WELCOME

APAC Talk Talks LIVE - Mandarin

Topic	Date
Evolution of Bluetooth 5, 5.1, & 5.2	10a.m., Tuesday, May 26
Bluetooth Mesh Solutions & Tools	10a.m., Thursday, May 28
15.4 Mesh Networking Technologies	10a.m., Tuesday, June 2
Bluetooth AoX Solutions	10a.m., Thursday, June 4
Connected Home Over IP (CHIP) for Beginners	10a.m., Tuesday, June 9
Device & Network Security for the IoT	9a.m., Thursday, June 11

SILICON LABS

Evolution of Bluetooth 5, 5.1, & 5.2

CHUNG MUI, SR. FAE | MAY 2020

Agenda

BT 5

- 2x data throughput with 2Mbps PHY : Faster OTAs
- 4x range: Building automation
- 8x Enh Advertisements configuration: Multiple Beacons

BT 5.1

- Direction finding: Asset tracking
- GATT Caching : Lower power on service discovery

BT 5.2

- LE Isochronous Channel: Multi-Stream Audio and Broadcast
- LE Power Control: Dynamic TX change, lower power, more reliability





Bluetooth 5 Summary

is transformative.

2x Speed

- 2M PHY vs. 1M PHY (BT 4x)
- double the throughput up to 1.4Mbps
- 15-50% lower power consumption

4x Range

- 125/500kbps coded PHYs improve Rx sensitivity /range
- New channel selection algorithm enables +20dBm TX

8x Advertisement Capacity

- Advertisement payload grows from 31B (BT 4) to 255B (BT 5)
- 37 new advertisement channels help offload 3 primary advertisment channels
- New advertisement schemes for advanced beacons
- Periodic Advertisement

Bluetooth 5 - 2M PHY

Bluetooth 4 uses a single 1M PHY

Bluetooth 5 adds an optional 2M PHY

- Faster data rate – up to 1.4Mbps
- ~15%-50% lower power due to shorter TX/RX
- 0.8x range (Rx senstivity lower for 2M PHY)

PHY	Symbol rate	Range multiplier	PDU Length	Minimum packet time	Maximum packet time	Maximum throughput
1M	1 M symbols/s	1x	0–257 B	80us	2.12ms	800 kbps
2M	2 M symbols/s	0.8x	0–257 B	44us	1.064ms	1438 kbps

Bluetooth 5 – LE Coded PHY or LE Long Range PHY

Bluetooth 5 adds two new LE coded PHYs

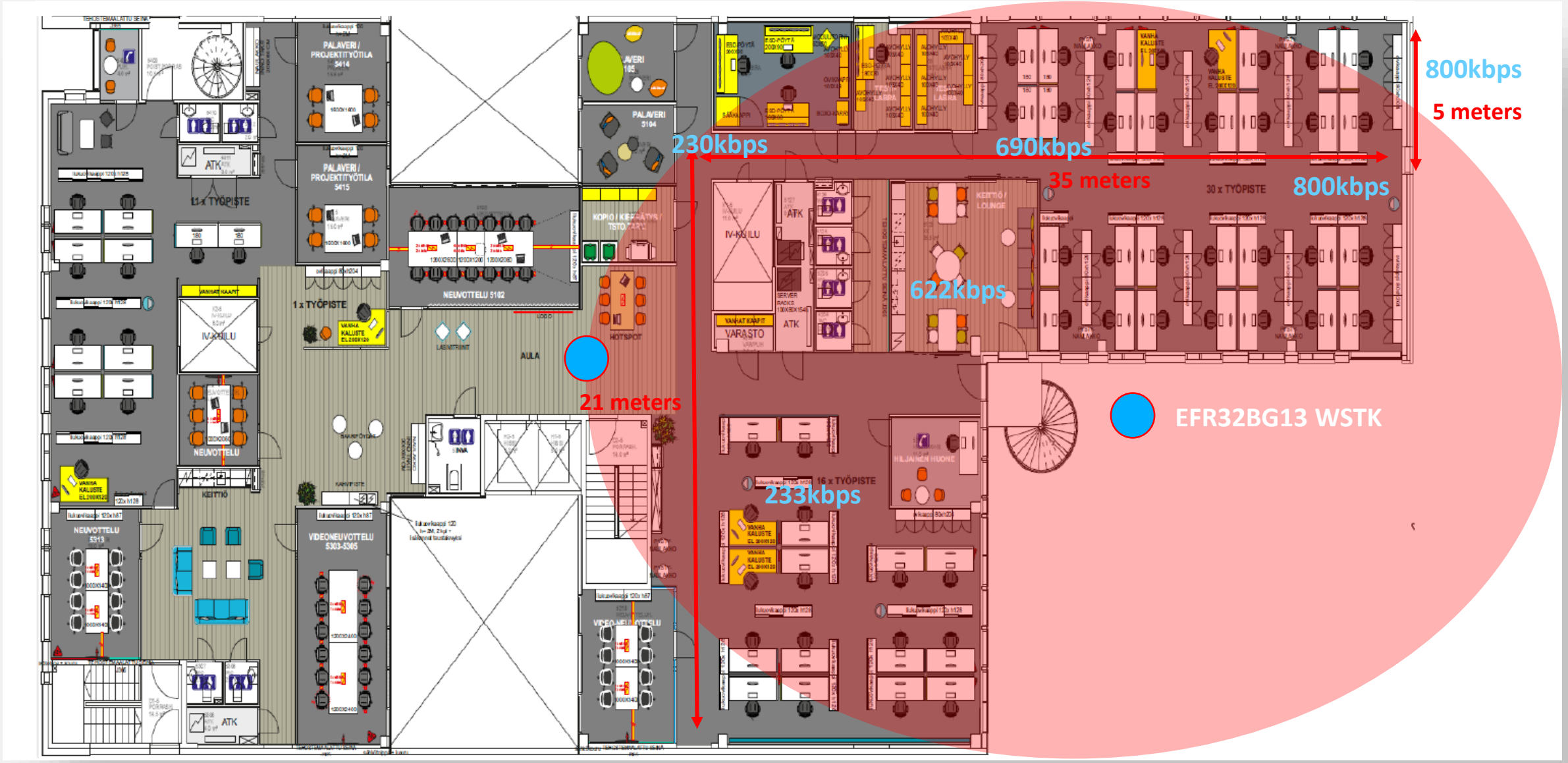
- Use 1M PHY but payload is coded at 125kbps or 500kbps
- Also adds Forward Error Correction and Pattern Mapper
- Improves sensitivity from 4 to 6dB and this means roughly 2x range
- LE Coded PHY can also be used for advertisement

