

IOT106

Bluetooth Trends of Today and Tomorrow



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Agenda

Past

- Bluetooth Low Energy standard and initial goals
- Pre 5.0 Bluetooth Low Energy Feature overview

Present

- Bluetooth 5.0 - big changes, major rev
- 5.x key features: Mesh, Audio, PaWR
- Bluetooth 6.0 – the next big step

Future

- High Data Throughput
- Higher Bands operation

Bluetooth Timeline

Bluetooth 4.0 Introducing Bluetooth Low Energy

Top three reasons why BLE was introduced

1. Long Battery Life
2. Efficient Data Transmission
3. Flexible connection topologies to unlock new use cases

Bluetooth 6.0

Channel Sounding

Advertisement filtering enhancements for Mesh

Isochronous channel updates for Bluetooth audio

Ancient Past with What We Now Call Bluetooth Classic

Key features:

First profile for cable replacement (SPP)

A2DP audio streaming

Multiple PHYs

Bluetooth 5.x

Higher Data Rates (5.0)

LE Coded Phy (5.0)

Location Services (AoX) – 5.1

LE Audio – 5.2

Advertising Enhancements – 5.3

PAwR – 5.4

Bluetooth Mesh

Bluetooth 4.x

4.x Features



4.0

Low energy technology feature to conserve power in connected state

Bluetooth Smart Ready

Bluetooth Smart devices with extended Battery life



4.1

Enhanced Co-existence - allows Bluetooth and LTE radios to communicate smoothly.

IP-based connections support – Initial step to support IoT applications.

"Peripheral and Hubs" support with Improved data transfer.



4.2

Improved Internet connectivity.

Enhanced Privacy with faster data transfer.

Power efficient with longer range.

Bluetooth 5.x

2M and LE Coded PHY

2M PHY – For higher data transfer

What is it:

- Optional New physical layer (PHY) with 2x symbol rate compared to legacy 1M PHY

Why is this important

- Saves power by reducing RF TX on time through faster transmission
- Improves user experience for large data transfers like device firmware update (DFU)

LE coded PHY – for longer range

What is it:

- Optional symbol coding schemes with forward error correction (FEC)

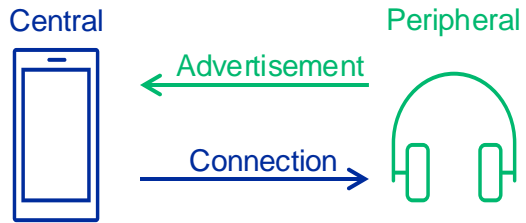
Why is this important

- Extends range by up to 4x for BLE connections
- Multiple coding schemes give users flexibility between bit rate and range

Bluetooth SIG bumps the major digit in the revision based on changes to PHY or inclusion of additional PHY. These PHY changes are why the release is 5.0 instead of 4.3.

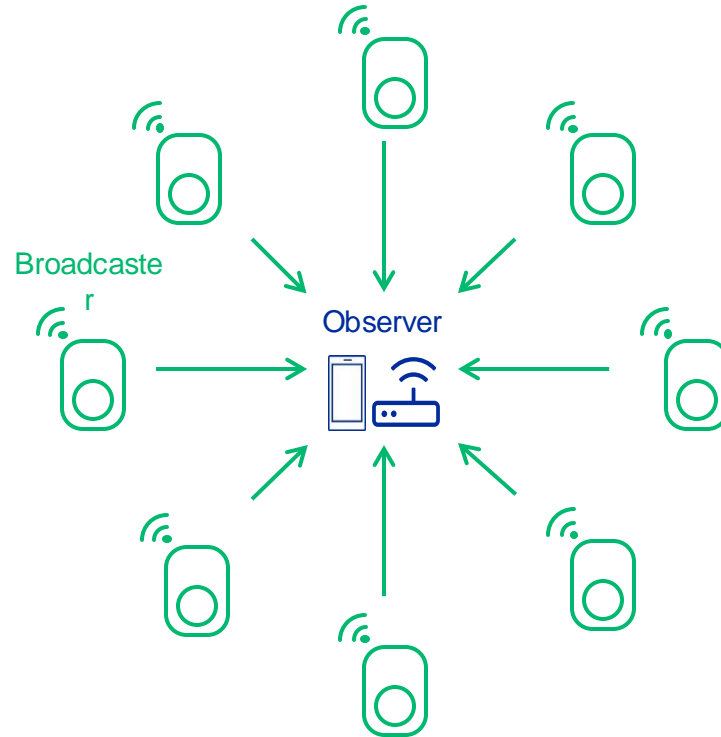
Advertising Modes in Bluetooth 5.4

Advertising for Connection (irregular, unidirectional)



