub-GHz QFN32, QFN48, WLCSP43, BGA125
Flex Gecko					✓	32-1024 kB Flash Up to 19.5 dBm Sub-GHz + 2.4 GHz QFN32, QFN48, BGA125

Introducing the Wireless Gecko Series 2 Platform

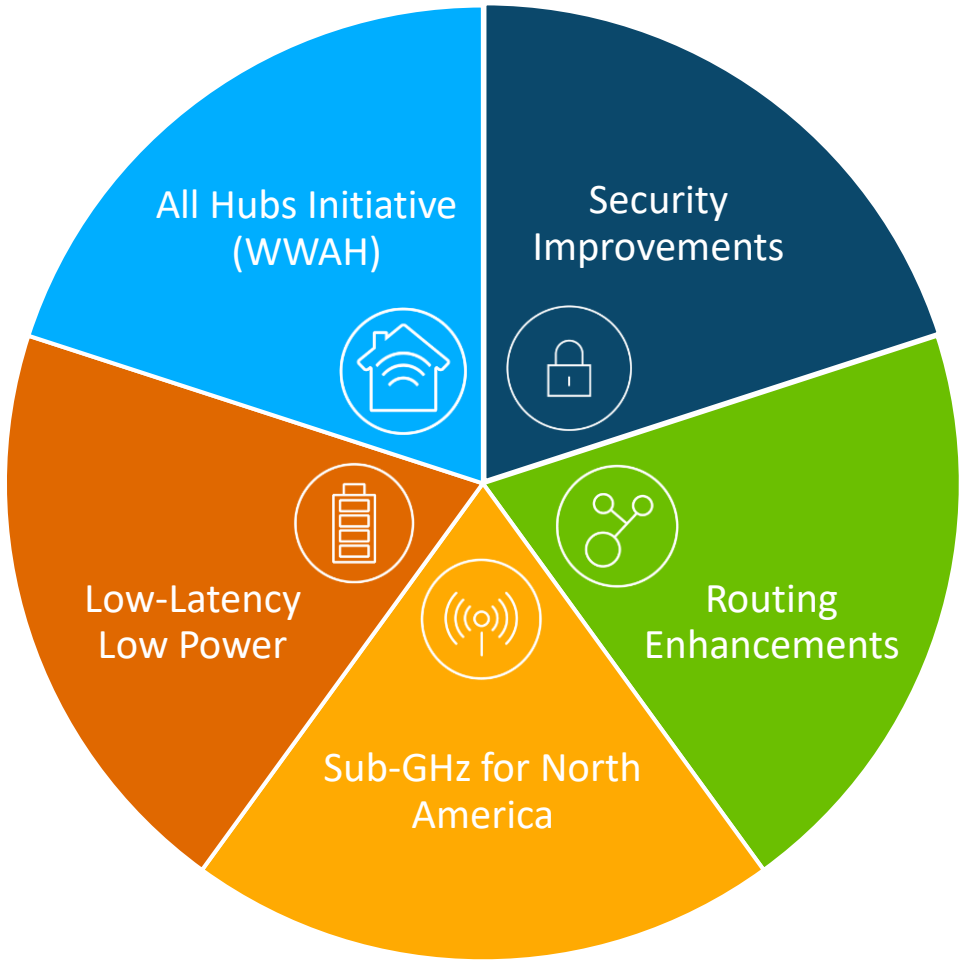
Bluetooth® Proprietary THREAD Wi Fi® zigbee Z-WAVE®



- Optimized for IoT Protocols
  - Zigbee, Thread, Bluetooth, Z-Wave and Wi-Fi
  - Multiband and multiprotocol portfolio
- High performance and integration
  - Arm Cortex-M33 processor core
  - Up to 125 dBm link budget with fully integrated PA/LNA
- Ultra-low power
  - Very low active current (27 µA/MHz)
  - Low sleep current (1.4 µA)
- Dedicated security core
  - Hardware crypto
  - Secure Boot
  - Secure Debug Access
  - True random number generator (TRNG)

Application Optimized for the IoT

Upcoming Zigbee 3.x (R23) Specification Updates 2020+



- All Hubs Initiative (WWAH)
  - Consistent behavior for Rejoin, Polling, Upgrades, etc
  - Enhanced Diagnostics and Debug
  - Improved ecosystem management
- Security Improvements
  - Modern key negotiation before joining network (ECDH)
  - Improved security for low touch installations
- Routing Enhancements
  - Routing loops detection w/ better handling of route failures
  - Improved testing
- Low-Latency Low Power Support
  - Reduced power consumption for Battery Powered Controllers
  - Faster reaction time for sleepy Door Locks and Shades
- Sub-GHz for North America
  - Adding Sub-GHz Routers to ZigBee for increased range
  - Adding Sub-GHz PHYs for North American Region

Zigbee PRO & Zigbee Green Power

Zigbee Green Power uses the same lower layers, with compressed messages (20% of Zigbee PRO energy)

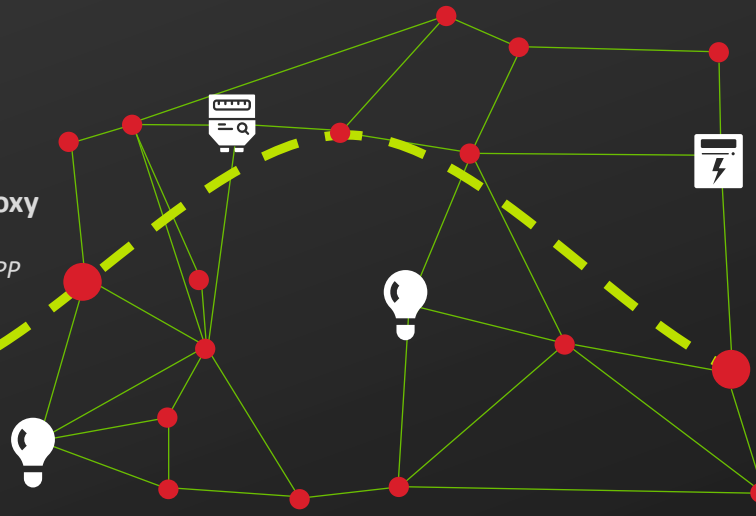
Low power mesh technology built on 802.15.4 MAC/PHY

green power by zigbee alliance

Energy Harvesting
Battery-less
Interoperable
Flexible
Eco-friendly

Zigbee PRO
GP frame packets are forwarded across the Z3 network in a Zigbee frame

