How *Bluetooth*® 5 is breaking barriers in connected applications

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Product Marketing Engineer // Low Power Radio Frequency

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Agenda

- Today's wireless landscape

- Bluetooth low energy

- New technical features of Bluetooth 5

- Application examples

- Benefits of multi-protocol

- Resources

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Today's wireless landscape

- Many emerging wireless connectivity options

- Can be difficult to select the best protocol
  - Seeking regulatory compliance
  - Range
  - Battery lifetime
  - Throughput
  - Interoperability

- TI.com makes it easy to choose the right solution!

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SimpleLink™ MCU Platform

One Environment. Unlimited Potential.

www.ti.com/simplelink

The ultimate flexibility with many connectivity options

	Bluetooth	Sub-1 GHz	Wi-Fi	Thread	Zigbee	Multi-standard	Ethernet
Key feature	Native smartphone connection	Long range star network	Wireless cloud connection	IPv6-based mesh network	Mesh network	Concurrent wireless standards	Low latency, wired connection
Power consumption	Coin cell to AAA	Coin cell	AA to Lithium Ion	Coin cell to AAA	Energy harvesting to AAA	Coin cell to AAA	AA to Lithium Ion
Throughput	Up to 2 Mbps	Up to 200 kbps	Up to 100 Mbps	Up to 250 kbps	Up to 250 kbps	Up to 3 Mbps	Up to 100 Mbps
Products	CC13xx / CC26xx	CC13xx	CC31xx / CC32xx	CC13xx / CC26xx	CC13xx / CC26xx	CC13xx / CC26xx	MSP432
SimpleLink SDK compatible	✓	✓	✓	✓	✓	✓	✓

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The SimpleLink™ SDK

The SimpleLink SDK is designed for simplified development within one environment using industry standard APIs, TI Drivers, and TI RTOS to provide a robust foundation for application development

- 100% application code compatibility across SimpleLink MCU portfolio

- TI Drivers offers standardized set of functional APIs for integrated peripherals

- Integrated TI-RTOS, a robust, intelligent kernel for complete, out-of-the-box development

- POSIX-compatible APIs offer flexible OS/kernels support

- Encryption-enabled security features

- IoT stacks and plugins to add functionality to your design

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Bluetooth low energy

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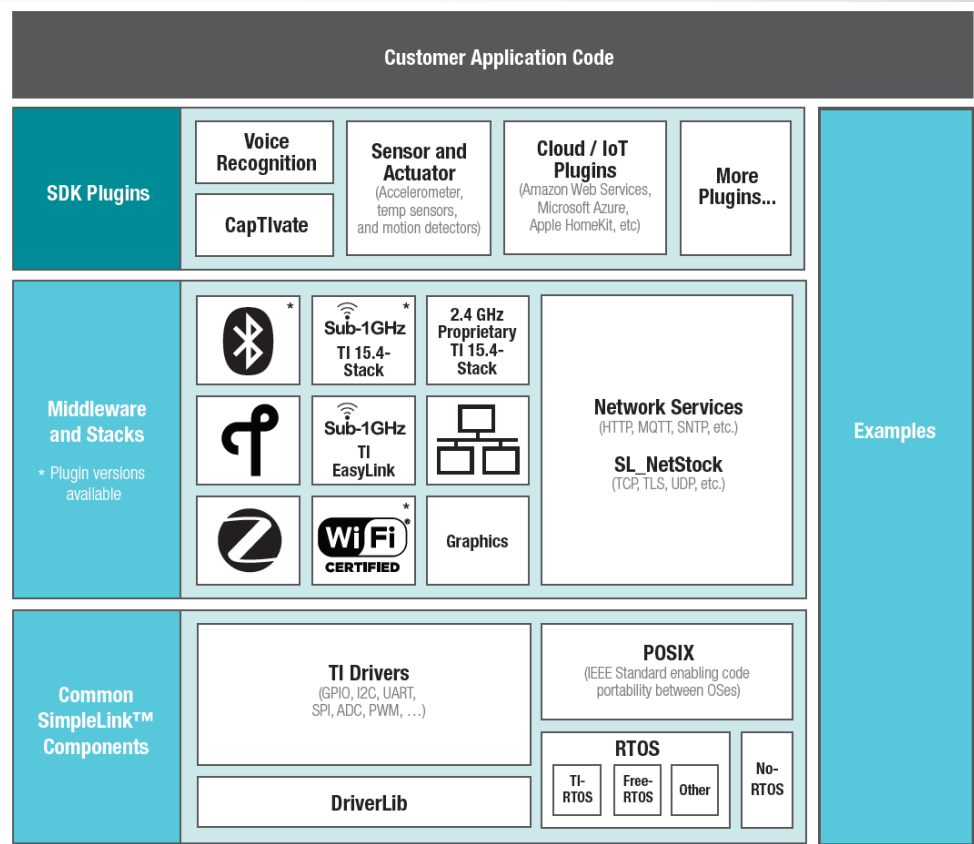
What are the benefits of Bluetooth low energy?