Up to 2x range improvement

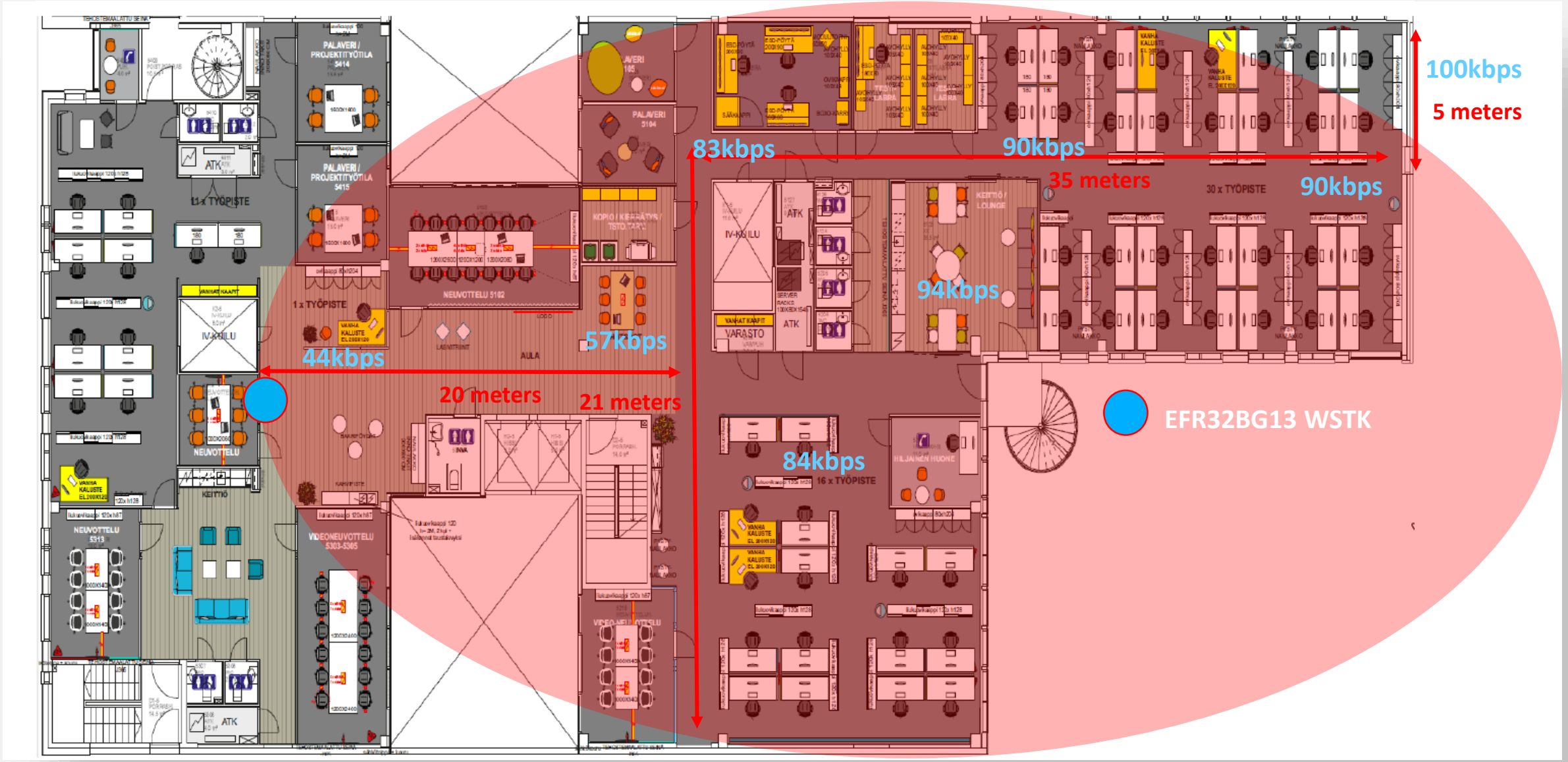
However, reduces throughput and increases TX/RX times (current consumption)

Coded PHY	Symbol rate	Error correction	Range multiplier	PDU Length	Minimum packet time	Maximum packet time	Maximum throughput
500 kbps	1 M symbols/s	FEC	1.5x	0–257 B	462 µs	4.54 ms	382 kbps
125 kbps	1 M symbols/s	FEC	2x	0–257 B	720 µs	17.04 ms	112 kbps