Zigbee Green Power
Extends support of 802.15.4 networks to battery powered and energy-harvesting nodes



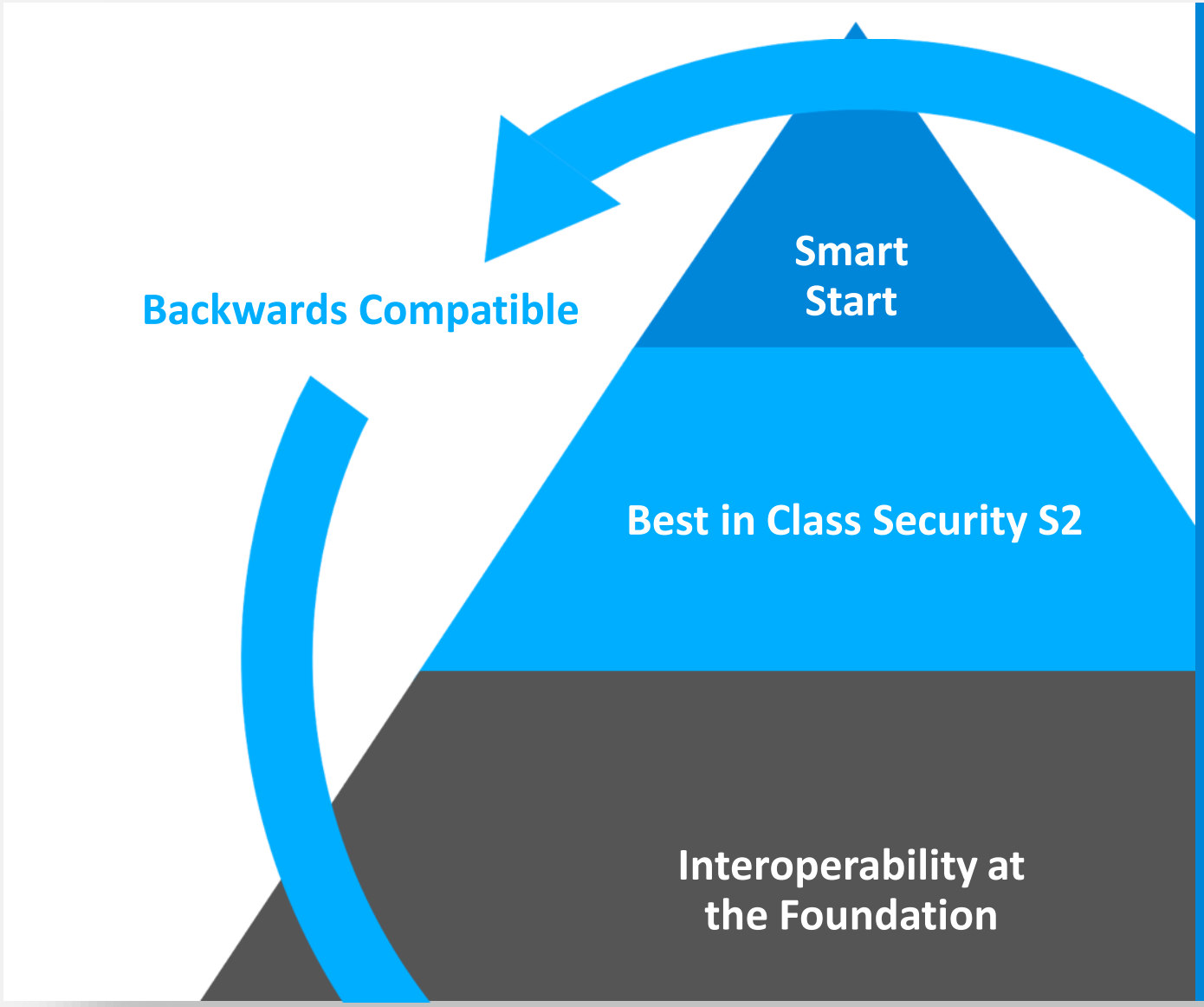
Green Power Proxy
(Always On)
Mains Powered GPP Node