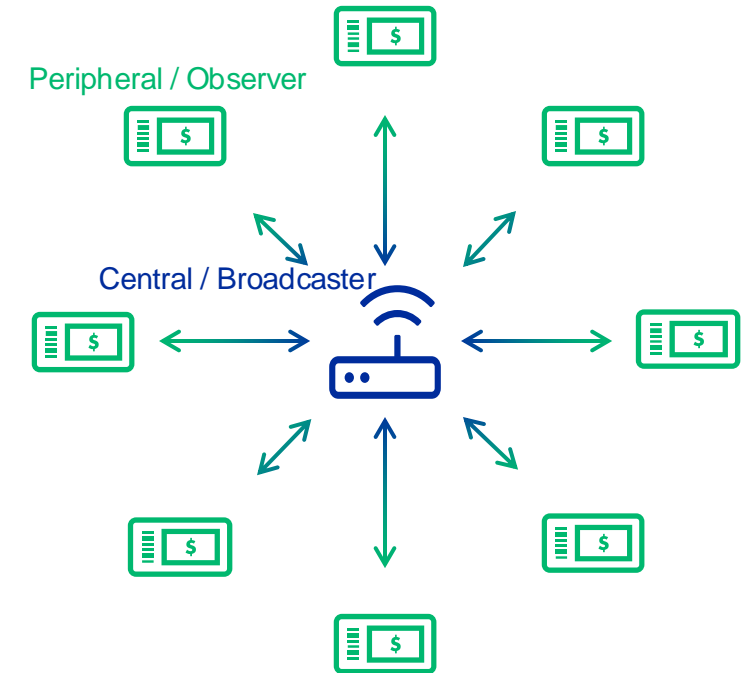
Max number of connections: **32**

One-way "Beaconing" (regular, unidirectional)



Max number of beacons:
limited by channel capacity to a **few 1000s**
(unsynchronized nature causes collisions)

Periodic Advertising with Responses (regular, bidirectional)



Max number of Peripherals: **32,767**
New mode enabling "Synchronized" mode network.