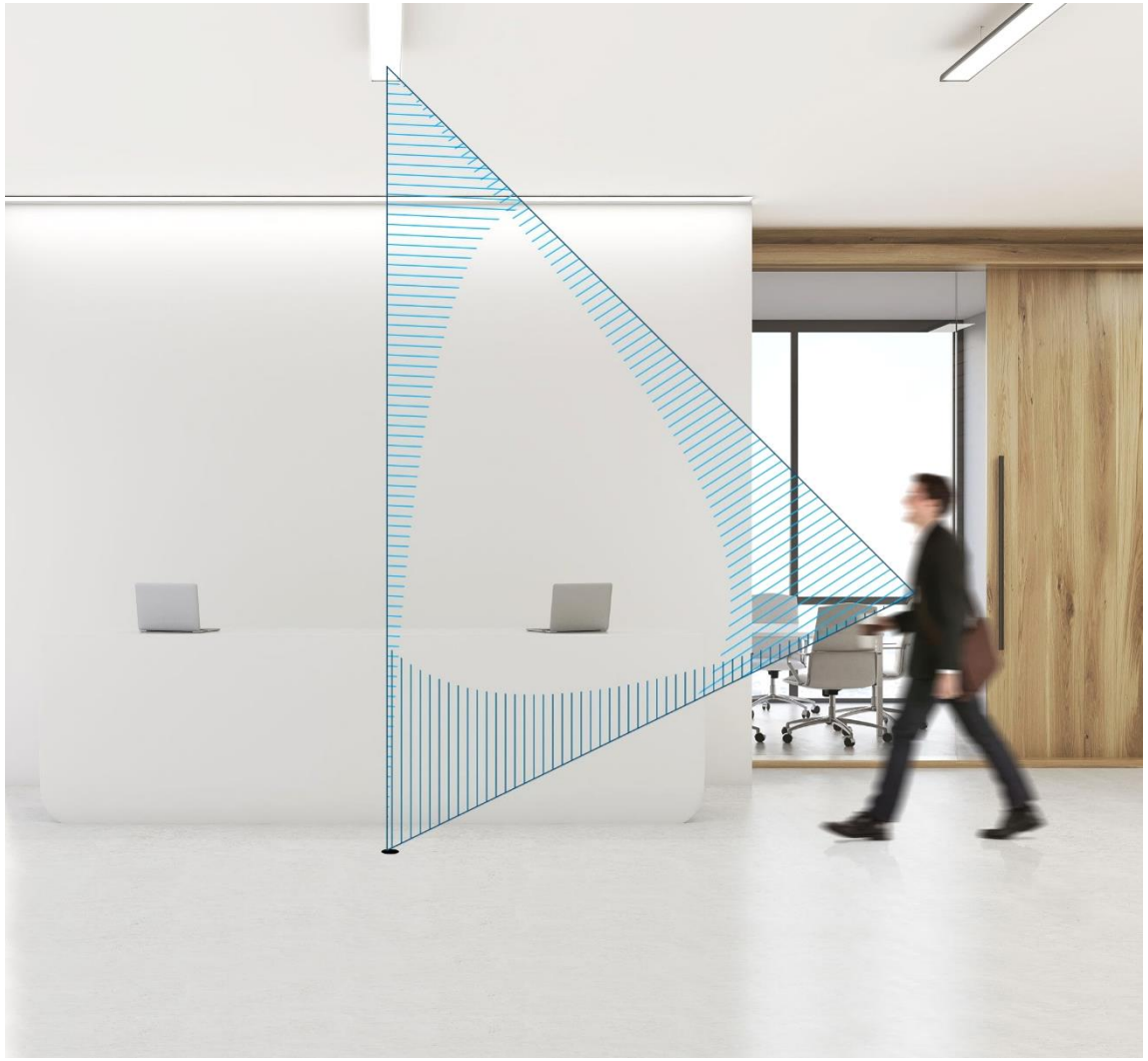
EFR32BG13 to EFR32BG13 Indoor Range: +10dBm, 1M PHY, PCB antenna



EFR32BG13 to EFR32BG13 Indoor Range: +10dBm, 125k PHY, PCB antenna



Bluetooth 5.1 Summary



Direction finding

- Detecting Bluetooth signal direction with AoA
- Adding signal direction to outgoing packets with AoD
- Benefits asset tracking and indoor positioning applications
- <1m accuracy vs. 3-5m accuracy with RSSI

Faster and lower power connections

- GATT caching
- Reduces need for GATT service discovery
- Faster and lower power connections

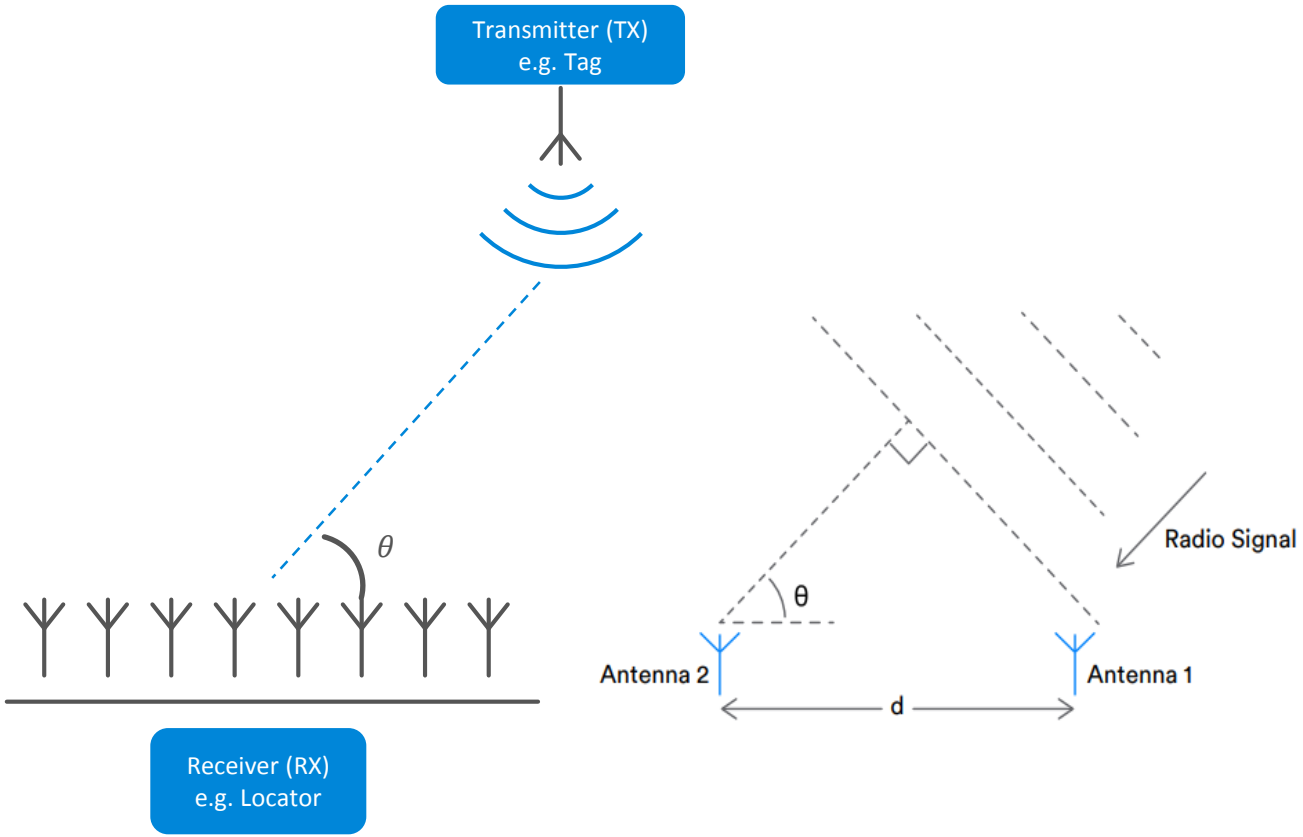
Reduced interference for busy RF environments

