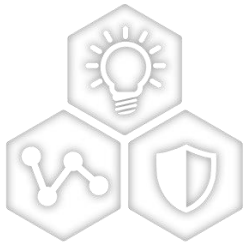


Global Regulatory Certified Bluetooth LE 5 & IEEE 802.15.4 Multi-Protocol Solutions of Microchip



A Leading Provider of Smart, Connected and Secure Embedded Solutions



SMART | CONNECTED | SECURE

Presented by:
Luke Roh, Senior Embedded Solutions Engineer

Aug 29, 2023

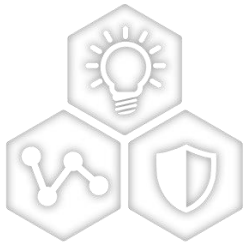
Table of Contents

- **Overview of Wireless Solutions**
- **Bluetooth LE & IEEE 802.15.4 Microchip Products**
 - PIC32CX-BZ2 MCU
 - WBZ451 Module
 - RNBD451 Module
- **Regulatory Certification**
- **Supporting Topologies & Features**
- **Development Tools**
- **Application Examples**

Overview of Wireless Solutions




A Leading Provider of Smart, Connected and Secure Embedded Solutions



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Wireless Solutions

Overview

Bluetooth® Audio	Bluetooth Low Energy	Wi-Fi®	IEEE 802.15.4 Zigbee®	LoRa®	Car Access	Voice and Audio	Medical
							
<ul style="list-style-type: none">• Headsets• Earbuds• Smart Speakers	<ul style="list-style-type: none">• IoT Devices• Connected Sensors• Home Automation	<ul style="list-style-type: none">• IoT Devices• Home Automation• Industrial Automation	<ul style="list-style-type: none">• Lighting• Home Automation• Metering• Smart Cities	<ul style="list-style-type: none">• IoT Sensors• Smart Cities• Smart Agriculture	<ul style="list-style-type: none">• Keyless Entry	<ul style="list-style-type: none">• AMZN Alexa or Google• Security Cameras• Sound Detection	<ul style="list-style-type: none">• Hearing Aids• Medical Implants• Medical Monitoring• Ingestible Capsules

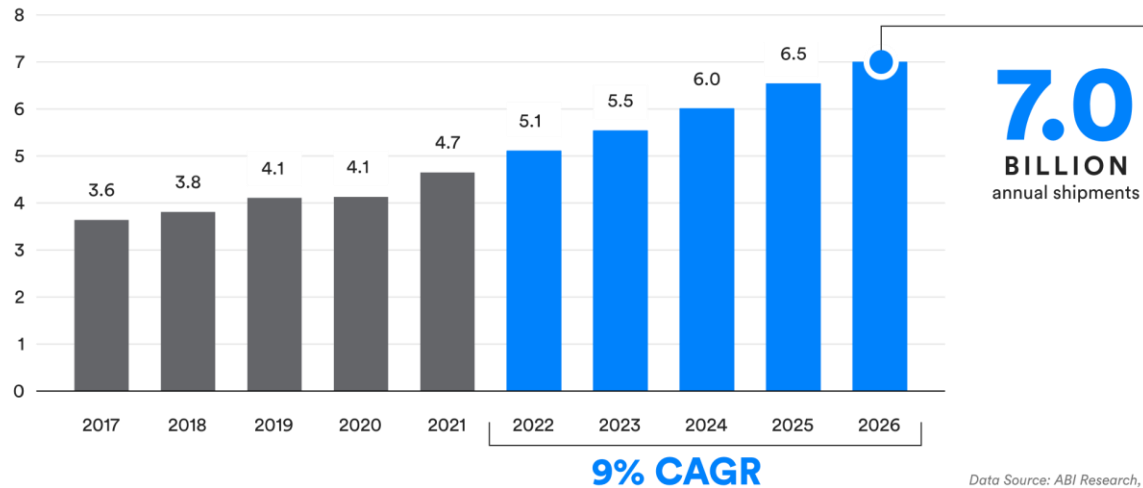
Bluetooth Low Energy (BLE)

Overview



Total Annual Bluetooth® Device Shipments

NUMBERS IN BILLIONS



- **Frequency Band**

- 2.4 GHz ISM band

- **Channels**

- 40 channels with 2MHz spacing
- 3 advertising channels & 37 data channels

- **Channel Usage**

- Frequency-hopping spread spectrum (FHSS)

- **Data Rate**

- LE 2M PHY: 2Mb/s
- LE 1M PHY: 1Mb/s
- LE Coded PHY(S=2): 500Kb/s
- LE Coded PHY(S=8): 125Kb/s

IEEE 802.15.4 (Zigbee)

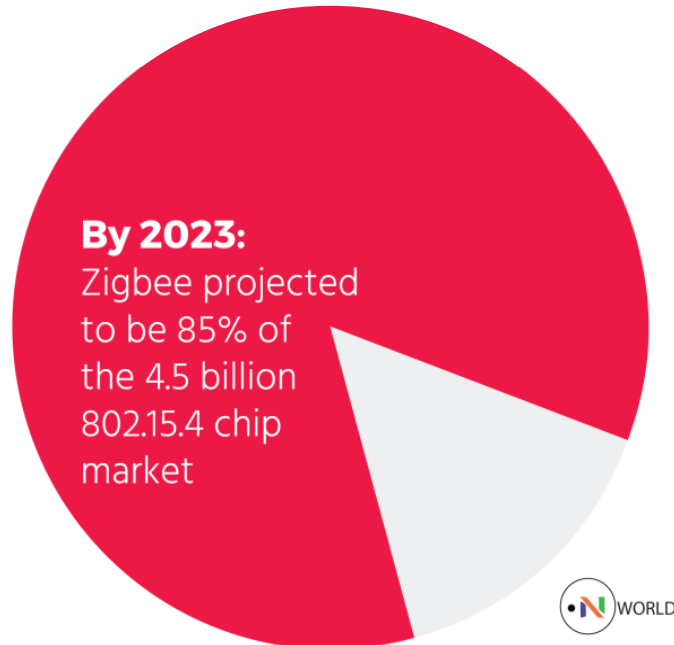
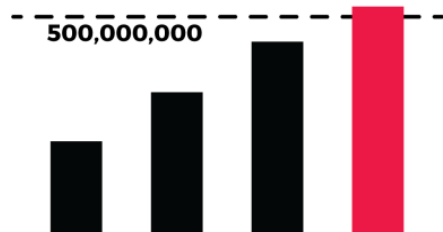
Overview



zigbee alliance

Zigbee today:

