



Introduction to Bluetooth Low Energy

What is Bluetooth low energy?

A NEW TECHNOLOGY

- Bluetooth low energy is part of the Bluetooth 4.0 specification
- New approach enables much lower power consumption in peripherals
- Opens up new applications and new markets
- Creates a new level of performance for existing applications



Basic Concepts

Optimized for power consumption

- Single-mode designed to run directly from a coin/button cell
 - < 16 mA peak current
 - 15 μ A average current
- Low data rates
 - Optimally less than 40 Kbps
 - Packets are short and the radio is off more
- Simple profile structure – Attributes
 - Peripheral operates like a database
 - Central devices can read or write the attributes e.g. battery level
 - Peripherals can inform central devices of a change e.g. #Key pressed



Basic Concepts

Important differences to classic Bluetooth

- Better range and robustness
 - Only 40 channels for Bluetooth LE (BT classic = 79)
 - Higher modulation index -> greater Signal to Noise ratio
 - No class system – 0dBm output give >50m range
- Devices advertise their capabilities and data
 - A peripheral can advertise its data and capabilities to all central
 - E.g The time is 15:30 CET
- Star networks only – one master many slaves
 - This means a watch can be slave display to a phone or master to some fitness sensors, but not both at the same time

Bluetooth low energy is Low power Low data rate Technology

Dual-mode and Single-mode Radios

■ Dual-mode Radio

- Can support Bluetooth classic connections and Bluetooth low energy connections
- Typically for Master devices - Phones, PC, Tablet, PMP, TV
- Does not deliver power savings of Bluetooth low energy

■ Single-mode Radio

- Only supports Bluetooth low energy devices (can't talk to legacy Bluetooth radios)
- Typically for sensors and peripherals (can act as master to a small number of sensors)
- Much lower power than Bluetooth Classic or dual mode radio

What is a Dual Mode device?

- Dual Mode device is a single chip solution supporting:
 - BR/EDR (Classic Bluetooth)
 - LE
- Contains all functionality of Classic Bluetooth with the addition of Bluetooth Low Energy functionality.
- Some restrictions on functionality due to shared clock, radio
- Some restrictions from Bluetooth Specification



Where does CSR8670 fit in?

- CSR8670 is a Dual Mode device
- ADK1.1
 - BT3.0
 - Classic Bluetooth (BR/EDR) only
- ADK2.0
 - BT4.0
 - Classic Bluetooth (BR/EDR)
 - Bluetooth Low Energy (LE)



Comparison between Classic Bluetooth and LE

Feature	BR/EDR	LE	Notes
RF Channels	79	40	2 MHz spacing in LE
Modulation	GFSK / DQPSK/8DPSK	GFSK	Simple and effective
Modulation Index	0.25 to 0.35	0.45 to 0.55	Wider signal – more robust
Max Tx Power	+20 dBm (class 1) +4 dBm (class 2)	+10 dBm	No “class” structure +10 dBm regulatory limit
Rx Sensitivity (typical)	-85 dBm	-85 dBm	Pathloss = 90 dB for BR Pathloss = 95 dB for LE
Range (typical)	30 meters	50 meters	Modulation Index, increased power for class 2

Comparison between Classic Bluetooth and LE

Feature	BR/EDR	LE	Notes
Packet Format	28 (BR / EDR)	2 (LE)	LE - Advertising / Data
Ack Packet Len	126 μ s	80 μ s	63% shorter
8 octet Packet	214 μ s	144 μ s	67% shorter
Max Packet Size	2875 μ s = 1021 octets	376 μ s = 37 octets	LE very short
Max Data Rate	2178.1 kb/s	305 kb/s	EDR much faster
Time to transfer 1Mbyte	DH1 = 18.2 s, DH5 = 8.8 s, 3-DH5 = 2.9 s	26 s (LE)	LE less efficient for large packets
CRC Strength	16	24	LE stronger
Encryption	Safer+	AES-CCM-128	LE stronger

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