Green Power Proxy

Green Power Device
(Energy Harvesting or Battery Powered)
GPD Node

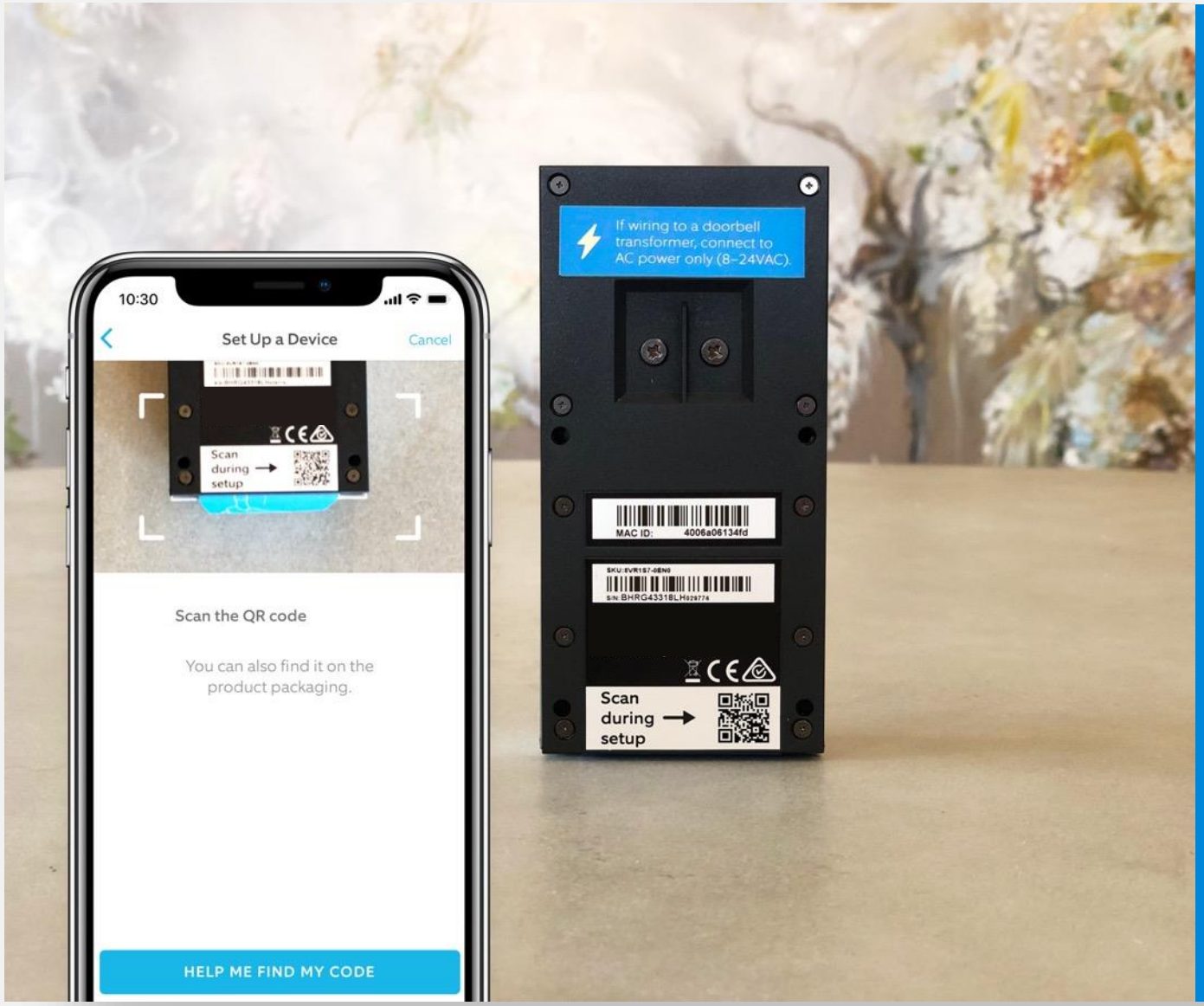
Green Power Sink
(Always On)
Mains Powered GPS Node

Z-Wave is Simple, Secure, Interoperable



- +15 years of interoperable products deployed
- Mandated security built into the Z-Wave protocol
- SmartStart automatic wireless setup

Z-Wave: SmartStart Delivers Automatic Secure Inclusion



- Scan QR codes to initiate plug and play secure installation
- Remove installation difficulty for mainstream users
- Enable consistent quality of install, every time, for every device
- Encourage shift from single device to whole home automation
- Supply service providers with tools to increase productivity and ROI

Z-Wave: Tool for Service Providers

Unique "Installation and Maintenance Application" (IMA) for monitoring the mesh-network health

- Determines link stability
- Measures latencies
- Monitors quality of service

Benefits to Service Providers

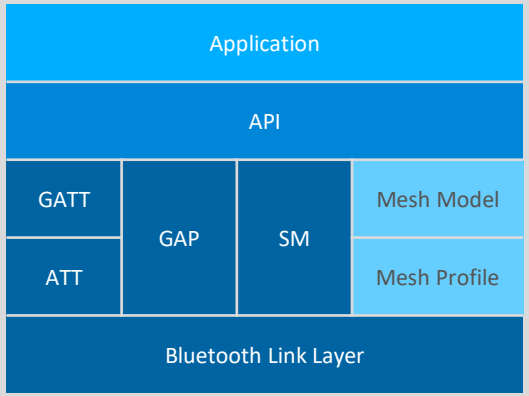
- Real-time monitoring and reporting
- Call centers can run IMA tool remotely to determine if or where there are issues

A Complete Solution for Enabling Bluetooth Products

SoCS AND MODULES

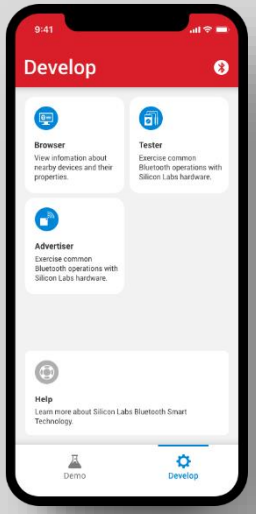
Industry leading Bluetooth 5.1 and 5.2 SoCs and pre-certified modules

STACK SOFTWARE



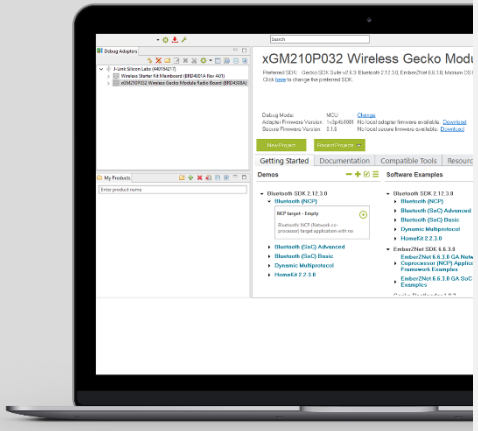
In-house developed stacks with latest Bluetooth 5.2 and mesh features

MOBILE APPLICATIONS



Reference applications and source code for iOS and Android

DEVELOPMENT TOOLS



Free-of-charge development and protocol analysis tools to boost productivity

BG22: Optimized Battery Powered Bluetooth LE

Optimized

Secure Bluetooth 5.2 SoCs for High-Volume Products

Radio
Bluetooth 5.2
TX: -27 to +6 dBm
RX: -96 to -107 dBm
1M, 2M and LE Coded PHYs
AoA & AoD

Ultra-Low Power
3.5 mA TX (radio)
2.6 mA RX (radio)
1.4 µA EM2 with 32 kB RAM
0.5 µA w/ RTC in EM4