Half a billion chipsets sold for the IoT



- **Frequency Band**

- 2.4 GHz ISM band

- **Range**

- 10 ~ 100 meters

- **Network Topologies**

- Star, Cluster Tree and Mesh

- **Device Type**

- Coordinator, router and end device

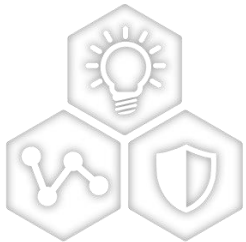
- **Data Rate**

- 250 Kb/s

Bluetooth LE & IEEE 802.15.4 Microchip Products



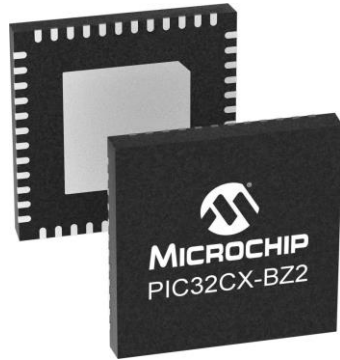
A Leading Provider of Smart, Connected and Secure Embedded Solutions



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Product Introduction

Overview



PIC32CX-BZ2 MCU

- ✓ IC Type
- ✓ 48-Pins, 7 x 7mm QFN
- ✓ ARM® Cortex® - Based MCU
- ✓ Bluetooth LE v5.2
- ✓ IEEE 802.15.4 v3.0
- ✓ AEC-Q100 Grade 1 (125°C) qualified



WBZ451 Module

- ✓ Module Type
- ✓ 27-Pins
- ✓ Including PIC32CX-BZ2
- ✓ Bluetooth LE v5.2
- ✓ IEEE 802.15.4 v3.0
- ✓ Global regulatory certified
- ✓ Robust TX Power



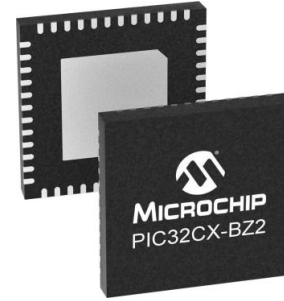
RNBD451 Module

- ✓ Module Type
- ✓ 27-Pins
- ✓ Including PIC32CX-BZ2
- ✓ Bluetooth LE v5.2
- ✓ Global regulatory certified
- ✓ Robust TX Power
- ✓ ASCII Command Interface

PIC32CX-BZ2 MCU

Details

- **Simultaneous multi-protocol operation** through hardware & software arbitration
- **Long Range Bluetooth** combining high transmit power (**up to +12 dBm**) and **125kbps coded PHY**
- **Secure** from remote attacks with advanced on-board security engine
- **1MB flash** grants ample code space for the application, or can be used for OTA updates



Keynote

Bluetooth LE & IEEE 802.15.4 48-Pin QFN Chip

Encryption Engine

- 256-bit AES Encryption
- ECC Elliptic Curve Public Keys
- True RNG
- Secure Hash Algorithm

Cortex™ M4F Core

- 64MHz
- FPU / DSP / DMA
- ICSP / Debug
- Low Latency Event System

2.4 GHz Radio

- **Bluetooth 5 & IEEE 802.15.4** w/Time-Division Arbitration
- Up to +12dBm TX Power
- Up to -103dBm RX Sensitivity
- 125Kbps – 2Mbps

1MB Embedded Flash w/OTA

128KB RAM w/ECC

WWDT

Die Temp Sensor

Peripherals & Interfaces

- 12-bit ADC, 2 MSPS, 8 channels
- 4x SERCOM (USART/SPI/I²C)
- 2x32-bit/4x16-bit Timer Counters
- 1x QSPI
- 2x24-bit/1x16-bit TCCs
- 27 GPIO