- Ubiquitous technology

- Inherent smartphone connectivity

- World-wide compliance

- Low power consumption

- Tested interoperability

- Evolving to reach new markets

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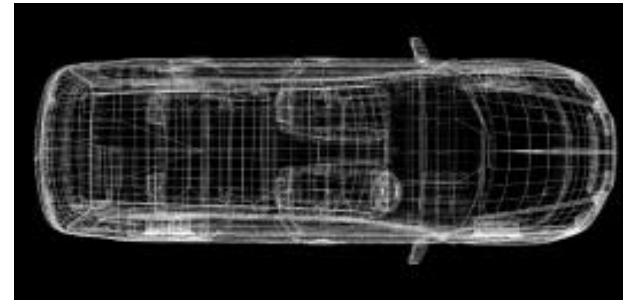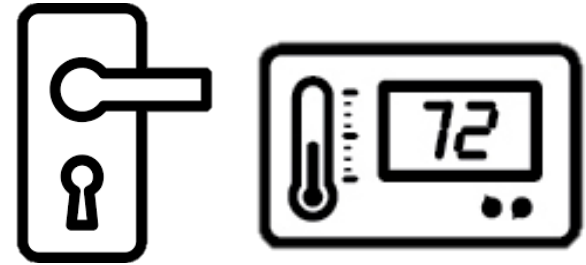# **Historically Bluetooth prevailed in personal electronics…**

- Portable speakers

- Headphones

- Fitness trackers

- Smart watches

- Keyboards and mice

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Now Bluetooth is evolving in new industries…

- Smart door locks

- Beacons

- Thermostat sensors

- Motor condition monitoring

- Automotive

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What has caused this shift?

- From personal area networks to industrial and automotive applications for Bluetooth low energy

- ❖ **Bluetooth® 5**
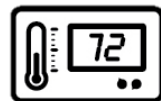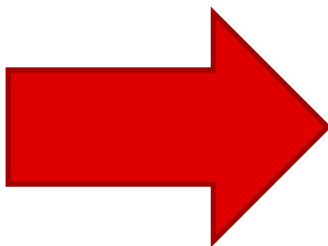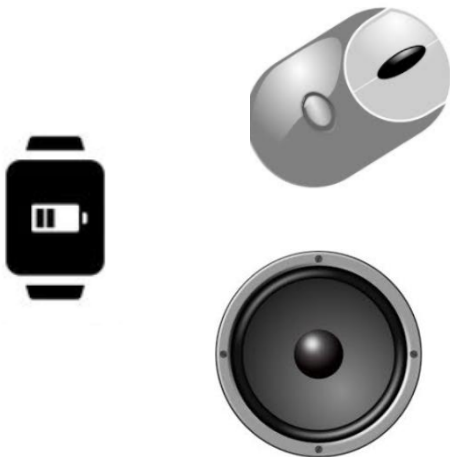
Thermostat

Electronic lock

Smoke / heat detector

Door / window sensor

Automotive

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What's new with Bluetooth 5?

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What's new with Bluetooth 5?

Longer range

4x range

- 6 dB improved sensitivity through coding – same TX/RX current
- Whole-house coverage (1.5km range)

Learn more

How is long range achieved?

- Data rate is reduced to $1/8^{th}$, every bit carries eight times more energy

- The number of over-the-air modulated symbols is increased for each bit of data, easier for receiver to distinguish a signal vs. noise

Home / building automation	Applicances	Logistics	Automotive	Industrial
Door locks, Smoke Detectors, Door bells, Lights	Coffee-Maker, Vacuum, HVAC	Anti-lost tags, Asset tracking Personnel locator	Remote keyless entry (RKE), Passive-entry Passive-start (PEPS), wire replacement	Power Tools, E-meters, Sensors

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What's new with Bluetooth 5?