World Class Software
Bluetooth 5.2
Bluetooth mesh LPN
Direction Finding

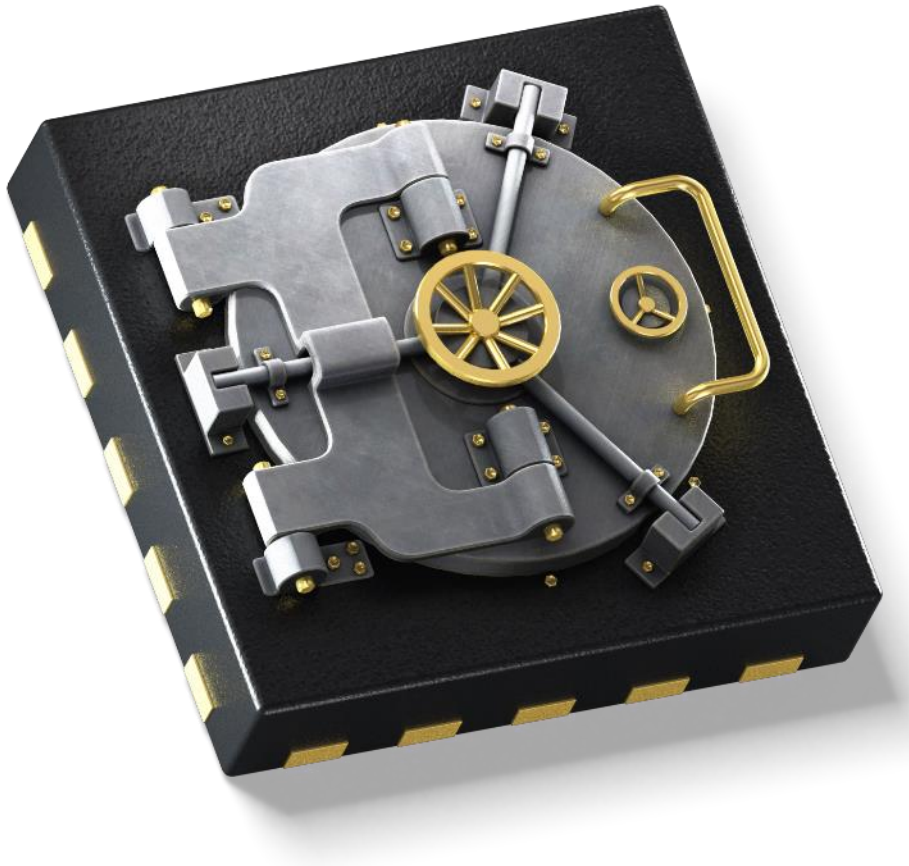
Compact Size
5x5 QFN40 (26 GPIO)
4x4 QFN32 (18 GPIO)
4x4 TQFN32 (18 GPIO)

ARM Cortex-M33 with TrustZone
38.4/76.8 MHz
352/512 kB of flash
32kB RAM

Peripherals Fit for Purpose
2x USART, 2x I2C, 2x PDM and GPIO
12-bit ADC (16 channels)
Built-in temperature sensor with +/- 1.5 °C
Built-in 32 kHz, 500ppm sleep clock

Security
AES128/256,SHA-1, SHA-2 (256-bit)
ECC (up to 256-bit), ECDSA and ECDH
True Random Number Generator (TRNG)
Secure boot with RTSL
Secure debug with lock/unlock