WBZ451 Module

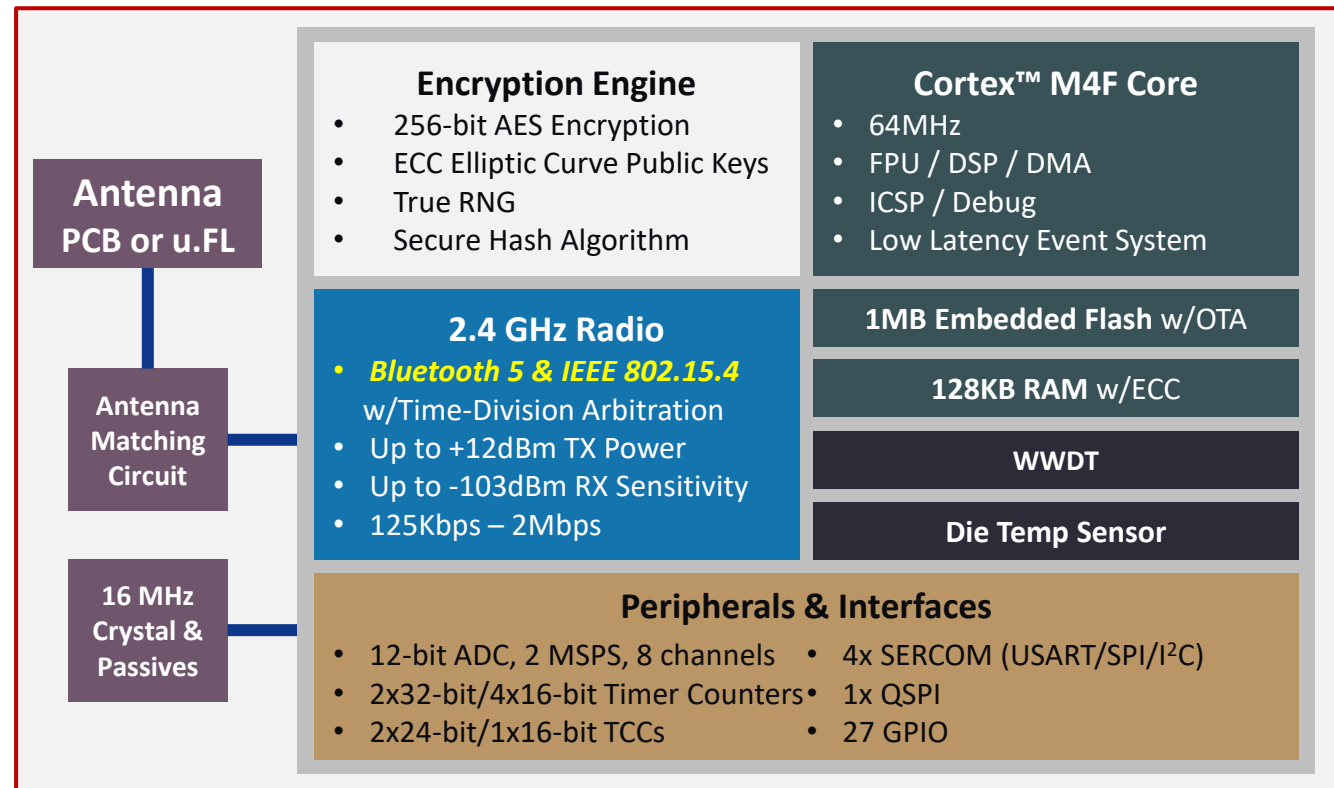
Details

- **Simultaneous multi-protocol operation** through hardware & software arbitration
- **Long Range Bluetooth** combining high transmit power (**up to +12 dBm**) and **125kbps coded PHY**
- **Secure** from remote attacks with advanced on-board security engine
- **1MB flash** grants ample code space for the application, or can be used for OTA updates



Keynote

Bluetooth LE & IEEE 802.15.4
Included PIC32CX-B22 MCU



RNBD451 Module

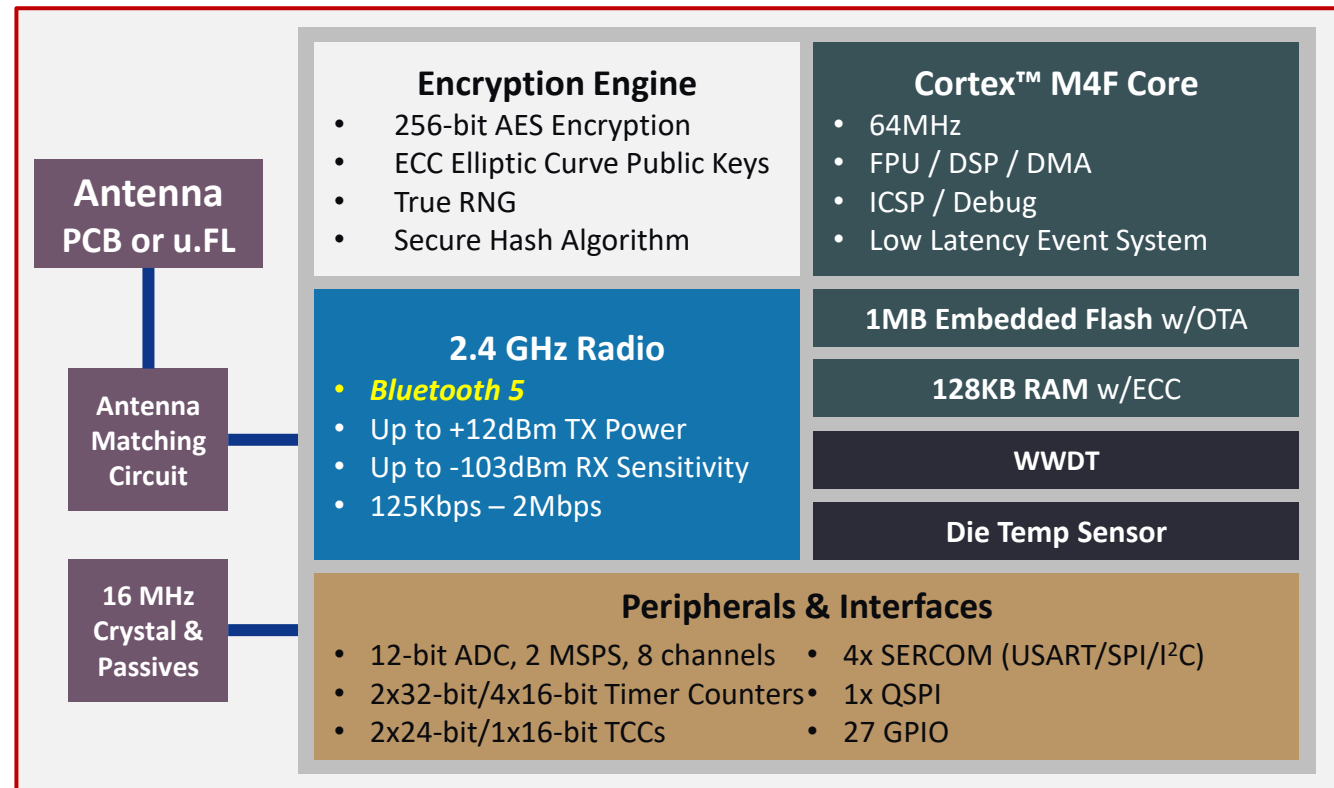
Details

- **Simultaneous multi-protocol operation** through hardware & software arbitration
- **Long Range Bluetooth** combining high transmit power (**up to +12 dBm**) and **125kbps coded PHY**
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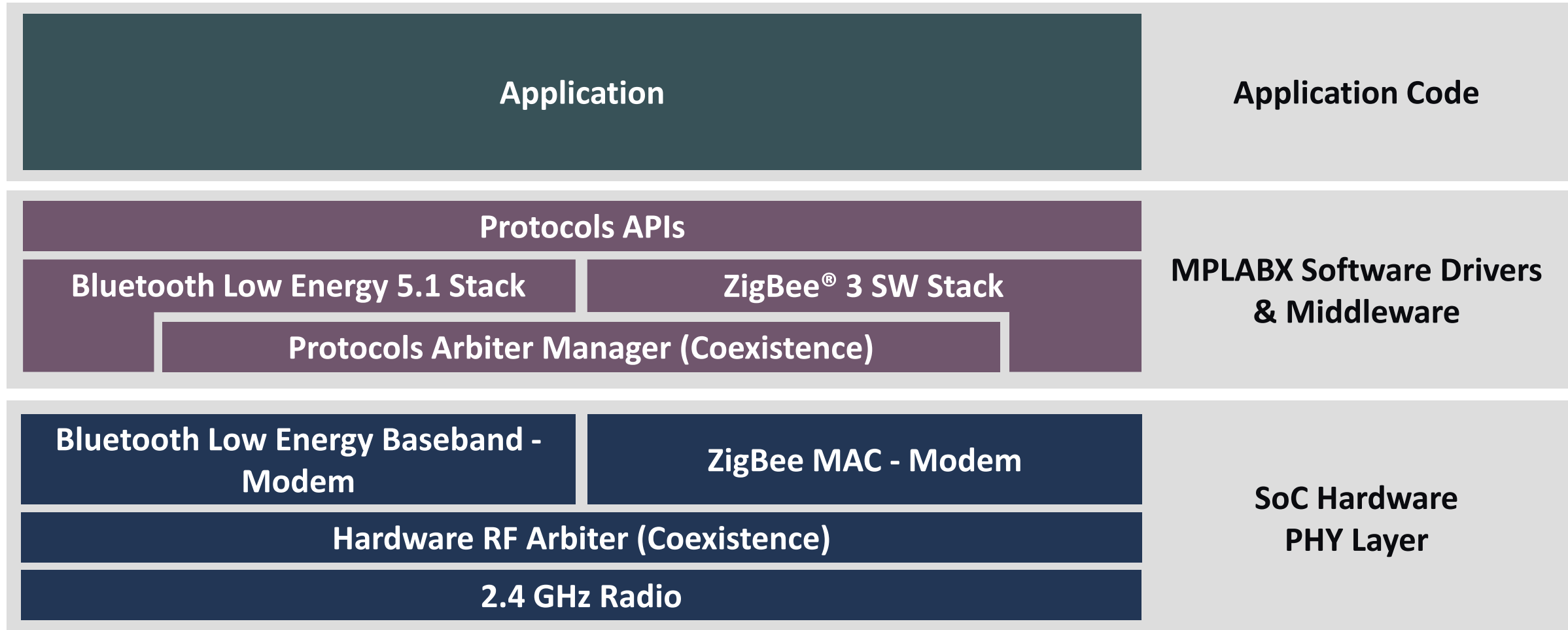
Keynote