- Randomizing the advertisement packet collisions
- Reduces the number of packet collisions and improves PER

Periodic advertising sync transfer

- Transfer of periodic advertising sync between devices

How Angle-of-Arrival (AoA) Works?



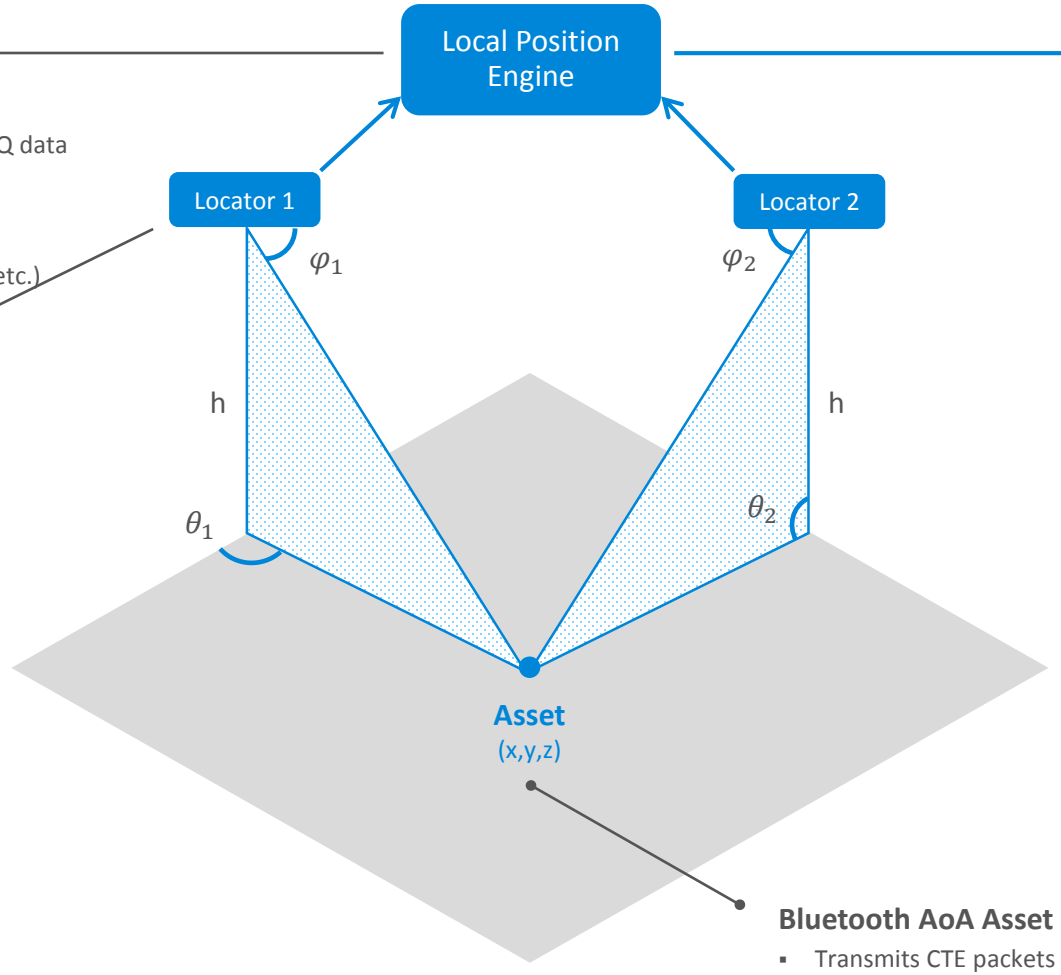
An asset wants to broadcast its location

- Continuous tone extension (CTE) is added to the end of a Bluetooth advertisement or connection packet
- Asset can support other Bluetooth functions while being tracked as CTE does not use the payload

A locator wants to find the asset

- A locator needs to have multiple antennas, as antenna is switched during the CTE reception
- A locator listens for CTE packets and measures IQ data from the CTE payload
- Can perform spherical azimuth and elevation calculation, or pass the IQ data forward to back-end processing

How AoA Works at a System Level?