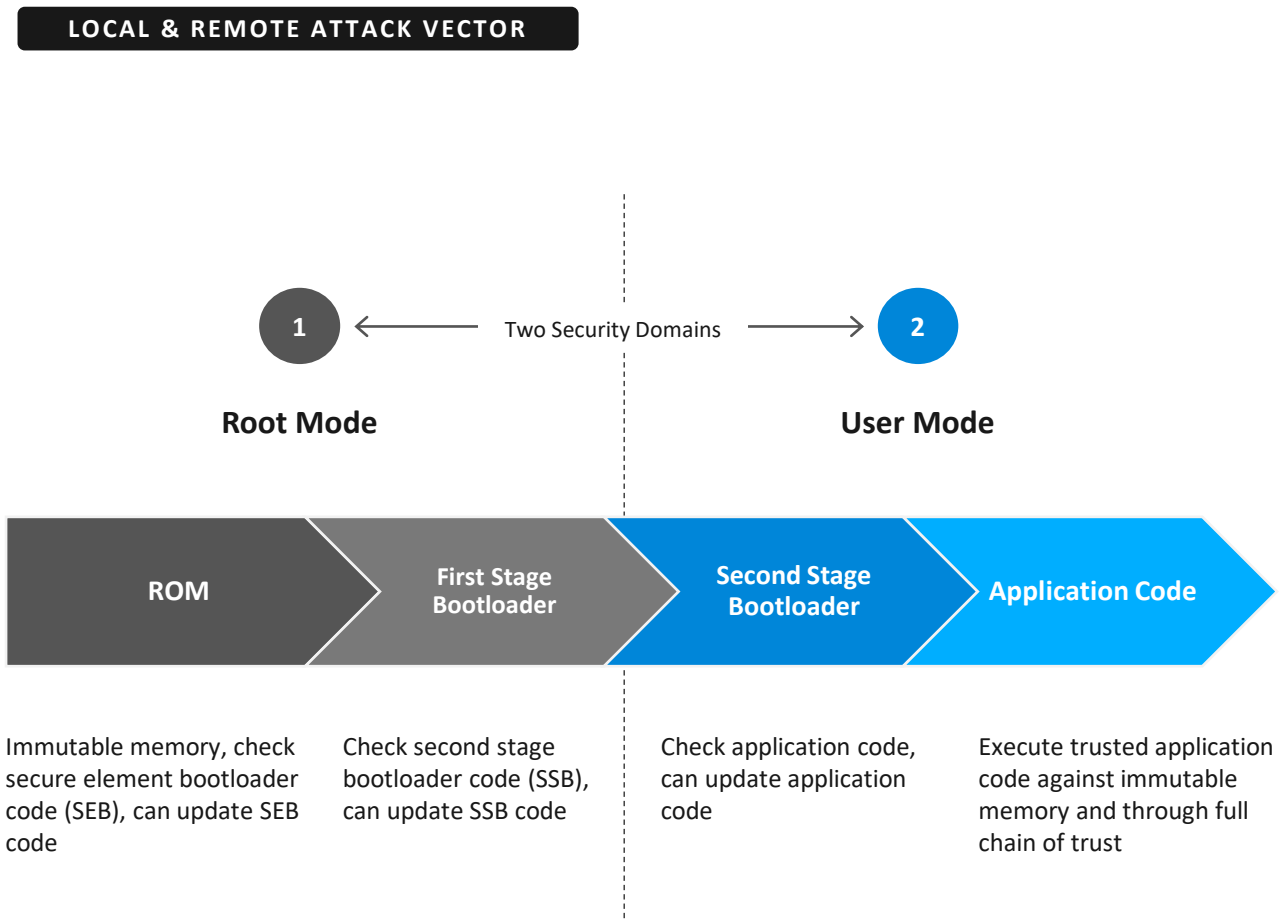
Securing Bluetooth Products with BG22



- **Hardware Accelerated Crypto**
  - Faster, more energy efficient and secure than software
- **True Random Number Generator (TRNG)**
  - Compliant with NIST SP800-90 and AIS-31
- **Secure Boot with Root of Trust and Secure Loader (RTSL)**
  - Prevents malware injection and rollback
  - Ensures authentic firmware execution and OTA updates
- **Secure Debug with Lock/Unlock**
  - Allows authenticated access for enhanced Failure Analysis (FA)
- **ARM Cortex M33 Core with TrustZone**
  - Provides cost effective hardware isolation

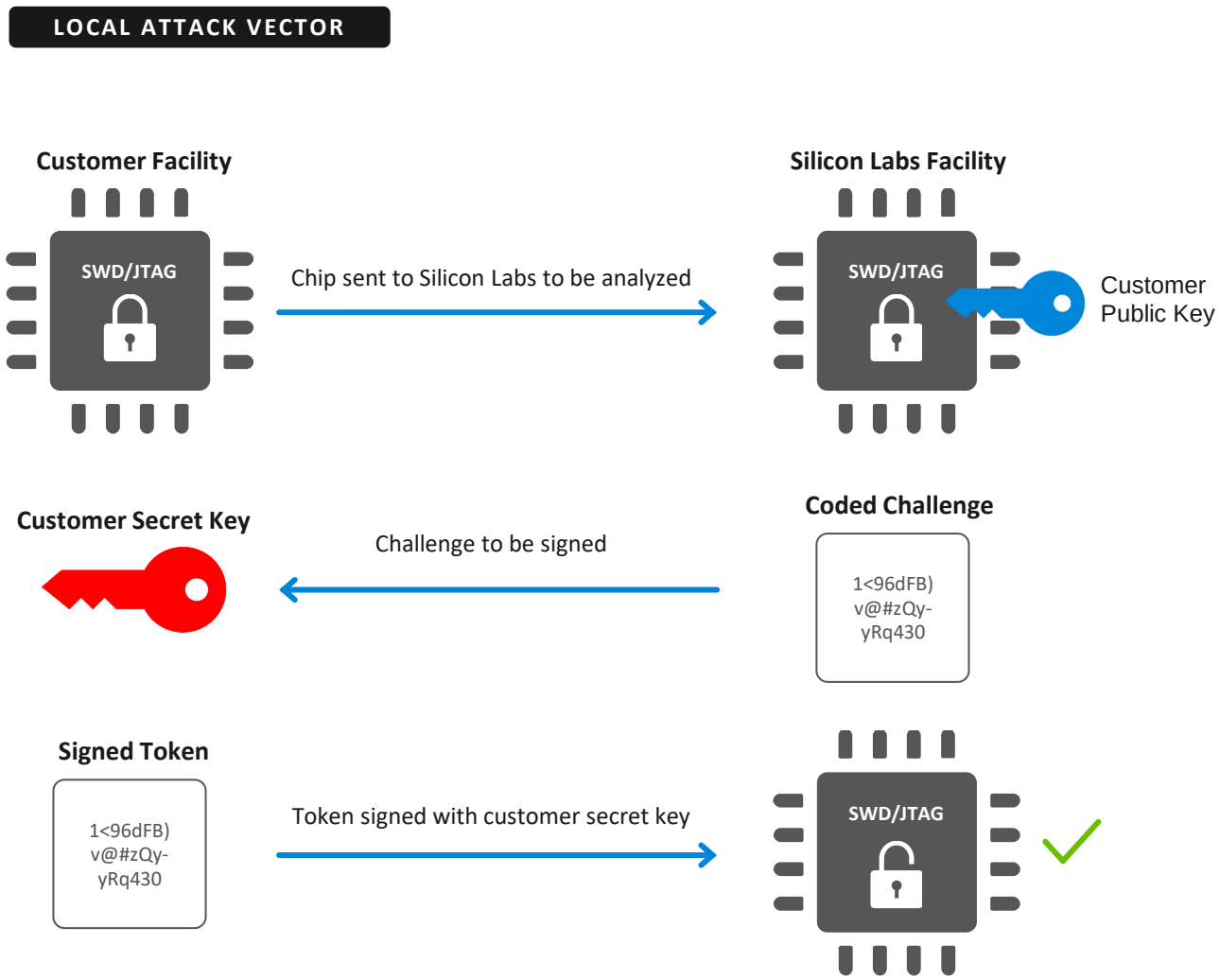
www.silabs.com/security

Secure Boot with Root of Trust and Secure Loader (RTSL)