Bluetooth LE only
ASCII Command Interface



Product Introduction

Software Architecture



Product Introduction

Global regulatory certified



Europe



Japan



Korea



U.K



Taiwan



USA

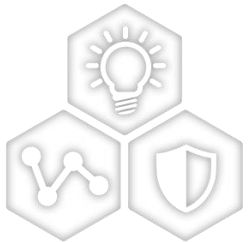


Canada

Supporting Topologies & Features



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Supporting Topologies & Features

Bluetooth LE v5.2 & IEEE 802.15.4 v3.0



From 5.0 & previous:

- LE Secure Connections
- LE Coded PHY (long range) – 500Kbps, 250Kbps , 125Kbps
- 2 MHz PHY (high throughput)
- Multi-link/Multi-role

From 5.1:

- GATT Caching

From 5.2:

- LE Power Control



Features:

- Small
- Low Power
- Low Data Rate
- Low Cost
- Mesh Topology

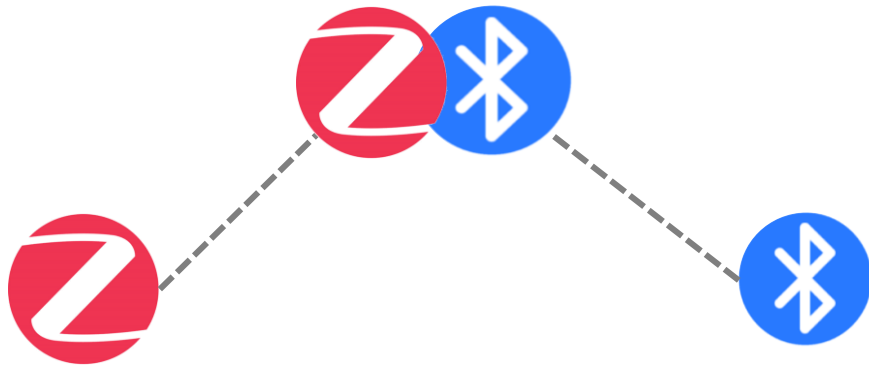
Application Profiles:

- Home Automation
- Networking Application
- Smart Building
- Hospitals, Schools, Offices

Topologies

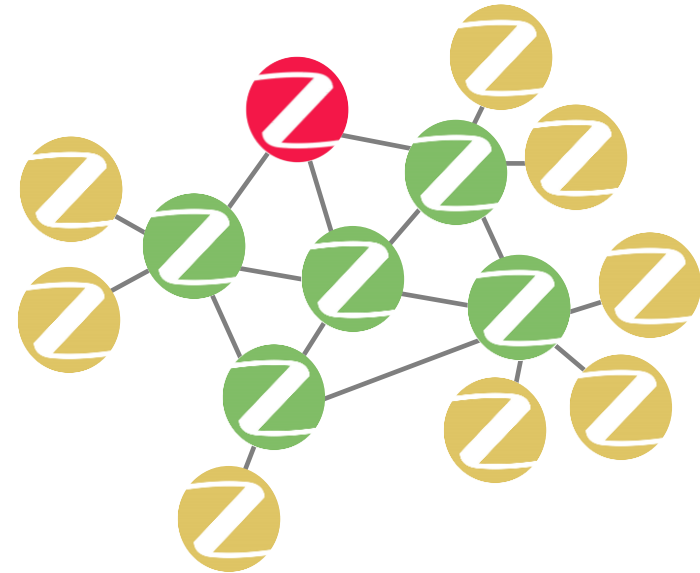
Multi-Protocol & Mesh

Multi-Protocol



- Able to run both BLE & Zigbee at the same time
- Support software & hardware arbiter

Mesh (Zigbee® Only)