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Learn more

Higher speeds

2x speed

- 500% increase in data throughput vs. Bluetooth 4.0 (2Mbps mode)
- CC2640R2F supports even higher throughput up to 5Mbps (proprietary)

The secret to moving faster

Home / building automation	Applicances	Logistics	Automotive	Industrial	Health / medical
Door locks, Smoke Detectors, Door bells, Lights	Coffee-Maker, Vacuum, HVAC	Anti-lost tags, Asset tracking Personel locator	Remote keyless entry (RKE), Passive-entry Passive-start (PEPS), wire replacement	Power Tools, E-meters, Sensors	Glucose Monitors, Patient Monitors, Drug delivery

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What's new with Bluetooth 5?

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Learn more

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The secret to moving faster

Increased broadcasting capacity

8x data

- Transmit more intelligent data over a beacon (up to 248 bytes)
- Enable rich location/navigation applications

Explore Bluetooth 5

Home / building automation	Applicances	Logistics	Automotive	Industrial	Health / medical	Retail
Door locks, Smoke Detectors, Door bells, Lights	Coffee-Maker, Vacuum, HVAC	Anti-lost tags, Asset tracking Personel locator	Remote keyless entry (RKE), Passive-entry Passive-start (PEPS), wire replacement	Power Tools, E-meters, Sensors	Glucose Monitors, Patient Monitors, Drug delivery	EPOS Card Readers EPOS Printers Handheld transaction terminals, Beacons

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Bluetooth 5 application examples

Texas Instruments

Door lock
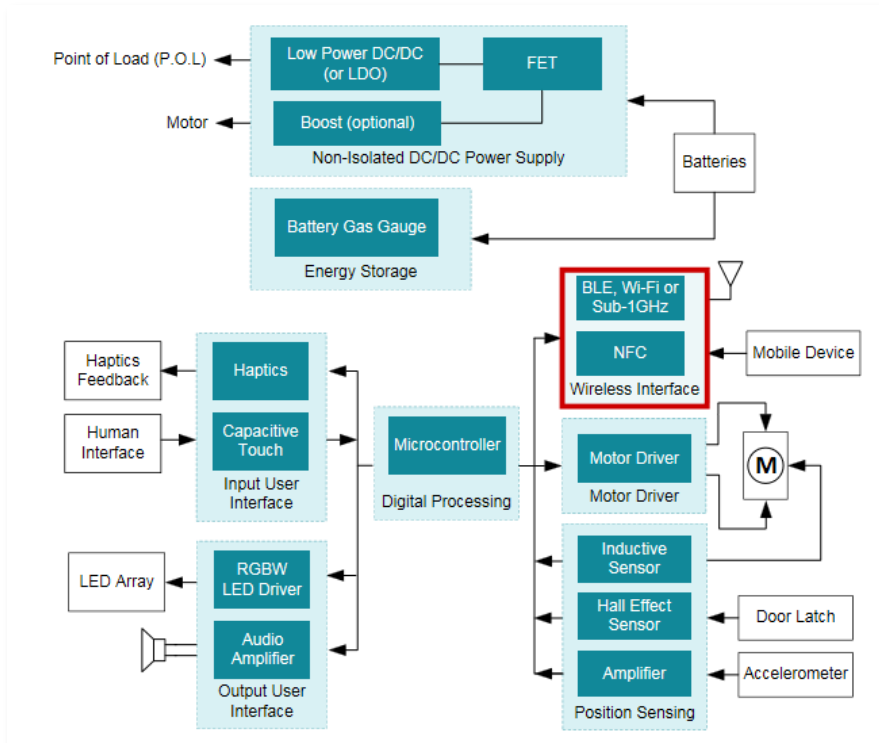
Electronic smart lock

BLE-enabled solution

Create a low-energy eLock solution that can last five years with wake-on-trigger and concurrent operation support for commercial deployment.