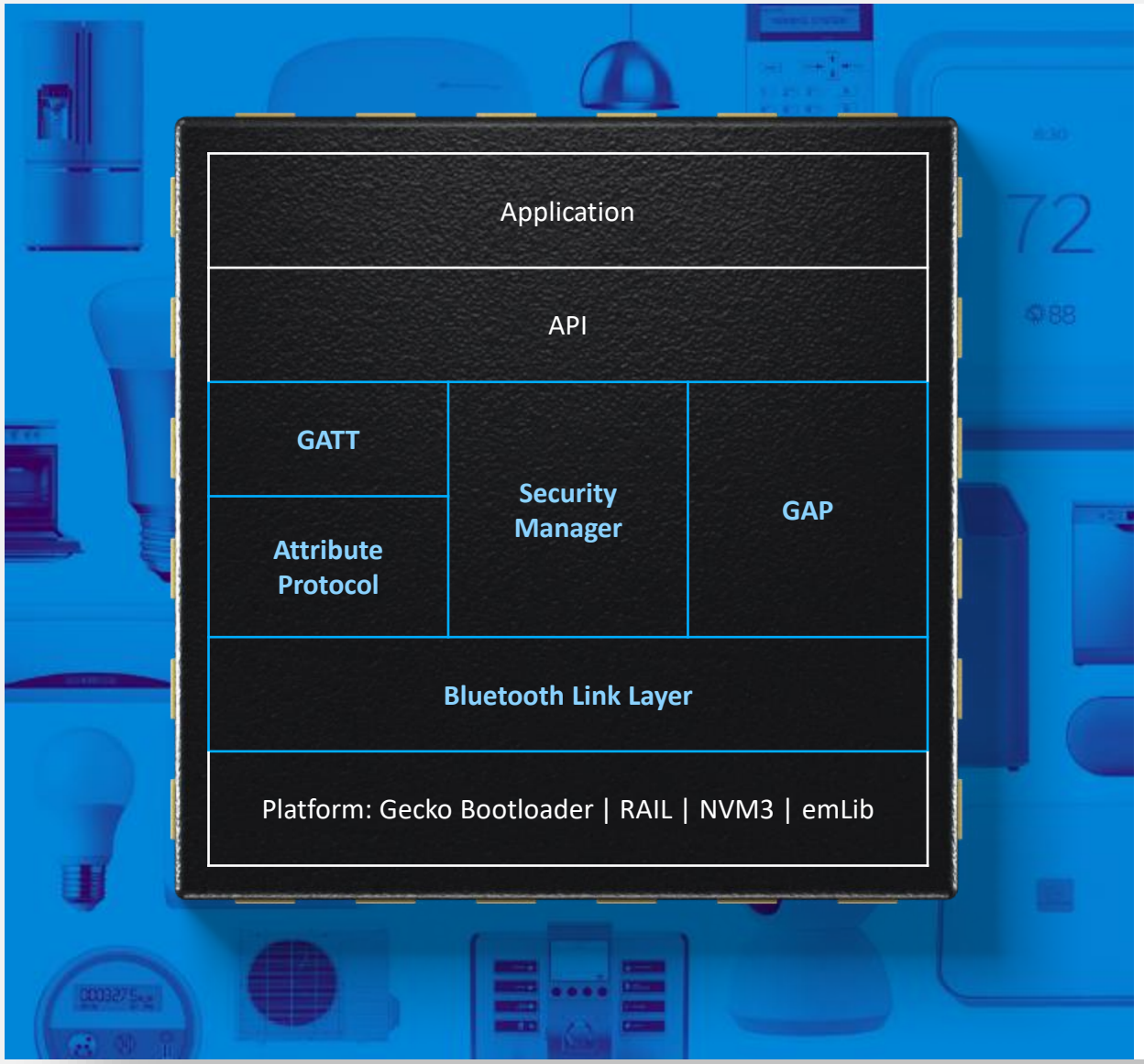
- Vulnerabilities
  - Replacing code with ‘look-alike code’ makes a product appear normal. Hackers use it to copy/re-direct data to alternate servers.
- Secure Boot with RTSL
  (Root-of-Trust & Secure Loader)
  - Use and execute only trusted application code against immutable memory and through a full chain of trust

Secure Debug with Lock/Unlock



- Vulnerabilities
  - Unlocked ports are a significant security vulnerability
  - Unlocking debug ports typically wipes the memory to protect IP but this limits device failure analysis capabilities
- Secure Debug
  - Lock the emulation port and use optional cryptographic tokens to unlock it allowing memory to remain intact

Bluetooth LE Software



A Bluetooth 5.2 compliant Bluetooth stack, with:

- Bluetooth 5.2 Dynamix TX power control
- Bluetooth 5.1 Direction Finding
- Bluetooth 5.0 standard features
- Relevant Bluetooth 4.x features