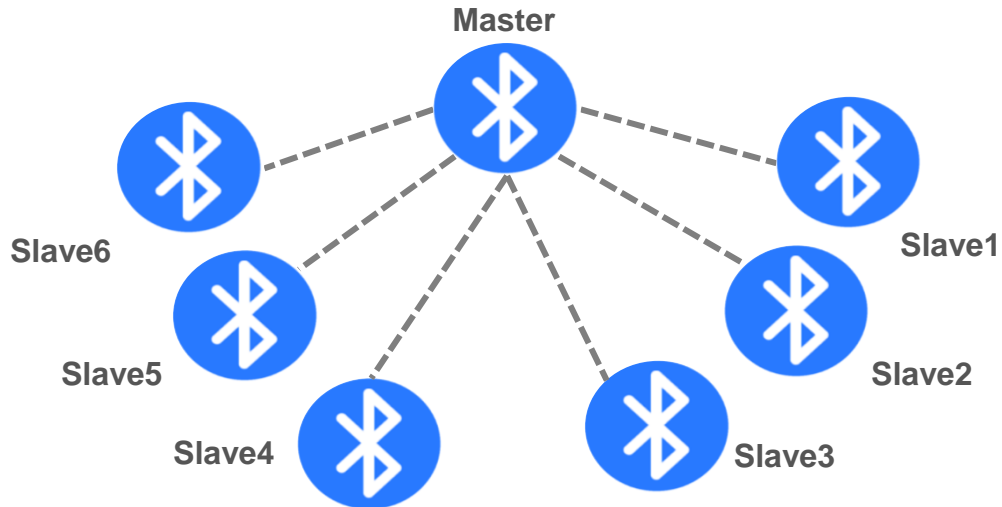


- Support Mesh topology via Zigbee

Topologies

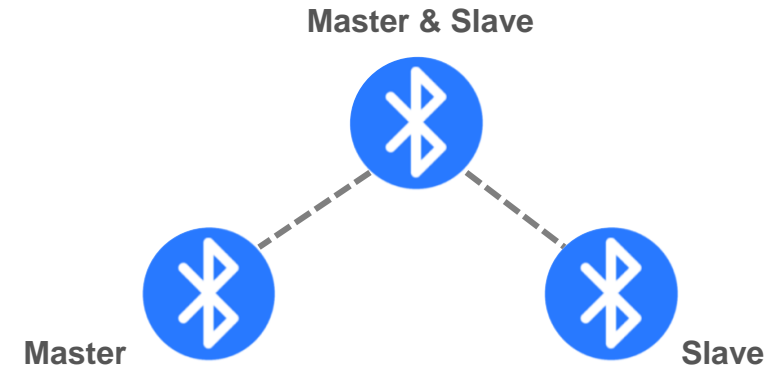
Multi-Link & Multi-Role

Multi-Link



- **Able to connect up to 1:6**
 - Note: Not mesh topology, 1:1 x 6 Connection

Multi-Role

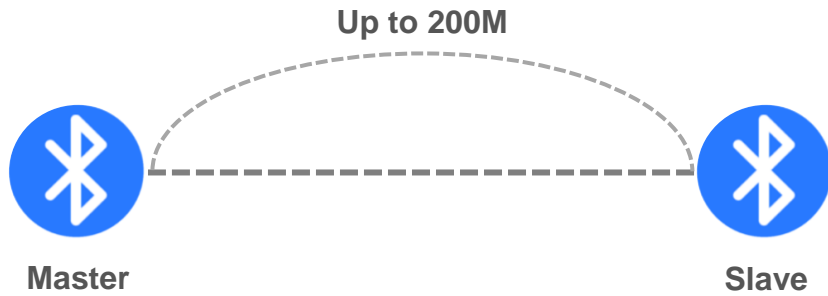


- **Able to run as role as Master & Slave at the same time**

Topologies

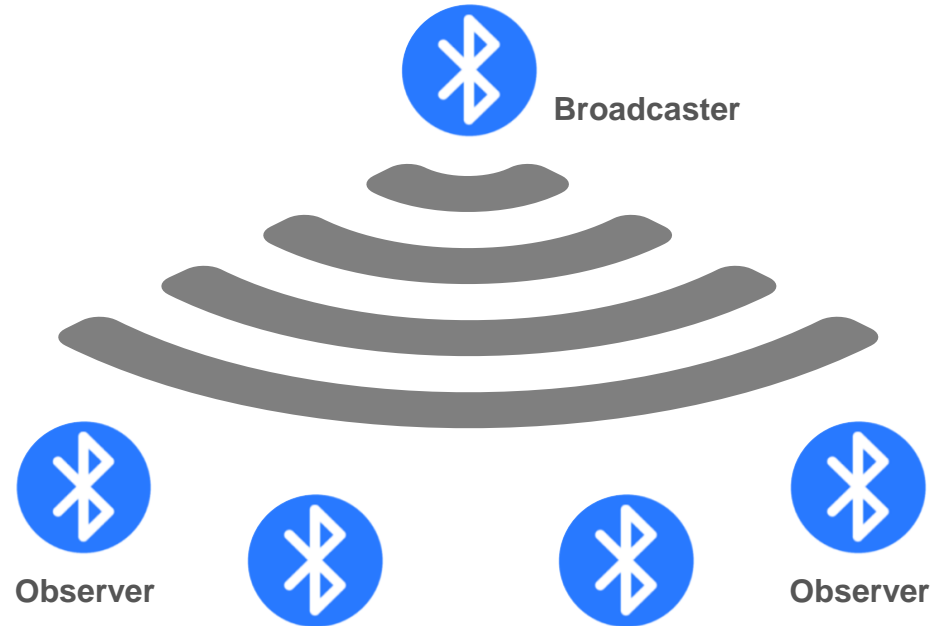
Long Range & Beacon

Long Range



- **Able to transmit up to 200 meters**
 - If “Coded PHY” is enabled (S=8 Option)
 - Condition if LOS (Line Of Sight)