Download reference design >

Learn more about this solution >

BLE-enabled solution resources

⇅	⇅ Type
Access Control Panel with BLE and Capacitive Touch	TI Design
How to train your door lock	Blog

Complete TI electronic lock solution

http://www.ti.com/solution/electronic-locks-encoders

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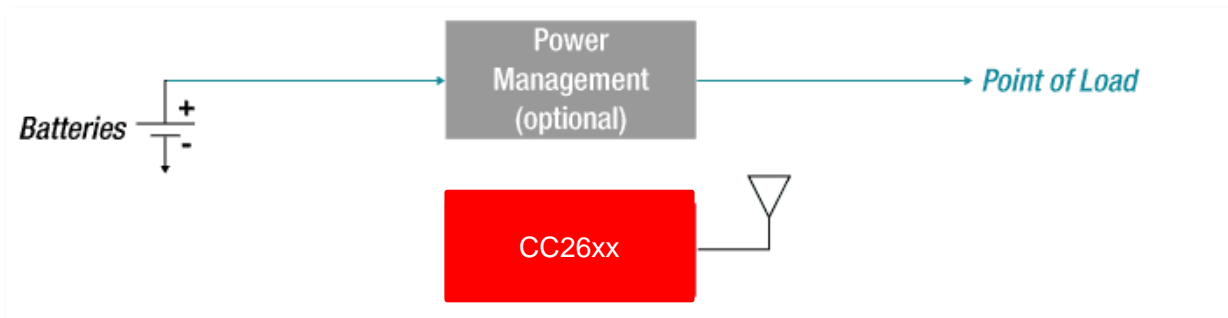
Beacon

Key benefits of TI's Bluetooth low energy for beacons:

- Supports iBeacon and Eddystone formats
- Low TX/RX and standby current
- High degree of freedom to set advertising parameters
- Small package size
- Supports Bluetooth 4.2 Data Length Extension & enhanced privacy

Source	Featured TI Design
Reference Design	Bluetooth low energy beacons reference design
Application Note	Implement an Eddystone Bluetooth low energy beacon using TI BLE-Stack
TI Design	SimpleLink™ Microtag: Ultra-compact Bluetooth low energy reference design
TI Design	Indoor light energy harvesting reference design for Bluetooth low energy beacon subsystem

http://www.ti.com/wireless-connectivity/simplelink-solutions/bluetooth-low-energy/applications.html

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Environmental sensor
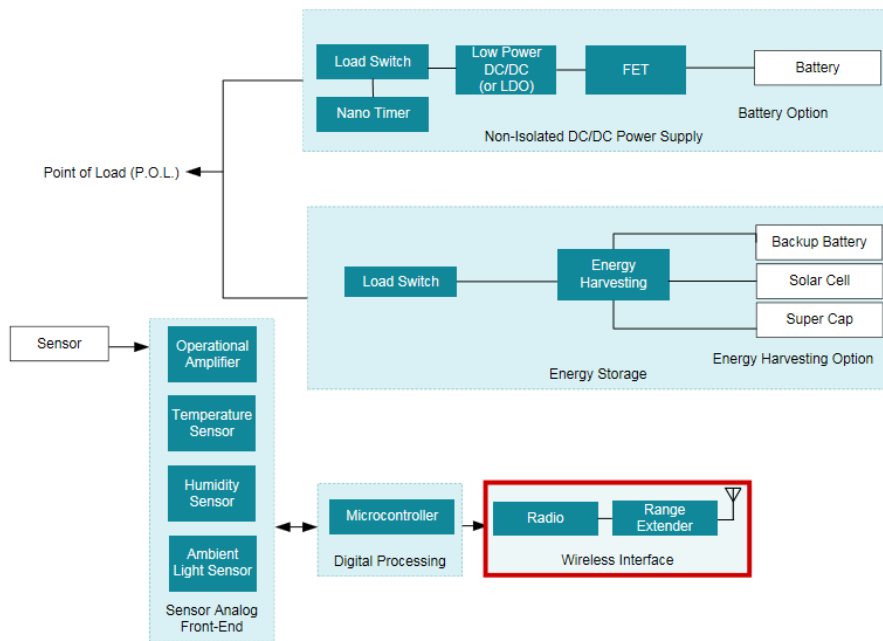
Environmental sensors

Remote, low-power sensing

Sense temperature, air quality and humidity with coin cell battery operation for up to 10 years with unique low power features. Wide area coverage with Sub-1 GHz or Bluetooth 5.0 for long range.