Periodic Advertisement with Responses (PAwR) Explained

PAwR train setup

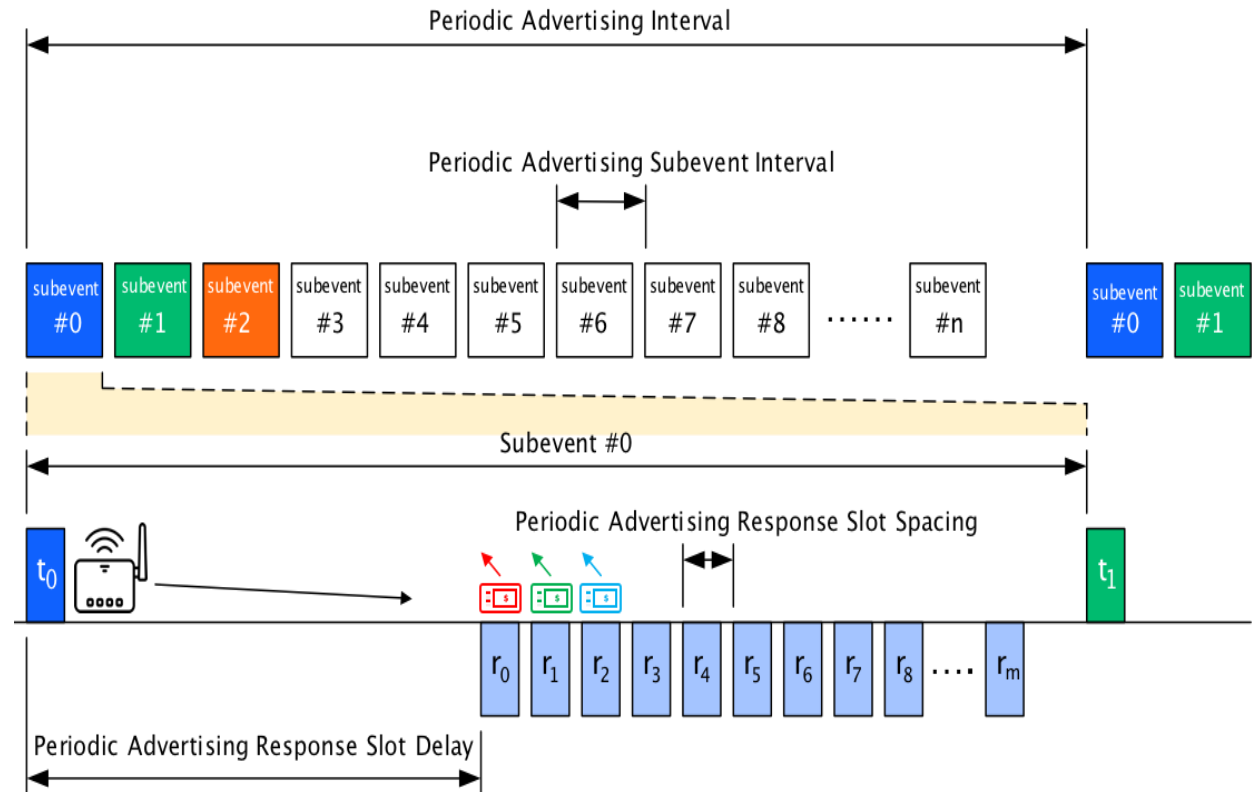
- Sets timing parameters
- Configure number of Subevents and Response Slots

Subevents

- Each Peripheral belongs to one Subevent
- Maximum 128 Subevents
- Maximum 255 Peripherals in one Subevent (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
- A given number of Peripherals can respond in dynamically allocated response slots (uplink)





Bluetooth Audio Overview

- Introduced in Bluetooth 5.2 in 2020
- Connection-oriented audio and broadcast ('Auracast') audio
- Based on use of isochronous streaming channels

Key Advantages Over Legacy Bluetooth Audio

- Generic Audio Framework (GAF) provides more flexible connectivity options
- Standardized LC3 codec provides audio quality equal to legacy Bluetooth audio
- More efficient link management over Low Energy connection for lower energy consumption

The Promise of Auracas

- Connection-oriented Bluetooth LE audio is a replacement to Bluetooth Classic
 - Addressing most of the same use cases
 - Expected 'long tail' of support for Classic as accessories begin supporting LE audio over the next 5+ years
- Auracast opens up new use cases not possible with connection-oriented audio
 - Audio retro-fitting of spaces for the hearing impaired
 - Broadcast announcements in public spaces
 - New audio experiences in entertainment venues

Bluetooth Mesh Overview



NETWORKED LIGHTING CONTROL (NLC)