Beacon



- **Send advertisement to many BLE devices**
- **Unconnected communications**

Features

Coded PHY

LE UNCODED PHY



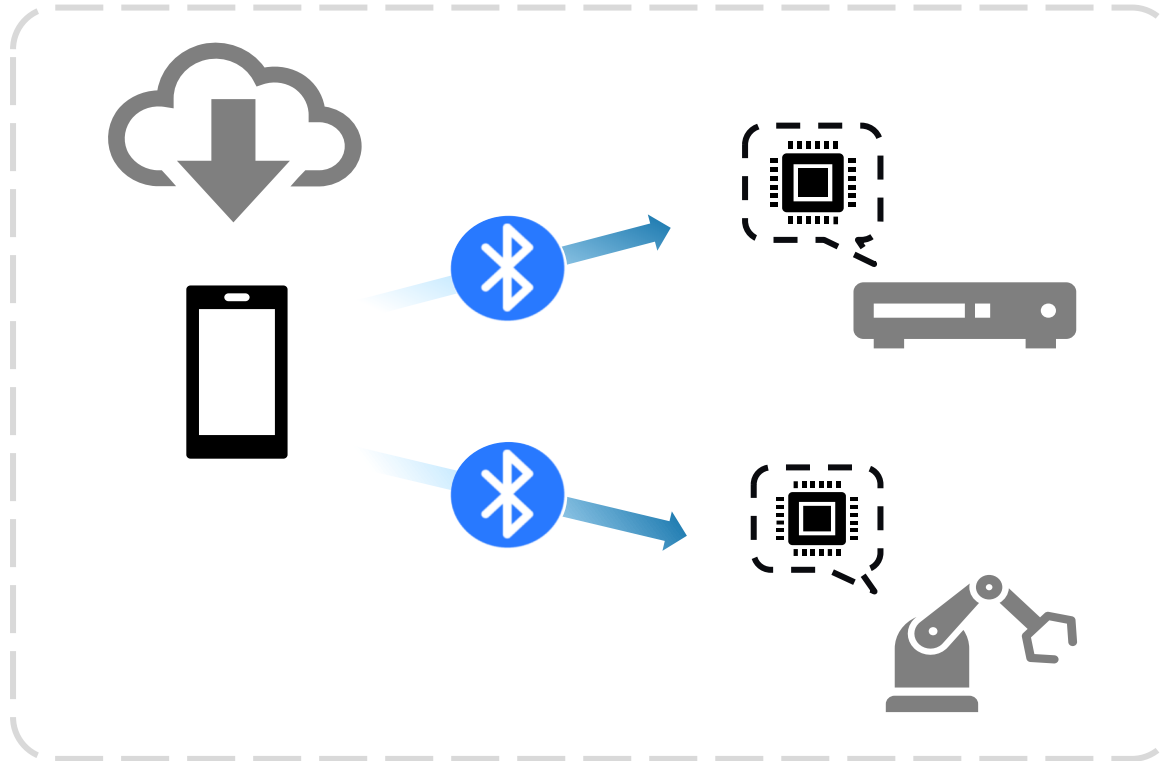
LE CODED PHY



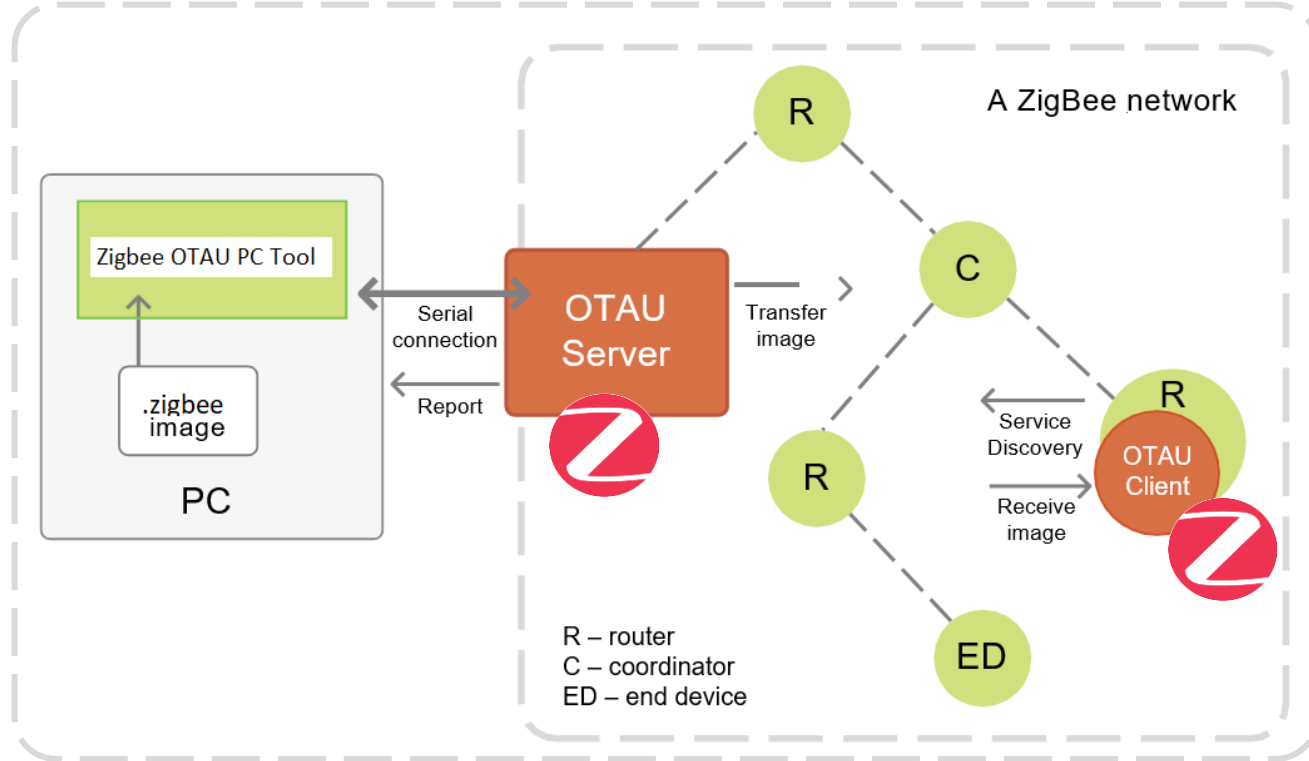
LE Coded PHY	Error Detection	Error Correction	Multiplier	PDU Length	Max Throughput
S = 2 (500kbps)	CRC	FEC	2	0 ~ 257 B	382kbps
S = 8 (125kbps)	CRC	FEC	4	0 ~ 257 B	112kbps

Features

OTA DFU (Over The Air Device Firmware Update)