Local Position Engine

- Collects relative raw or pre-processed IQ data from all locators
- Performs X,Yand Z calculations
- Additional applications (site planning zones, alerts, heat maps etc.)

Bluetooth AoA Locators

- While one locator can be used to estimate the assets location, a network of multiple locators improve accuracy and reliability
- Locators with enough processing power can pre-process to IQ data

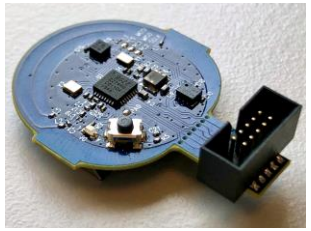
Cloud Position Engine

Cloud Position Engine

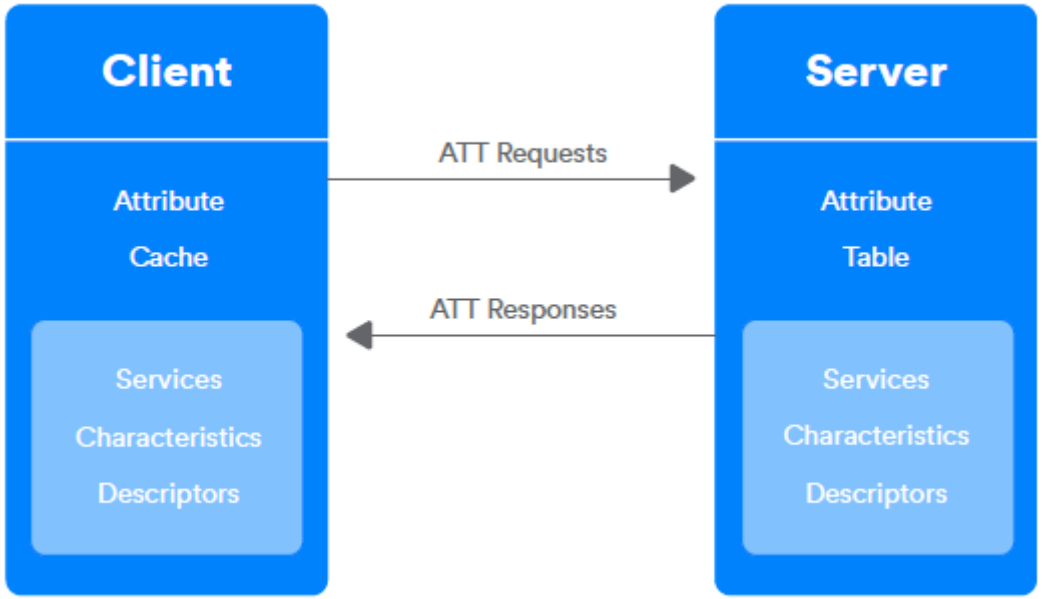
- Collects relative raw or pre-processed IQ data from all locators
- Performs X,Yand Z calculations
- Additional applications (site planning zones, alerts, heat maps etc.)

Bluetooth AoA Asset

- Transmits CTE packets



GATT Caching



How it works?

- A hash value is calculated over the GATT service database
- Its value is exposed via Generic Attribute Service
- Reading the value does not require bonding

Benefits

- Client device can easily check if GATT database has changed
- Reduces the need for service discovery and therefore saves power and enables faster connections
- If client connects to multiple same type devices, can reduce the need for service discovery significantly

Applications that benefit

- Any that use connections

Bluetooth 5.2 Summary

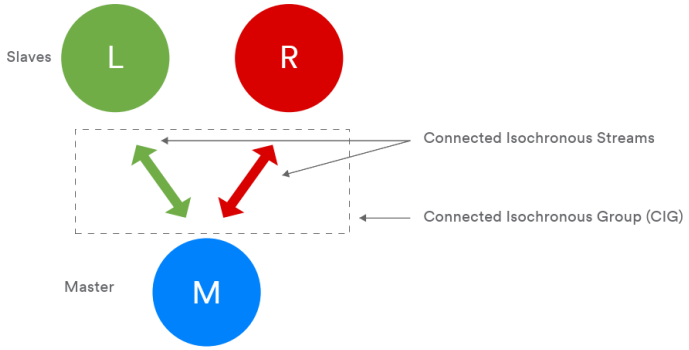


Figure 9 - Connection-oriented isochronous streams and group servicing left and right stereo ear buds