Download Reference Design >

Environmental Sensors resources

Resources	Type
Energy Harvesting Light & Environment Sensor Node for Sub-1GHz Networks	TI Design
Humidity & temperature sensors enabling Sub-1 GHz & Sensor-to-Cloud Networks	TI Design

Complete TI environmental sensors solutions

http://www.ti.com/solution/smart_sensing

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Benefits of Bluetooth & multi-standard

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Sub-1 GHz + Bluetooth 5

Hotel door locks

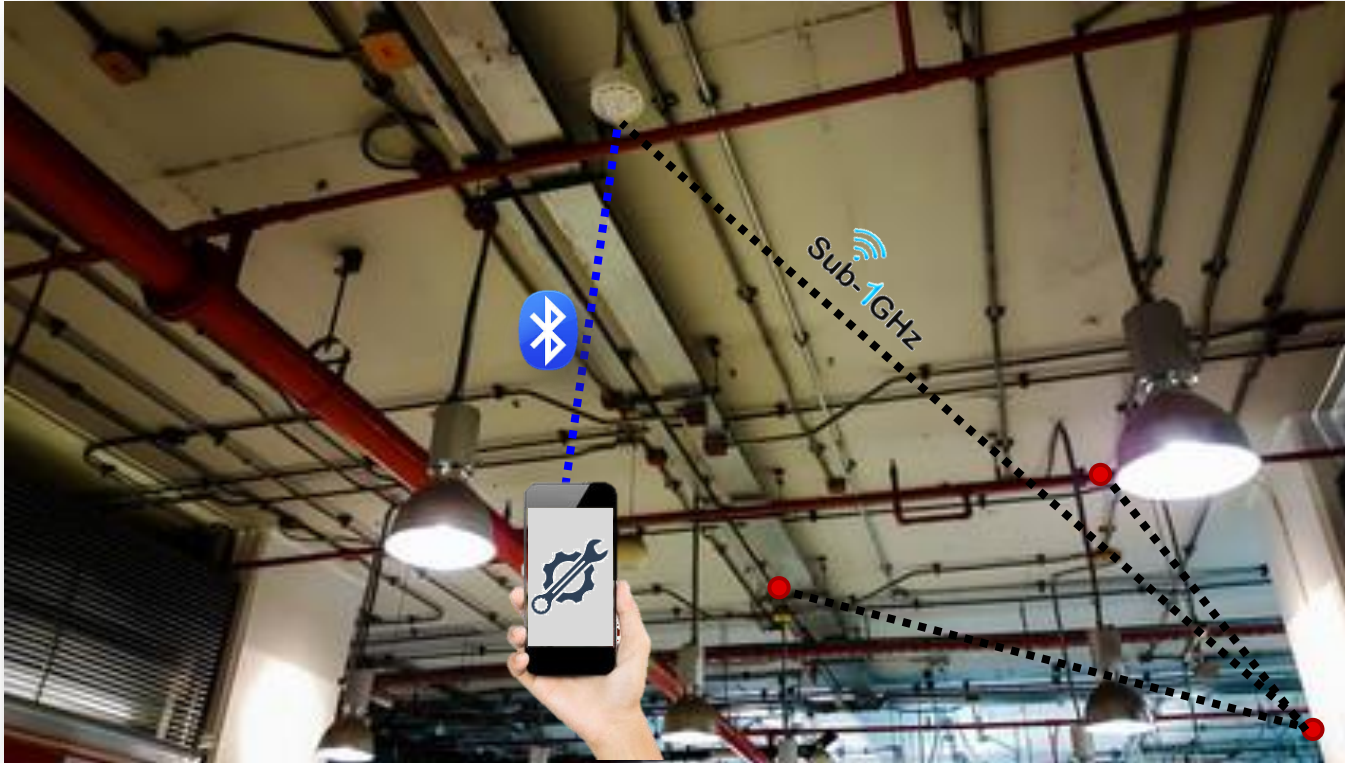- Enable long range low power Sub-1 GHz network with concurrent smartphone control

Firmware upgrade
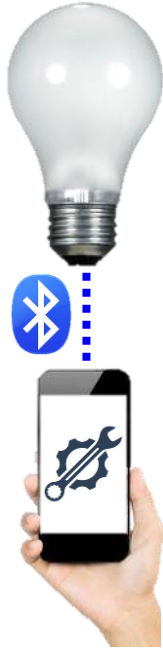## Smoke detector system

- Use Bluetooth low energy for in-field over the air firmware updates of a Sub-1 GHz network

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Multi-standard
Device configuration
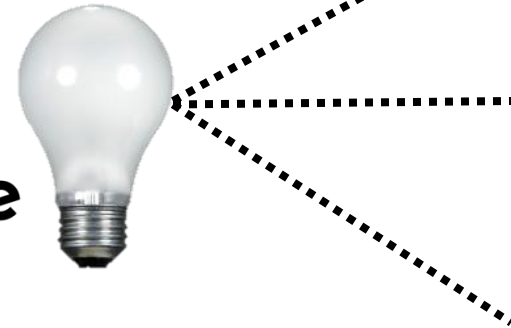
- Configure new Zigbee nodes using Bluetooth low energy