- Commercial
- Residential
- Street lighting

SMART HOME & BUILDING AUTOMATION

- HVAC
- Switches
- Sensors



Easier Smart Phone Connectivity



Optional Gateway



Scalability and Security

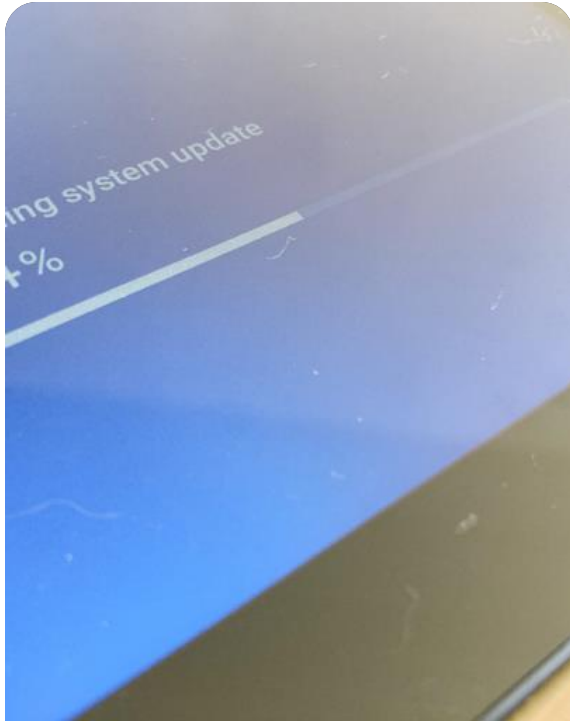


Easy Extendibility and Flexibility



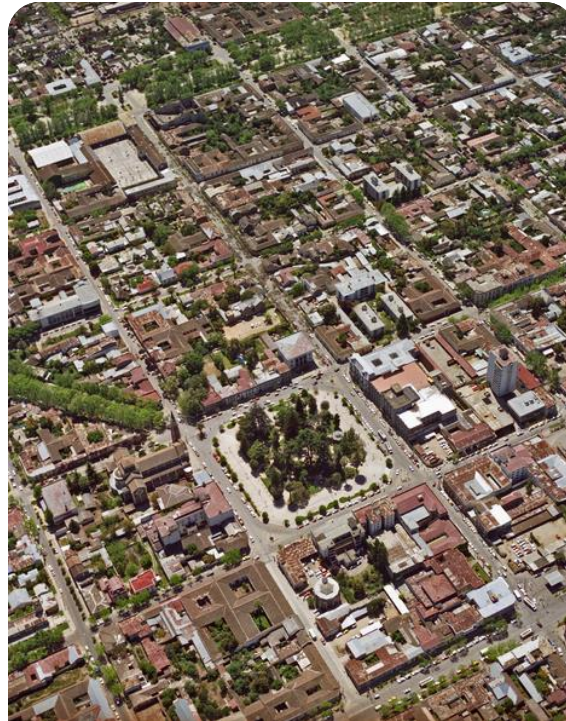
Value Added Service

Bluetooth Mesh 1.1 Enhancements



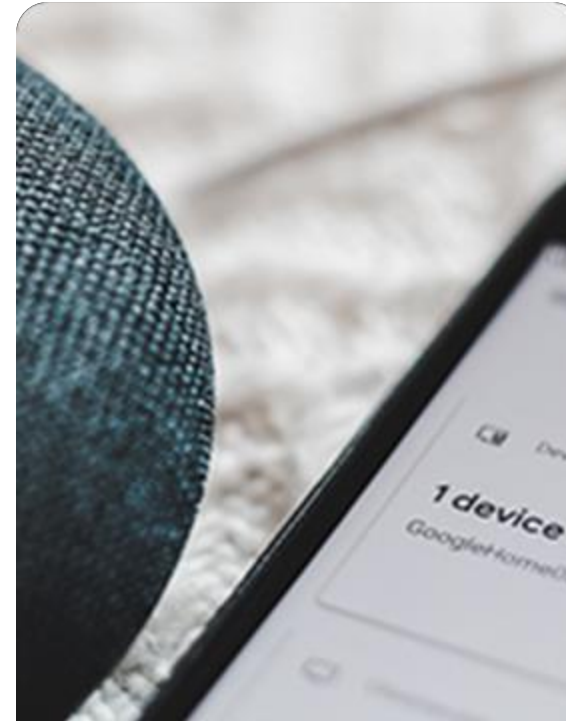
SIMPLIFIED NETWORK UPGRADE

- Automatic check for new firmware with installation
- Standardize Over-the-Air firmware updates for any vendor
- Simultaneous update for homogenous devices
- Reduces time, cost, and complexity