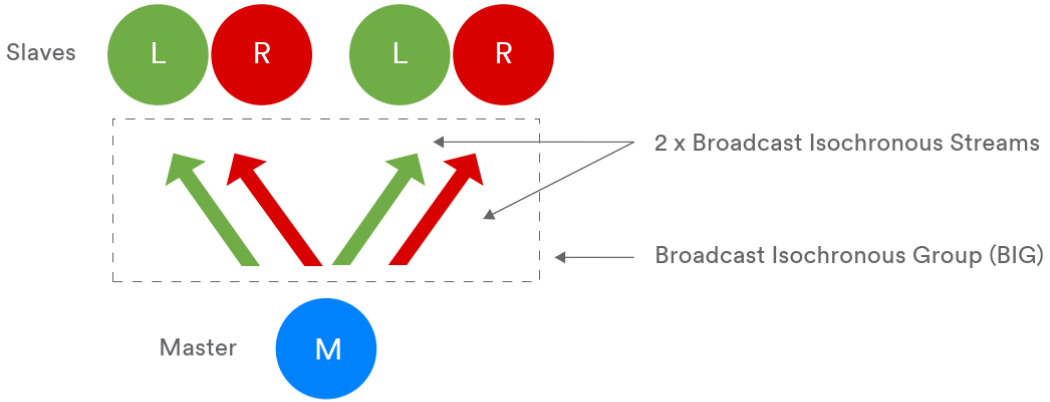


Figure 11 - Broadcast isochronous stream and group

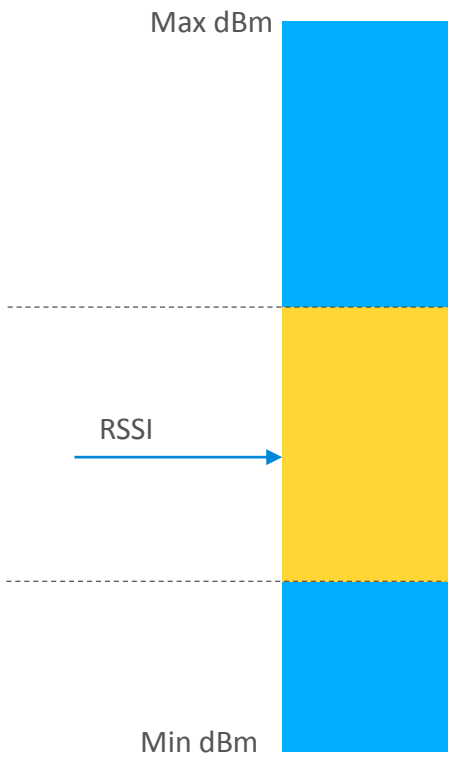
LE Isochronous Channels

- Time-bound data distribution to one or more devices
- LE Audio
- Low Complexity Communications Codec (LC3)
- Four Bluetooth LE PHYs (2M, 1M, 500K, 125K)
- Multi-Stream Audio
  - True Wireless Earbuds, Multi-room audio synchronization syst
- Broadcast Audio → Audio Sharing
  - Personal audio sharing
  - Location-based audio sharing: public venues

More reliable connections, lower power and better coexistence

- LE Power Control
- Reduction of overall power consumption by dynamic power management conducted between connected devices.
- Improvements in reliability through the active maintenance of receiver signal strength
- Improvements relating to coexistence with other wireless devices that are in the environment and are using the 2.4 GHz frequency range.

LE Power Control



How it works?

- Dynamic changing of the Transmitter Power level based on Receiver RSSI
- Allows receiving device to be on the *Golden Receiving Range*
  - RSSI is too low – request to increase TX power
  - RSSI is in the optimal range – no need to change
  - RSSI is too high – request to decrease TX power
- Monitors and reports path loss

Benefits

- Optimization on Power from TX and RX sides
- Improvement on Reliability and requiring less retries
- Better Over the Air Coexistence with other 2.4GHz devices
- Better user experience in terms of throughput and responsiveness.

Applications that benefit

- Any that use connections

BG21: Optimized for Secure Mains Powered Devices

Bluetooth®

BG21 can be paired with Energy Friendly Power Management IC *to reduce active TX/RX current consumption:*
https://www.silabs.com/power/efp01-power-management-ic

Radio
Up to +20 dBm TX
-97.5 dBm @1 Mbps RX sensitivity
Bluetooth 5.1

Current Consumption
8.8 mA RX (1 Mbit/s GFSK)
10.5 mA TX @ 0 dBm
33.8 mA TX @ 10 dBm
4-8uA EM2 (DeepSleep Mode)

World Class Protocol Stacks
Bluetooth 5.1 and Bluetooth mesh
Apple HomeKit protocol

Compact Size
4x4 QFN32 (20 GPIO)

Operating Temp.
-40 to 125 °C ambient

ARM Cortex-M33 with TrustZone
38.4/80 MHz
FPU and DSP
Up to 96kB RAM and 1024kB flash
50.9 µA/MHz

Peripherals Fit for Purpose
3x USART, 2x I2C
1x 12-bit ADC, 2x ACMP
7x timers
Up to 20x GPIO

Security
True Random Number Generator
Hardware Accelerated Crypto Engine
Secure Boot with root of trust
Secure debug with lock/unlock
DPA Countermeasures

With Secure Vault™
Anti tamper
Secure attestation
Secure key management and storage
Advanced crypto

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 @ 0dBm 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

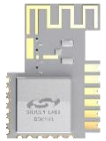
Security
AES128/256,SHA-1, SHA-2 (256-bit)
ECC (up to 256-bit), ECDSA and ECDH
True Random Number Generator (TRNG)
Secure boot with RTSL
Secure debug with lock/unlock