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How to get started…

Texas Instruments

SimpleLink Bluetooth low energy solutions

	New! CC2642R Wireless MCU	CC2640R2F Wireless MCU	CC2640R2F-Q1 Wireless MCU
Description			
	Expanded memory and lower power with the newly enhanced ultra-low-power sensor controller	Smallest Bluetooth 5 solution on the market including automotive qualified option	Smallest automotive qualified Bluetooth 5 solution on the market
Key Features			
SimpleLink MCU Platform Compliant	✓	✓	✓
Bluetooth Standard	Bluetooth 5.0, Bluetooth 4.x	Bluetooth 5.0, Bluetooth 4.x	Bluetooth 5.0, Bluetooth 4.x
Application MCU	Arm® Cortex®- M4F	Arm® Cortex®- M3	Arm® Cortex®- M3
Memory	352kB Flash, 256kB ROM*, 80kB RAM	128kB Flash, 144kB ROM*, 20kB RAM	128kB Flash, 144kB ROM*, 20kB RAM
Standby Current Consumption	0.9µA	1.1µA	1.1µA
Module	—	Third party	—

*some software components will be included in ROM in production devices to free application code space

- Bluetooth low energy wireless MCUs

- Can be used as standalone SoC or as a network processor

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SimpleLink multi-protocol solutions

	New! CC1352R Wireless MCU	Coming soon! CC1352P	CC2652R
Description			
	Support for Sub-1 GHz + 2.4 GHz concurrency with the lowest power multi-band wireless MCU	Support for Sub-1 GHz + 2.4 GHz concurrency with an integrated 20dBm PA enabling longer range	Get all the benefits of 2.4 GHz concurrency with the loweset power multi-protocol wireless MCU
Key Features			
SimpleLink MCU Platform Compliant	✓	✓	✓
Application MCU	Arm® Cortex®- M4F	Arm® Cortex®- M4F	Arm® Cortex®- M4F
Memory	352kB flash, 256kB ROM*, 80kB RAM	352kB flash, 256kB ROM*, 80kB RAM	352kB flash, 256kB ROM*, 80kB RAM
Standby Current Consumption	0.8µA	0.8µA	0.9µA
Connectivity			
Bluetooth	✓	✓	✓
Thread	✓	✓	✓
Sub-1 GHz	✓	✓	—
Zigbee	✓	✓	✓

*some stack components will be embedded in ROM in production devices to increase application code space in flash

- Dual-band and multi-protocol wireless MCUs

- Leverage Bluetooth low energy plus Sub-1 GHz or Zigbee

http://www.ti.com/wireless-connectivity/simplelink-solutions/multi-standard/overview.html

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LaunchPad development kit

Featured SimpleLink™ development kits

CC26x2R LaunchPad Development Kit

· Bluetooth 5 wireless MCU

· Arm Cortex-M4F

· 352kB Flash, 256kB ROM, 80kB RAM

SimpleLink CC26x2R Software Development Kit

CC26x2R SimpleLink Academy Training

Tool info

CC2640R2F LaunchPad Development Kit

· Bluetooth 5 wireless MCU

· Arm Cortex-M3

· 128kB Flash, 144kB ROM, 20kB RAM

SimpleLink CC2640R2F SDK

CC2640R2F SimpleLink Academy Training

Tool info

- Easy to use development kits
- Project Zero & many example applications

http://www.ti.com/wireless-connectivity/simplelink-solutions/bluetooth-low-energy/tools-software.html

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SimpleLink software

SimpleLink software

SimpleLink CC26x2 SDK

The SimpleLink CC26x2 Software Development Kit (SDK) provides a complete package for the development of multi-standard, Bluetooth® Low Energy, Zigbee®, Thread, and 802.15.4-based applications for the CC2652R and CC2642R wireless MCUs.

Learn more

SimpleLink CC2640R2F SDK

The SimpleLink™ CC2640R2 Software Development Kit (SDK) includes the TI royalty-free *Bluetooth®* low energy (BLE) software stacks for developing on the ARM® Cortex®-M3 based CC2640R2F wireless MCU.