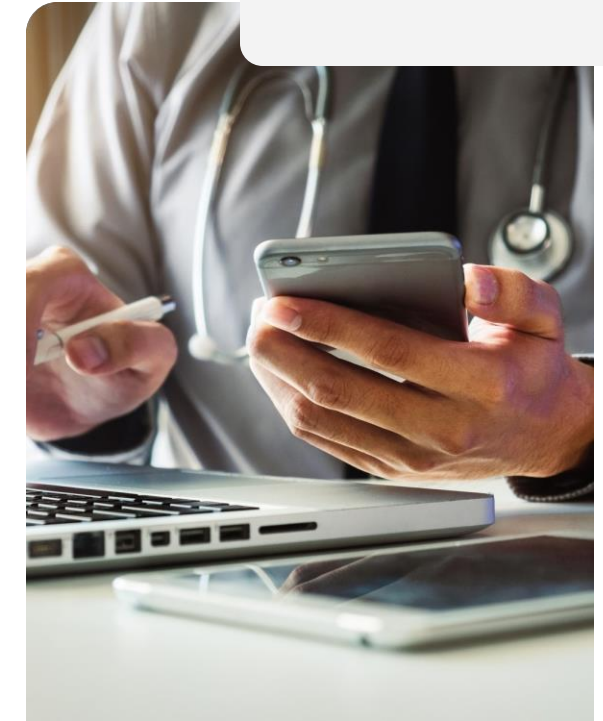
SCALABILITY MADE EASY

- Scalable commissioning in large deployments
- Provisioner **NO LONGER** needs to be within radio range of device getting provisioned
- Enables faster and simpler network setup



PLUG AND PLAY

- Automatic detection of change in device ownership
- Reset nodes for security and identity purposes in case of change in device ownership
- Eliminates the need to reset, reprovision, and reconfigure



INCREASE NETWORK SECURITY & PRIVACY

- Onboarding authenticated devices
- Certificates to authenticate devices before provisioning
- Prevent tracking of devices within network

Bluetooth Mesh 1.1 Features



EFR32BG26/24/21

Supports all Bluetooth mesh features
(Relay, Proxy, Friend etc.)
768-1536kB flash recommended for OTA

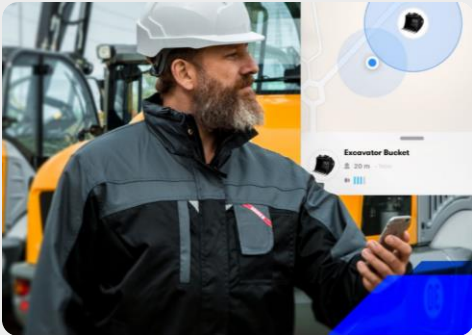


EFR32BG27

Supports the following Bluetooth
mesh features - Relay, Proxy, Friend
DFU – Updating node only

Feature	Value(s)
Certificate Based Provisioning	<ul style="list-style-type: none">Use certificates to authenticate devices before provisioning, thus saving cost and time.Prevents counterfeit devices from being provisioned into the network
Remote Provisioning	<ul style="list-style-type: none">Provisions even when the nodes are not in direct radio range of the provisioner, thereby reducing installation cost and time
Private Beacons	<ul style="list-style-type: none">Does not allow for static information in beacons to be shared outside of the network
Device Firmware Update	<ul style="list-style-type: none">Standardized way to do simultaneous DFU for homogenous devices, reducing cost and timeZero downtime as nodes continue to operate normally while being updated with new firmware
Directed Forwarding	<ul style="list-style-type: none">Improves network scalability by utilizing forwarding nodes with optimized paths and lanes to ensure efficient message delivery
Subnet Bridging	<ul style="list-style-type: none">Allows communication between devices in different subnets

Bluetooth Low Energy 5.x Innovations



LOCATION SERVICES

- Enhances location awareness
- Distance estimation and positioning
- Enhances location tracking with Angle of Arrival (AoA) and Angle of Departure (AoD)



DATA TRANSFER

- 2 Mbps PHY
- Faster PHY is the reduced time required for transmitting and receiving data, which leads to lower average current consumption
- Faster data transfers for use cases like over-the-air (OTA) firmware upgrades or transmitting of days' worth of collected data from a sensor



DEVICE NETWORKS

- 4x the range of Bluetooth 4.x for robust and reliable connections
- New use cases for outdoor, industrial, and commercial applications
- Contains two additional optional PHYs called LE Coded PHYs in addition to the 2M PHY, which improves RX sensitivity, which also improves range



