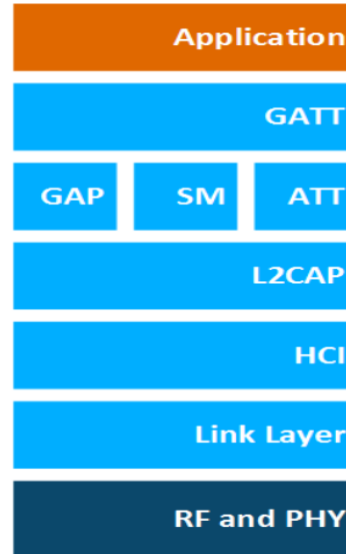# Bluetooth Low Energy

Overview

Bluetooth version 4.0 introduced Bluetooth with low energy functionality. Bluetooth low energy technology allows for short bursts of long-range radio connections, making it ideal for applications that depend on long battery life and don't need high throughput streaming data. Developers are now able to create sensors that can run on coin-cell batteries for months and even years. Bluetooth low energy technology is built on an entirely new development framework using GATT (Generic Attributes). Silicon Labs supports the latest version of the Bluetooth® Core Specification, Bluetooth™ LE 5.4. This enables customers to claim compliance with the latest Bluetooth spec.

Bluetooth Low Energy Architecture

The Bluetooth Low Energy architecture components are as follows:

Physical Layer: Controls radio transmission/receiving.

Link Layer: Defines packet structure, includes the state machine and radio control, and provides link layer-level encryption.

HCI: A Host-to-Controller interface (HCI) standardizes communication between the controller and the host.

L2CAP: Logical Link Control and Adaptation Protocol acts as a protocol multiplexer and handles segmentation and reassembly of packets.

ATT: Attribute protocol provides means to transmit data between Bluetooth low energy devices.

SM: Security Manager provides means for bonding devices, encrypting and decrypting data, and enabling device privacy

GAP: Generic Access Profile layer provides means for Bluetooth low energy devices to advertise themselves or other devices, make device discovery, open and manage connections, and broadcast data.

GATT: GATT is used to group individual attributes into logical services GATT also provides information about the attributes, that is, how they can be accessed and what security level is needed.

Key Features of Silicon Labs Bluetooth Low Energy Stack

Feature	Benefit
Core Features	Direction finding, Periodic Advertising with Responses (PAwR), Encrypted Advertising Data (EAD), Advertisement Extensions, Periodic Advertising, LE secure connections, 2M PHY, Long Range, AFH, LE Privacy 1.2 (peripheral), LE packet length extensions, Accept List (central side), GATT, & GATT Caching
Scalable AoA	Scale to AoA to few hundred devices simultaneously
Certificate Based Authentication and Pairing (CBAP)	Use certificates to authenticate devices before provisioning, thus saving cost and time. Also, prevents counterfeit devices from being provisioned into the network

Silicon Labs Bluetooth stack supports three modes:

Standalone mode: Bluetooth stack and the application run in an EFR32SoC or module

Network Co-Processor mode: Bluetooth stack runs on the EFR32, and the application runs on a separate host MCU. API is exposed over a serial interface such as UART.

Radio Co-Processor mode: Link layer of the Bluetooth stack runs on the EFR32, and the Host Layer of the stack, as well as the application runs on a separate host MCU or PC. Link Layer and Host Layer communicate via HCI.