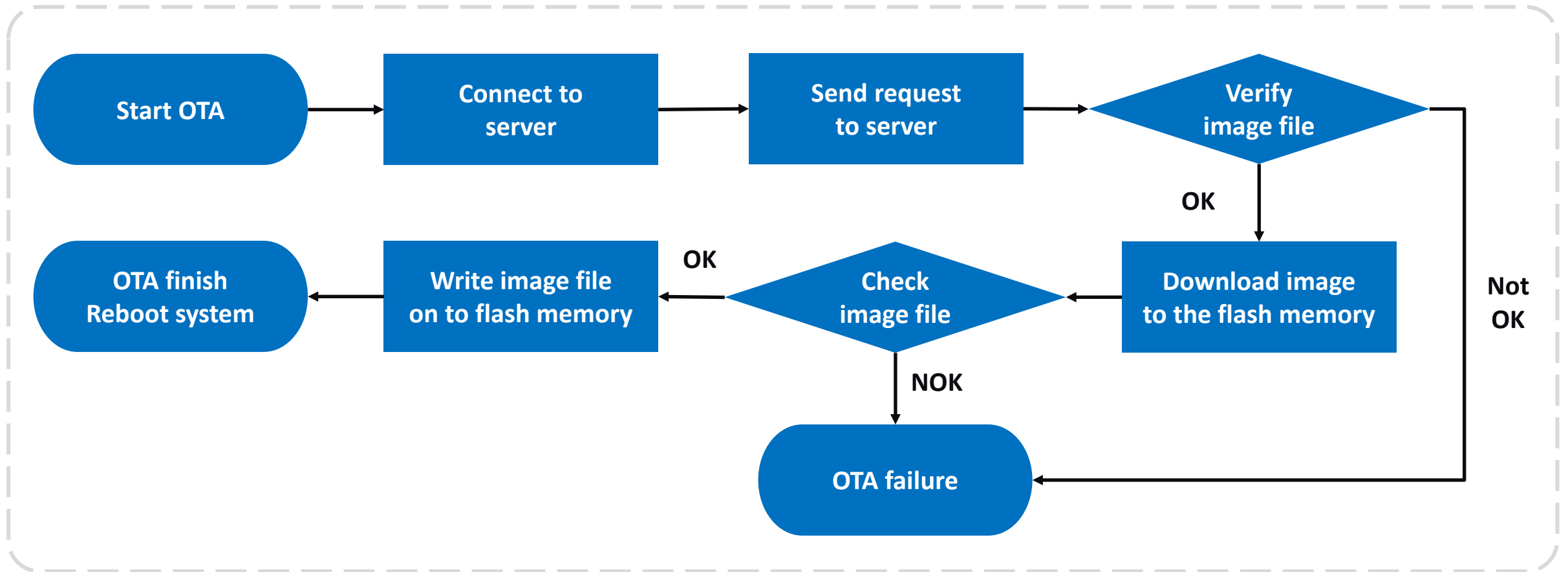
BLE OTA



Zigbee® OTA

Features

OTA DFU Flow Chart

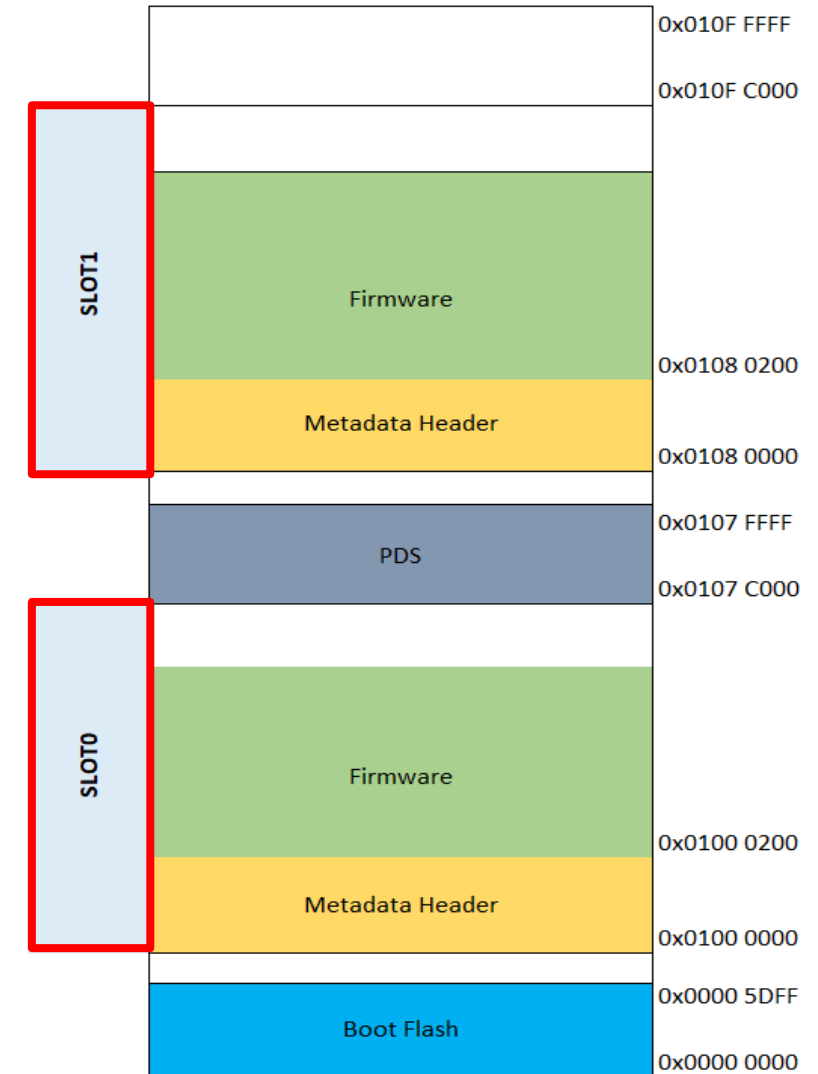


Features

OTA DFU Detail

- **OTA DFU Operation**

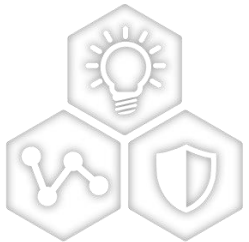
- Flash Image = Meta Header + F/W
- SLOT 0 using for saving the firmware which is running
- SLOT 1 using for saving the firmware which is downloading from OTA server
- If the downloaded firmware in SLOT 1 contains no error, it'll be moved on to SLOT 0



Development Tools



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Development Tools

MPLAB ECO System

- **Requirement**
 - Above MPLAB X IDE v6.05
 - Device Family Pack v1.0.107
 - Above MCC v5.1.9
 - Above XC32 Compiler v4.10



Development Tools

Boards for Development

You can get information about the device through URL below

WBZ451 Curiosity Board → <https://www.microchipdirect.com/dev-tools/EA71C53A>

RNBD451 Add on Board → <https://www.microchip.com/en-us/development-tool/EV25F14A>

WBZ451 Curiosity Board



MIKRO Click Interface

Power Break-out Current Pin

PIC Kit on Board 4

RNBD451 Add on Board



References

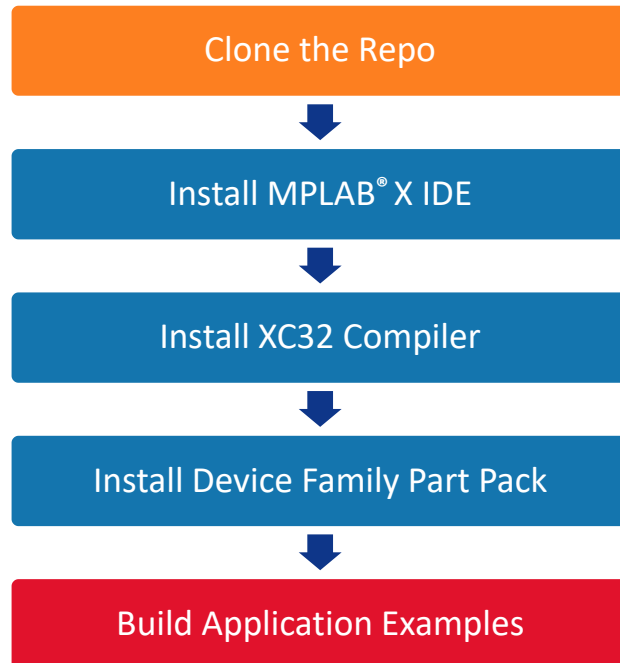
Developer's Guide

This guide may help you out to getting started develop application using PIC32CX-BZ2 family.