AUDIO STREAMING

- Compared to Bluetooth Classic audio, Bluetooth Low Energy audio streaming:
- Consumes lower power
- Offers higher perceived quality
- Provides more flexible configuration options
- Unlocks new use cases with connectionless 'Auracast' audio

Bluetooth 6

Channel Sounding

What is it:

- Distance measurement between two Bluetooth LE devices using:
 - Round Trip Time (RTT)
 - Phase-based Ranging (PBR)

RTT and PBR performed on multiple RF channels

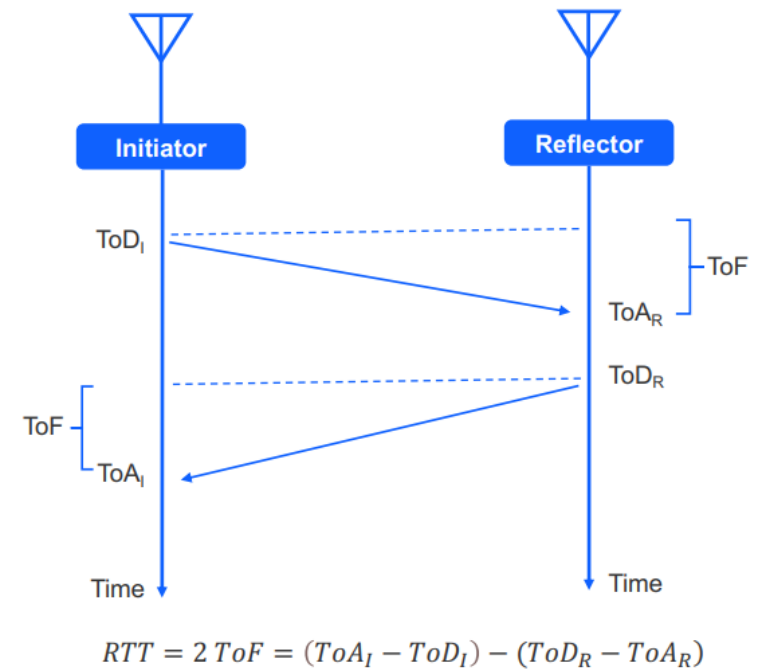
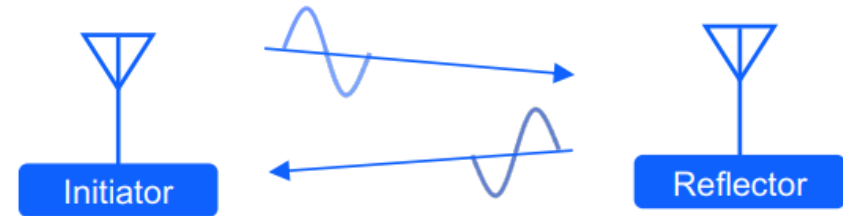
- Standard specifies up to 72 channels
- Random hopping pattern

Connection-Oriented 2-way ranging

- Initiator and reflector roles
- Data transfer from reflector to initiator for processing
- Multiple antennas can be used to improve performance

Why this is important

- Fine ranging for new UI features, no extra chips required
- Brings spatial awareness to the IoT



Other Bluetooth 6.0 features



Feature	Definition	Applications
Decision-based advertising filtering	Optimization to efficiently filter extended advertisements	Bluetooth Mesh Applications with connectionless high bandwidth data transfers
Enhancements for isochronous channels	New data frame for isochronous PDUs	Bluetooth LE audio streaming
Frame space update	Enables adjustable spacing between transmitted packets	Bluetooth LE audio streaming Device firmware updates
Monitoring advertisers	HCI commands to alert host stack when advertisers go into range or leave range	'Find My' applications with presence detection or geofencing

Features of the Next-Generation Bluetooth

Bluetooth Specifications in development

High Data Throughput (HDT)

- The 'next step' after the 2M PHY introduced in 2016
- New PHYs will support up to 8 Mbps data rate
- Enhances performance and opens up new use cases for LE audio

Higher Band (HB)

- Specification expands Bluetooth beyond 2.4 GHz, into the 5-6 GHz spectrum
- Ensures better coexistence as 2.4 GHz band becomes more crowded
- Improves data throughput, lowers latency, and promises to improve Channel Sounding accuracy