Silicon Labs' Bluetooth SoC Families

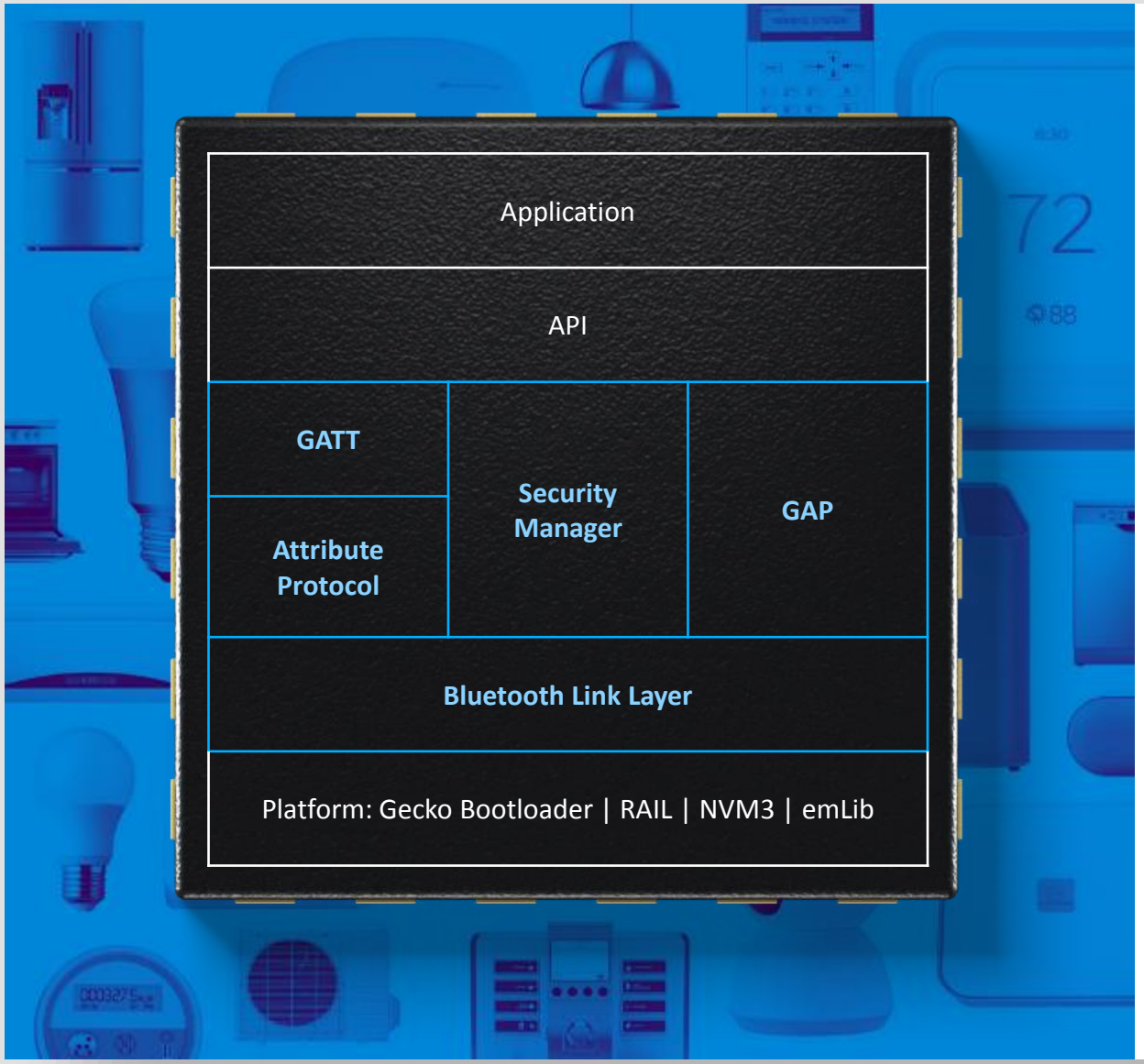
	Series 1 - BG13	Series 2 - BG21	Series 2 - BG22
Target applications	General purpose Bluetooth LE and mesh	Mains powered Bluetooth LE and mesh	Lowest power Bluetooth LE, Direction Finding and Bluetooth mesh LPNs
Bluetooth features	5.1 and mesh 1.0 (1M, 2M, LE Coded PHYs and AE)	5.1 and mesh 1.0 (1M, 2M, LE Coded PHYs and AE)	5.2 and Bluetooth mesh LPN (1M, 2M, LE Coded PHYs, AE and AoA/D)
Proprietary 2.4G	2/4(G)FSK, OQPSK/(G)MSK, DSSS, BPSK/DBPSK TX, OOK/ASK	N/A	2/4(G)FSK, (G)MSK, OQPSK, DSSS
TX / RX (1M, GFSK)	+19 dBm / -95.8 dBm	+20 dBm / -97.5 dBm	+6 dBm / -99 dBm
TX Current (0 dBm)	10.5 mA	10.5 mA	4.1 mA* 8.2 mA (6 dBm)*
RX Current (1M, GFSK)	9.5 mA	8.8 mA	3.6 mA
CPU / Clock Speed	Cortex M4 (38.4 MHz)	Cortex M33 (80 MHz)	Cortex M33 (up to 76.8 MHz) Cortex M0+ for radio
Flash (kB)	512	Up to 1024	Up to 512
RAM (kB)	64	Up to 96	32
Sleep Current (EM2)	1.3 µA (16 kB RAM)	4.5 µA (96 RAM)	1.21 µA (8 kB RAM) - 1.4 µA (32 kB RAM)
Active Current (EM0)	70 µA/MHz	51 µA/MHz	25 µA/MHz
Security	2x AES-128/256, ECC, SHA-1/224/256, TRNG	AES-128/256, SHA-1/2 ECC, ECDSA and TRNG DPA countermeasures Secure boot with RTSL Secure debug with debug lock/unlock	AES-128/256, SHA-1/2 ECC, ECDSA and TRNG Secure boot with RTSL Secure debug with debug lock/unlock
Operating Voltage	1.8V – 3.6V	1.8V – 3.8V	1.71V – 3.8V
Packages (mm)	7x7 QFN48, 5x5 QFN32	4x4 QFN32 (20x GPIO)	5x5 QFN40 (26x GPIO) 4x4 QFN32, TQFN32 (18x GPIO)