Silicon Labs' Bluetooth Low Energy HW support

BG24	BG22	BG21	BG27
High Performance device for Bluetooth LE and Bluetooth mesh applications that require advance features and more Flash and RAM	Industry-leading, energy efficient device for Bluetooth LE applications	Optimized for line-powered devices including LED bulbs, and gateways for Bluetooth LE and Bluetooth mesh	Most Battery Versatile SoC for Connected Health, Smart Home, Portable Products
1536kB Flash	**512kB** Flash	**1024kB** Flash	**768kB** Flash
256kB RAM	**32kB** RAM	**96kB** RAM	**64kB** RAM
TX power **19.5dBm**	TX power **6dBm**	TX power **20dBm**	TX power **8dBm**
-105.7dBm @ 125kbps	**-106.7dBm** @ 125kbps	**-104.9dBm** @ 125kbps	**-106.9dBm** @ 125kbps
-97.6dBm @ 1Mbit/s	**-98.9dBm** @ 1Mbit/s	**-97.5dBm** @ 1Mbit/s	**-99.2dBm** @ 1Mbit/s
-94.8dBm @ 2Mbit/s	**-96.2dBm** @ 2Mbit/s	**-94.4dBm** @ 2Mbit/s	**-96.3dBm** @ 2Mbit/s
RX current **4.4mA** @ 1Mbps	RX current **3.6mA** @ 1Mbps	RX current **8.8mA** @ 1Mbps	RX current **3.6mA** @ 1Mbps
TX current **5.0mA** @ 0dBm	TX current **4.1mA** @ 0dBm	TX current **9.3mA** @ 0dBm	TX current **4.1mA** @ 0dBm
1.3 µA Sleep current (**16kB**)	**1.26µA** Sleep current (**16kB**)	**+135 Junc. Temperature**	**1.26µA** Sleep current (16**kB**)
Robust peripheral set	Lowest Power Bluetooth LE	**Secure Vault High**	**Secure Vault Mid**
AI/ML hardware accelerator	**Secure Vault Mid**	Line-Powered Bluetooth LE	QFN40 5x5 (26)
Secure Vault High	QFN40 5x5 (26)	QFN32 4x4 (20)	QFN32 4x4 (18)
QFN40 5x5 (26)	QFN32 4x4 (18)		TQFN32 4x4 (18)
QFN48 6x6 (32)	TQFN32 4x4 (18)		

Silicon Labs' Bluetooth LE Development Kits

Silicon Labs' Bluetooth development kits are divided into three categories based on your development need:
- Rapid Prototyping
- Proof of Concept
- Advanced RF Development

For more information on the portfolio, check the link:

https://www.silabs.com/bluetooth-kits

Technical Resources

Bluetooth Low Energy xG24 Technical Library
Data Sheets, App Notes, and more

Bluetooth Low Energy xG21 Technical Library
Data Sheets, App Notes, and more

Bluetooth Low Energy xG22 Technical Library
Data Sheets, App Notes, and more

Bluetooth Low Energy xG27 Data Short

Bluetooth Low Energy API Documentation
Bluetooth Low Energy API documentation

Bluetooth LE Target Applications

- ESL
- Medical
- Direction Finding
- Smart Home
- Smart Tags
- Sensors
- Switches
- Building Automation
- HVAC

Bluetooth LE Software / Tools

Silicon Labs Bluetooth Low Energy SDK helps you build smooth, reliable, and secure wireless connectivity for your IoT applications.

Software and Tools features
- Supports Bluetooth™ LE 5.4
- Wi-Fi Coexistence
- Simplicity Studio IDE
- GATT Configurator
- Network Analyzer
- Direction Finding Tool Suite
- Bluetooth NCP Commander
- Proprietary Radio Configurator
- Energy Profiler
- Tool Chain – GCC and IAR

Links: Bluetooth Low Energy SDK

Learning Center

Ready for Bluetooth 5.4?
Learn more about the latest specification

Bluetooth Direction Finding
Bluetooth Location Services: AoA/AoD

Why EFR?
Silicon Labs EFR32 Features

Silicon Labs Secure Vault accreditations
Product security certifications

Bluetooth SoC and Module Selector Guide
Bluetooth Low Energy Selector Guide

Case Study: Rethinking Epilepsy Management
EFR32 Portable Medical Device

Bluetooth Beacons
Bluetooth Beacons and Advertising

Smart. Connected.
Energy-Friendly.

IoT Portfolio
www.silabs.com/products

Quality
www.silabs.com/quality

Support & Community
www.silabs.com/community

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