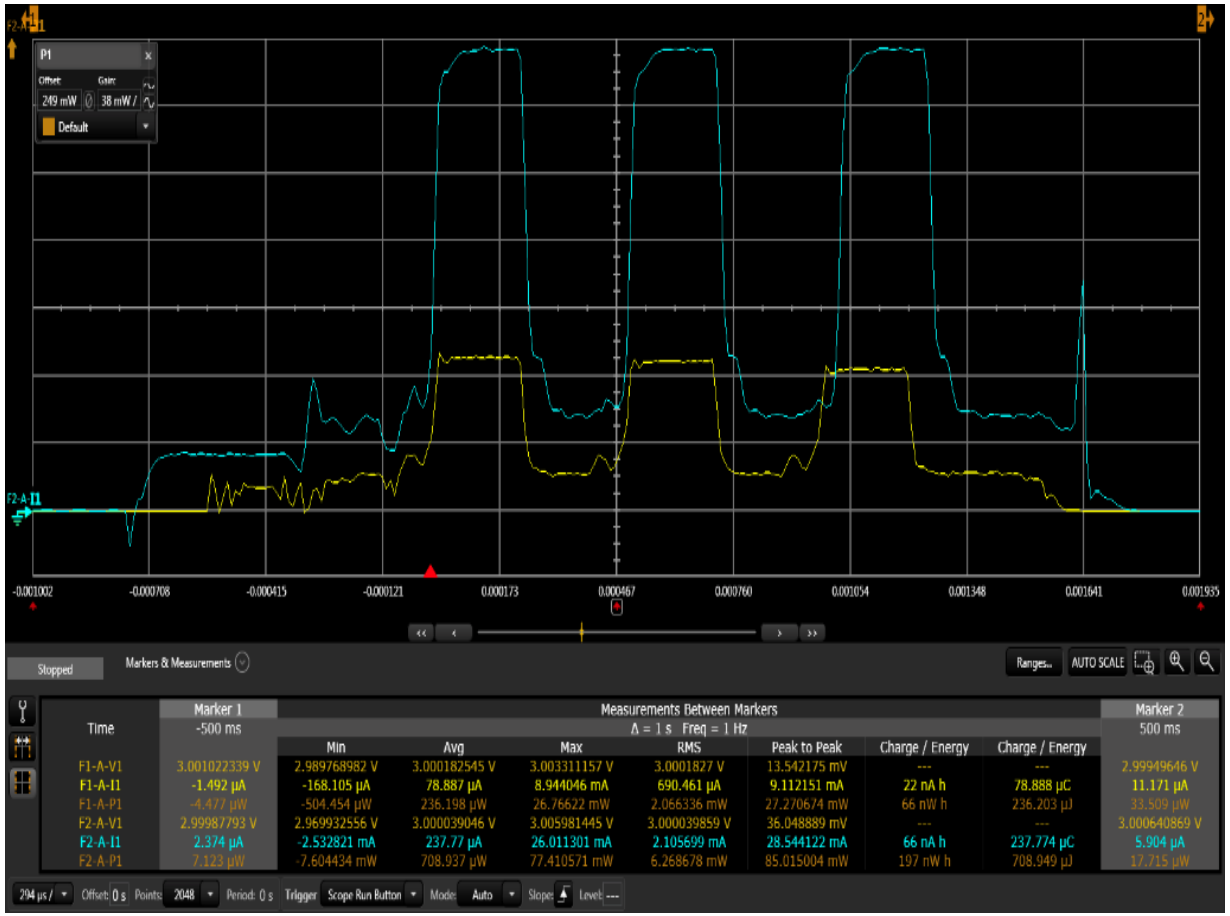
Packed with advanced functionality

- Multiple connections and advertisers
- Concurrent advertising, scanning and LE connections
- Optimized throughput and power consumption

Built on top of the common EFR32 software platform

- Gecko bootloader
- emLib for MCU peripherals and drivers
- NVM3 key/value pair data storage with wear leveling
- RAIL radio driver

6dBm Current Consumption Profile – BG22 vs BG13



- **EFR32BG13 when advertising:**
  - Current consumption at +6 dBm with default parameters in soc-empty sample app shown below (~419uA)
- **EFR32BG13 when connected:**
  - Current consumption at +6 dBm with default parameters in soc-empty sample app shown below: ~220uA
- **EFR32BG22 advertising**
  - Current consumption at +6 dBm with default parameters in soc-empty sample app shown below: ~130 uA
- **EFR32BG22 connected**
  - Current consumption at +6 dBm with default parameters in soc-empty sample app shown below: ~65uA

BG22 Extends Battery Life in Bluetooth Applications

Data Transfer	Location Services
Connected to a phone at 2000ms interval	Advertising 10 bytes every 1000ms
Using 2M PHY and transmitting 10 Byte / packet	TX at 0dBm and using 1 channel
Average current: 4.0 µA	**Average current: 3.7 µA**

5+ years on CR2032
10+ years on a CR2354

Highly Accurate Indoor Location Services

- **Silicon Labs and Quuppa (www.quuppa.com) cooperate to provide accurate Bluetooth indoor positioning services**

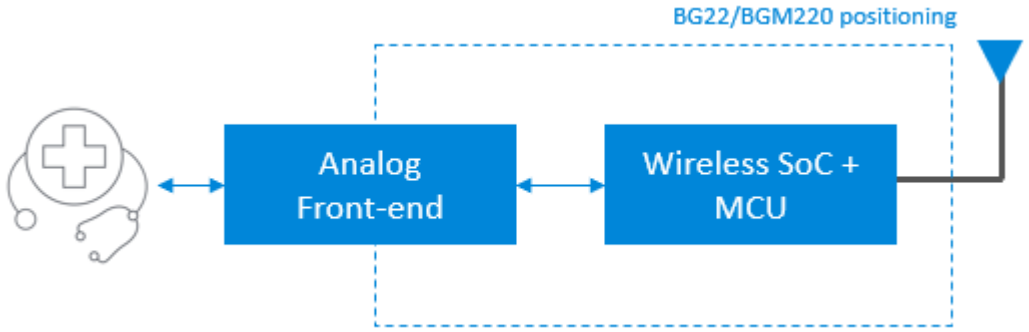
Silicon Labs

- BG22-based tag can operate 5-10 years on coin cells batteries
- The BOM of a Bluetooth tags can be reach <$1 in high volume

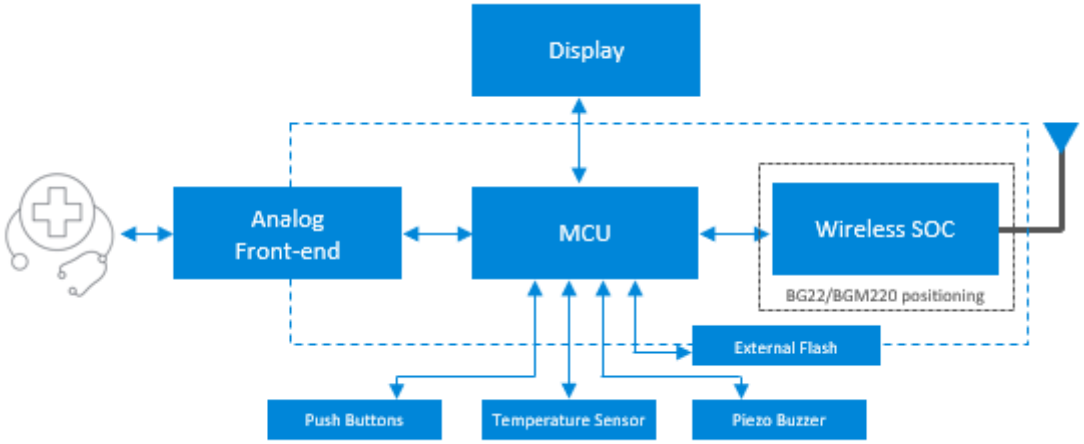
Quuppa

- Bluetooth AoA-based infrastructure for indoor and outdoor asset tracking
- The positioning engine provides the X, Y and Z coordinates of the asset through the REST API and bidirectional IoT data
- https://quuppa.com/technology/products/