* MCU + radio value

Silicon Labs' Bluetooth Module Families

						
	BGM13P	**BGM13S**	**BGM210P**	**BGM210L**	**BGM220P (Q2'20)**	**BGM220S (Q2'20)**
Protocols	5.1 and mesh (1M, 2M, Coded PHY and AE)	5.1 and mesh (1M, 2M, Coded PHY and AE)	5.1 and mesh 1.0 (1M, 2M, Coded PHY and AE)	5.1 and mesh 1.0 (1M, 2M, Coded PHY and AE)	5.2 and mesh 1.0 LPN (1M, 2M, Coded PHY, AE and AoA/D)	5.2 and mesh 1.0 LPN (1M, 2M, Coded PHY, AE and AoA/D)
EFR32 SoC	BG13	BG13	BG21	BG21	BG22	BG22
Antenna	Built-in or U.FL	Built-in or RF pin	Built-in or RF pin	Built-in	Built-in	Built-in or RF pin
Max TX power	+8 / +19 dBm	+8 / +18 dBm	+10 / +20 dBm	+12.5 dBm	+8 dBm	+6 dBm
Sensitivity (1M)	-94.8 dBm	-94.1 dBm	-97 dBm	-97 dBm	-98 dBm	-98 dbm
Flash (kB)	512	512	1024	1024	512	512
RAM (kB)	64	64	96	96	32	32
GPIO	25	30	20	12	24,25	25
Operating Voltage	1.8V – 3.6V	1.8V – 3.6V	1.8 – 3.8V	1.8 – 3.8V	1.71V – 3.8V	1.71V – 3.8V
Operating Temp.	-40 to +85C	-40 to +85C	-40 to +125C	-40 to +125C	-40 to +105C	-40 to +105C
Dimensions W x L x H (mm)	13.0 x 15.0 x 2.2	6.5 x 6.5 x 1.4	13.0 x 15.0 x 2.2	13.0 x 15.0 x 2.2	13.0 x 15.0 x 2.2	6 x 6 x 1.3
Certifications	BT, CE, FCC, ISED, Japan, S-Korea and Taiwan	BT, CE, FCC, ISED, Japan & S-Korea	BT, CE, FCC, ISED, Japan & S-Korea	BT, CE, FCC, ISED, Japan & S-Korea	BT, CE, FCC, ISED, Japan & S-Korea	BT, CE, FCC, ISED, Japan & S-Korea

Bluetooth LE Software



A Bluetooth 5.2 compliant Bluetooth stack, with:

- Bluetooth 5.2 LE power control*
- Bluetooth 5.1 Direction Finding* and GATT cashing
- Bluetooth 5.0 standard features
- Relevant Bluetooth 4.x features

Packed with advanced functionality

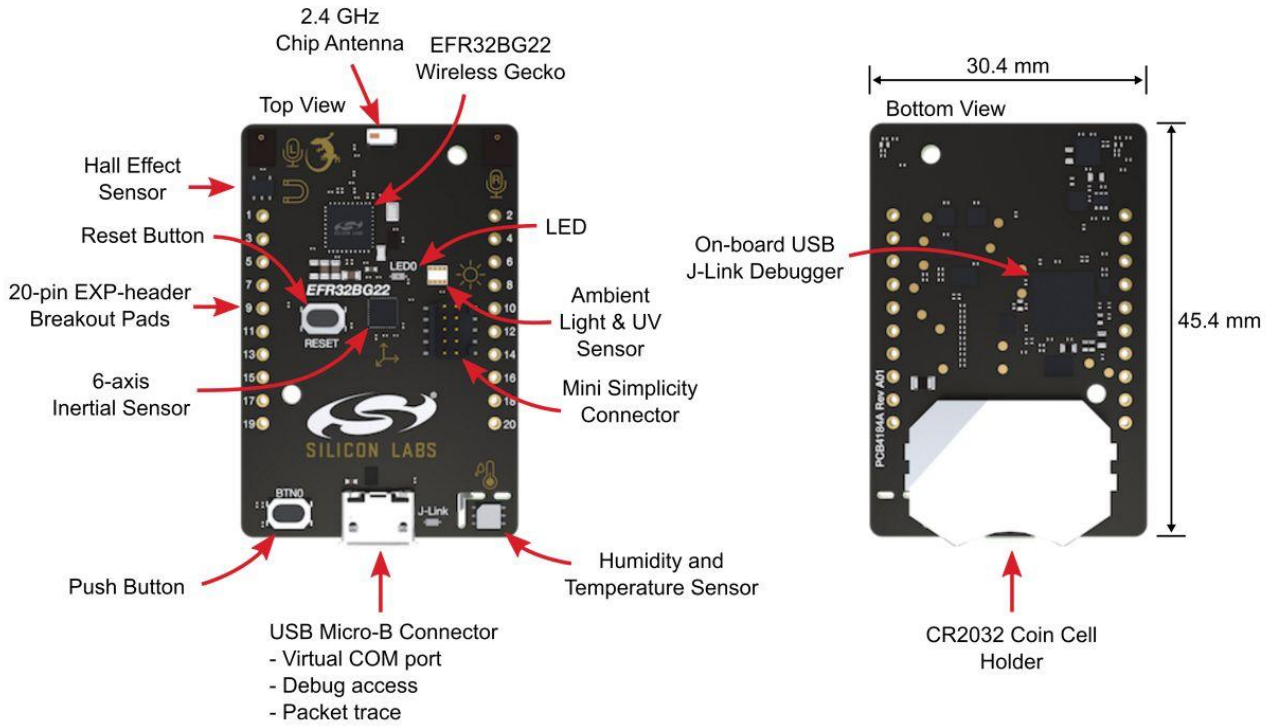
- Multiple connections and advertisers
- Concurrent advertising, scanning and LE connections
- Optimized throughput and power consumption

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

Software and reference designs availability in H2'20.

Thunderboard BG22



- Bluetooth 5.2 BG22 Soc
- Relative Humidity Sensor
- Ambient Light and UV Index Sensor
- Hall effect sensor
- 6 axis Gyro and Accel Sensor (Asset Tags and Beacons)
- 2 Digital mems Microphones with PDM output
- Built-in Debugger
- Free iPhone and Android App
- $19.99

BG22 Virtual Workshop

Learn how to develop and deploy more powerful, efficient, and secure IoT products with your own BG22 Thunderboard – free for all registrants!

Asia Pacific (Mandarin): June 17th - June 19th , 2020

10:00AM –11:30 HKT

(Other sessions available for Americas and Europe)

Register today! https://cn.silabs.com/about-us/events/virtual-bluetooth-workshop

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Thank You | Questions

Any query, please contact us or email to Winking.He@silabs.com

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