Like so many innovations before them, HDT and HB expand Bluetooth's reach into new applications, pushing standardization of wireless communication still further

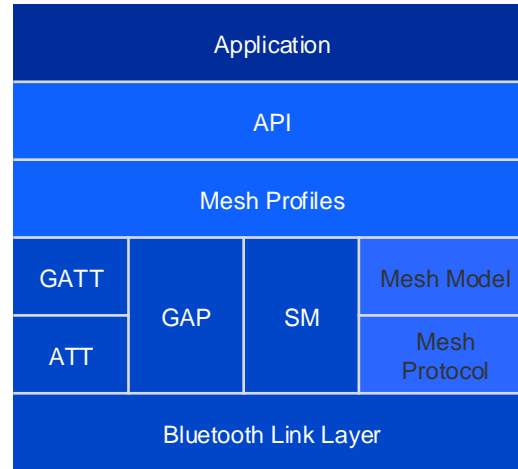
SiLabs Offering

A Complete Solution for Enabling Bluetooth Products



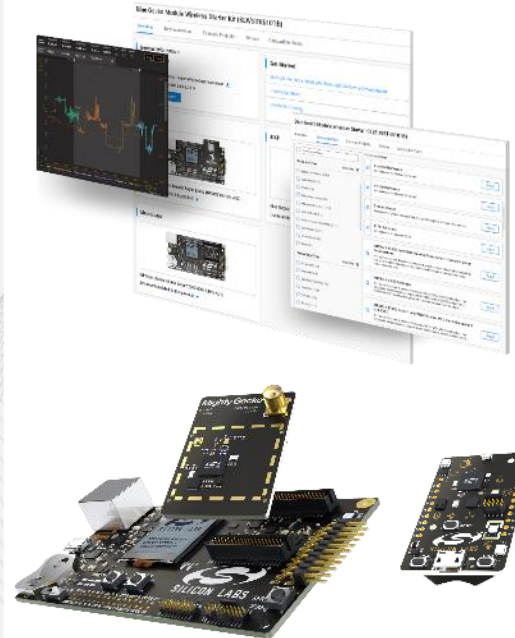
SoCS AND MODULES

Industry leading Bluetooth 5.4 SoCs and pre-certified modules



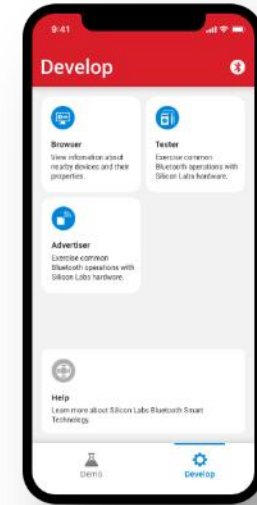
STACK SOFTWARE

In-house developed stacks with latest Bluetooth 5.4 and Bluetooth mesh features



DEVELOPMENT TOOLS

Advanced development hardware and software simplify development and speed time to market



MOBILE APPLICATIONS

Reference applications and source code for iOS and Android

Phone interoperability test program

Bluetooth Portfolio

Increasing Features



BG22/22E SoC



BGM220S SiP & PCB Modules

Industry-leading energy efficient SoC

BG22

- Lowest power Bluetooth LE
- Direction Finding
- Bluetooth Mesh LPNs
- SoC, PCB Module and SiP
- Balance of features, size, power, cost

BG22E

- Efficient, low-energy cold start
- Low-energy deep sleep wake-up
- Power-efficient energy mode transitions
- Bluetooth Mesh LPNs



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)
- 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



BG24 SoC



BGM240S SiP & PCB Modules

Feature rich device with Highest integration

- High I/O pin count
- AI/ML hardware accelerator
- High sensing ADC
- Small form factor WLCSP
- Secure Vault High, PSA L3
- Bluetooth mesh



BG26 SoC

Maximum Flash and RAM ensuring device longevity

- Largest Flash/RAM
- High I/O pin count
- Secure Vault High, PSA L3
- Robust RF Performance
- AI/ML Accelerator
- High sensing ADC
- Bluetooth Mesh
- Available in BGA packages

Increasing Flash/RAM

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RESOURCES

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