Portable Medical Devices



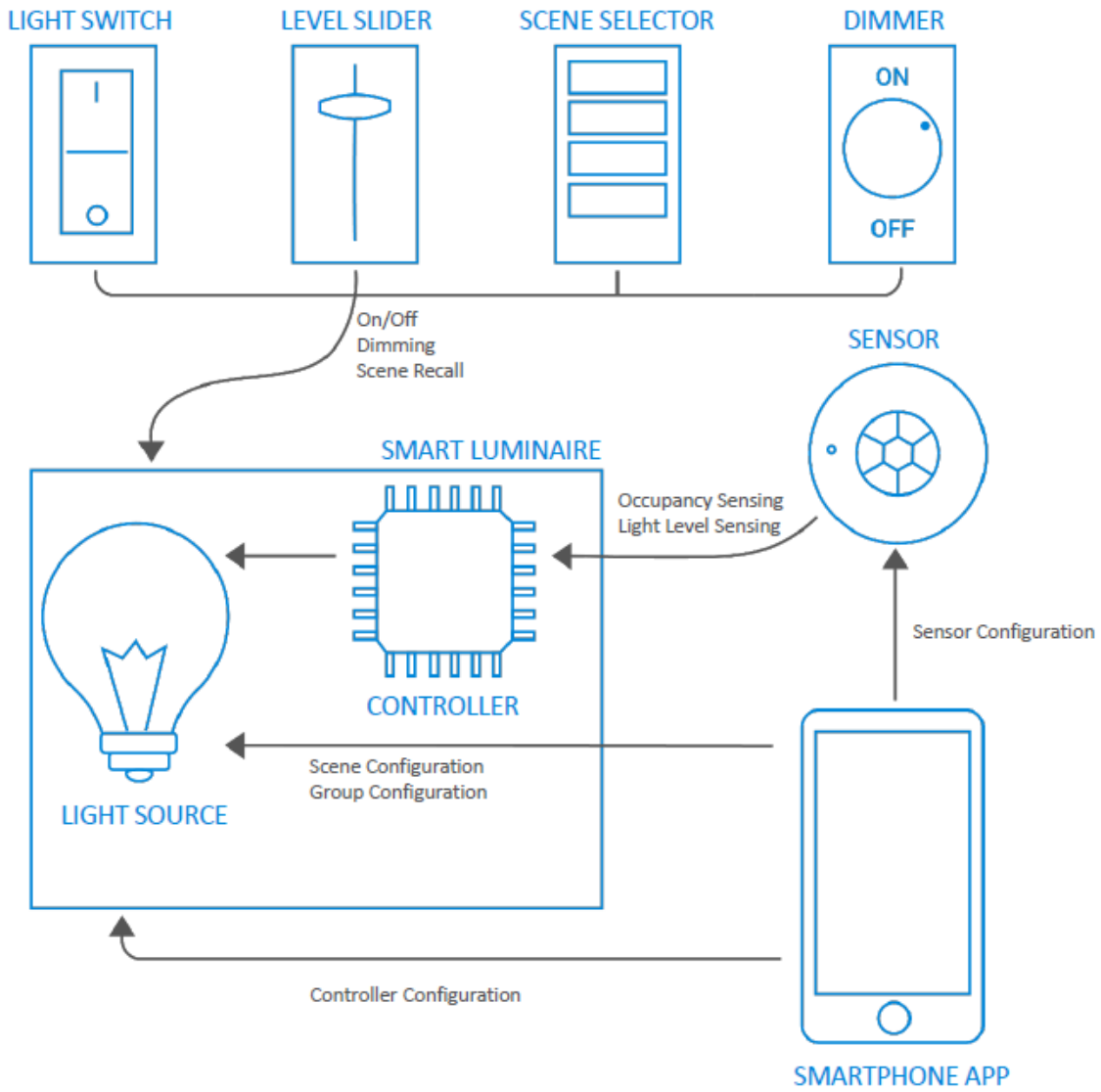
- **BG22 can run as a radio and MCU for simple devices like continuous glucose monitoring patches**
  - BG22 provides Bluetooth connectivity to a phone
  - Low power features help reach required lifetime
  - Interface to AFE or sensors
  - Small size packages like 4x4 TQFN32 help minimize size



- **For more complex devices with an external MCU, BG22 can be used as a low power Network Co-Processor**

- **BG22 supports DTSec security requirements**
  - https://www/diabetestechnology.org/dtsec.shtml

BG22 Enables Bluetooth Mesh Low Power Nodes



What do mesh network usually consist of?

- Main powered relaying/routing nodes like lights
  - Always of RX and sporadic TX
- Battery powered nodes like sensors or controls
  - Sleeping most the time and TX only when necessary

BG22 is ideal for Bluetooth mesh Low Power Nodes

- 32kB RAM and 512kB flash enough for LPN
- Ultra-low TX, RX and sleep currents
- Direct operation from coin cell batteries

BG21 is better suited for mains powered relaying nodes

- 96kB RAM and 1024kB flash support relaying/routing
- BG21 does not have DC-DC, which is not needed
- TX power up to +10/20 dBm

Getting Started with IoT Solutions

SELECT RIGHT PROTOCOL	OBTAIN DEVELOPMENT KIT	LEVERAGE TOOLS
Z-WAVE Bluetooth zigbee THREAD		14 Simplicity Studio Silicon 28.086 SILICON LABS
Z-Wave: Z-Wave ecosystem **BLE & Bluetooth Mesh:** Hub-less systems enabled by smartphones **Zigbee:** Comcast/Xfinity & other Zigbee ecosystems **OpenThread:** IP-based devices	**Z-Wave:** – silabs.com/wireless/z-wave **Bluetooth** – silabs.com/wireless/bluetooth **Zigbee:** – silabs.com/wireless/zigbee **OpenThread**: – silabs.com/wireless/thread	**Get information on datasheets, app notes and much more:** silabs.com/community

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