Learn more

- Royalty-free software stacks available to download

http://www.ti.com/wireless-connectivity/simplelink-solutions/bluetooth-low-energy/tools-software.html

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SimpleLink Academy

Extensive worldwide development support

Comprehensive training and videos including reference designs and development kits

SimpleLink training >

Lab overview

Introduction
Getting Started
Lab overview
Videos
What's new

Bluetooth 5

Labs related to using Bluetooth 5 and the BLE5-Stack. We recommend starting with the "Fundamentals" lab for a jump directly into Bluetooth® low energy and then progressing down the list of labs. If you are unfamiliar with the TI SDKs you might want to read through the lecture on RTOS Concepts and do a TI-RTOS lab first.

Lab	Description
Fundamentals	Setting up the debug environment, connecting to Project Zero using the Device Monitor PC tool, reading and writing characteristic data, changing the advertisement/device name
Scanning and Advertising	Tutorial on how to use the advertising and scanning features of the TI BLE-Stack with example code.
Connections	This tutorial will give you an overview of how to set up Bluetooth low energy connections suited to your needs. Explanation of key concepts such as master-slave and connection parameters.
Bluetooth 5 2Mbps PHY	Learn about new Bluetooth 5 PHY options and how to add support for the 2Mbps PHY to Project Zero. Bonus material also covers using the LE Coded PHY for long range mode evaluation.
Custom Profile	Explanation of the GATT and ATT protocols that Bluetooth Low Energy data exchange is based on, a walk-through of how to implement a custom Bluetooth service using the APIs provided in the TI BLE SDK, and a basic code generator for custom services
BLE Enhanced OAD	Learn about the fundamentals of TI's Over the Air Dowload (OAD) solution. Topics include performing an OAD, factory images, adding OAD to exisitng projects, and advanced OAD debugging techniques.

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Bluetooth 5 2Mbps PHY training

Bluetooth Low Energy 2M PHY

Introduction

One of the highlighted new features in Bluetooth 5 is the increased throughput. This is achieved through the 2 Mbps physical layer. In this module we will learn about the *Bluetooth*® low energy (BLE) 2 Mbps physical layer (PHY), how to maintain a connection when using the LE 2M PHY and what the benefits of using the LE 2M PHY are.

In this lab we will be working with the example project *Project Zero* and BTool in order to form a BLE connection and issue a PHY change request. This SimpleLink Academy lab uses projects from the BLE5-Stack, which is found in the SimpleLink™ CC26X2 software development kit (SDK) and the SimpleLink™ CC13X2 software development kit (SDK).

To start with this training module, two LaunchPads will be programmed with

1. *Project Zero* to act as a peripheral device
2. *Host Test* to act as a central device.

You can use CC26X2R1 LaunchPads or CC1352 LaunchPads.

In the first task, BTool will be used to initiate a connection and send a Read Current PHY, `HCI_LE_ReadPhy`, command from the central device using BTool.

In the second task, we will try to send a change PHY request from the central device using BTool.

In the third task, we will try to send a change PHY request from the peripheral device instead.

In the fourth task, we are going to show what happens when a change PHY request is sent to a device that does not support LE 2M PHY.

In the first bonus task, we will use the LE Coded PHY.

In the second bonus task, the LE 2M PHY will be used for advertisements.

This tutorial will take about two hours to complete and requires basic embedded programming skills (see the **Prerequisites** section for details).

In this module you will learn about:

- *Bluetooth*® low energy 2 Mbps physical layer (PHY)

- How to maintain a connection when using the LE 2M PHY

- What the benefits of using the LE 2M PHY

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SimpleLink™ **Resources**

Bluetooth®
Learn more >

- **New!** CC2642R
- CC2640R2F
- CC2640R2F-Q1

Tools and Software >

Sub-1GHz
Learn more >

- **New!** CC1312R
- CC1310
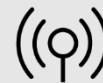
Tools and Software >

THREAD
Learn more >

- **New!** CC2652R

Tools and Software >

zigbee
Learn more >

- **New!** CC2652R

Tools and Software >

Multi-standard
Learn more >

- **New!** CC1352R
- **New!** CC2652R
- CC1350

Tools and Software >

SimpleLink Sensor to Cloud	• Web • Video • Blog • TI-RTOS-based design • Linux-based design

End Equipment Information	Building Automation, HVAC, and Smart Meters

Support and Training	• Training • TI E2E Support Forum

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Thank you!

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