<https://onlinedocs.microchip.com/pr/GUID-A5330D3A-9F51-4A26-B71D-8503A493DF9C-en-US-2/index.html?GUID-4A40968E-8B6E-4C84-93B9-D31419BBBDA6>



Getting started is easy:



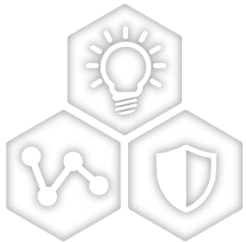
Everything you need to get your development journey started

- **Data Sheet, Schematics and User guide**
- **Example applications**
 - BLE Sensor App
 - BLE UART Demo
 - Zigbee Lights
 - Zigbee Multi-sensor
- **Building Blocks**
 - Training module for BLE feature implementation
 - Exercise to each steps

Application Examples



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Applications

Consumer

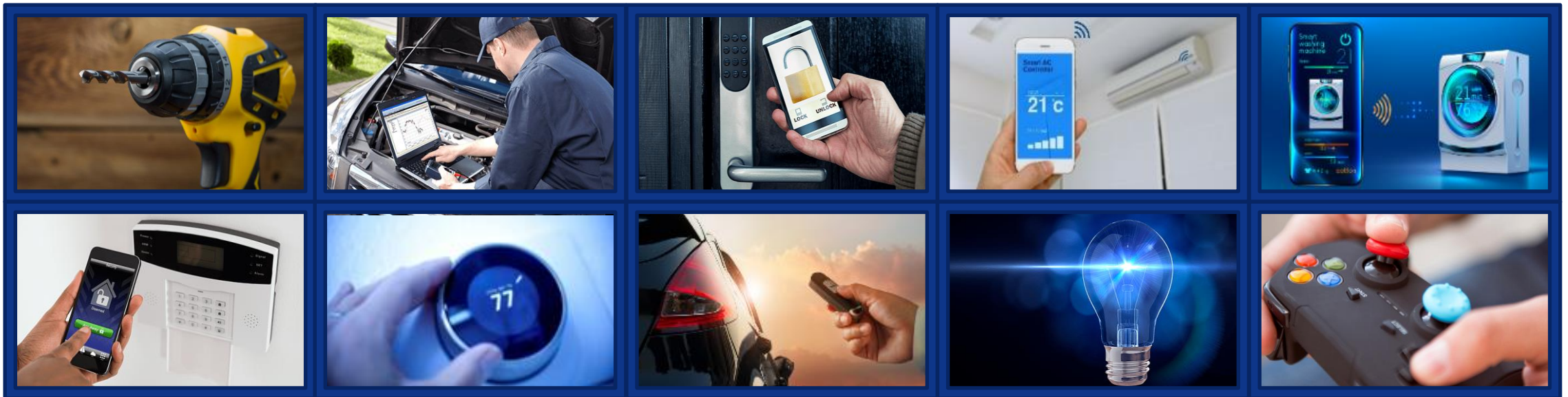
- Internet of Things
- Connected Lighting
- Smart Door Lock
- Smart Sensor

Industrial

- Connected Sensor
- HVAC Controls
- Diagnostics

Automotive

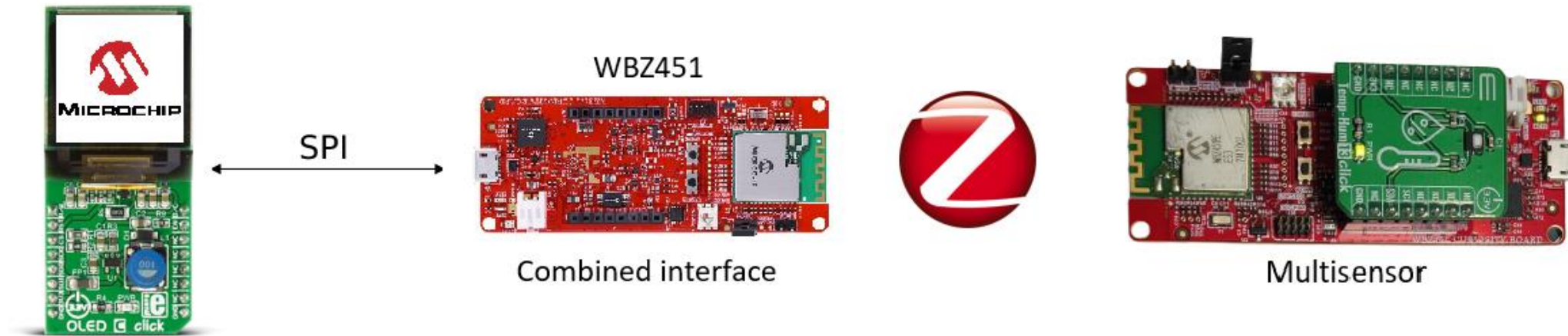
- Car-to-Home Automation
- Diagnostics



Application Examples

Zigbee® x OLED Display

- Sensor value displaying via Zigbee connection



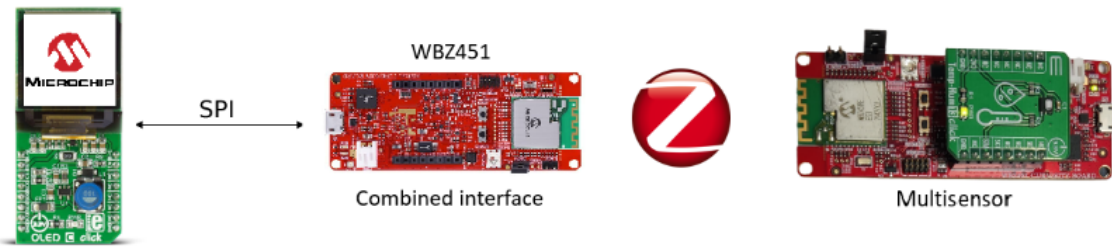
https://github.com/MicrochipTech/PIC32CXBZ2_WBZ45x_ZIGBEE_CI_OLED_Display

Application Examples

Zigbee® x OLED Display

1. Introduction

This application demonstrates the integration of the OLED Display and Zigbee (Combined Interface) stack on the PIC32CxBZ2/WBZ451 device. The temperature and humidity measurements from the [Zigbee Multisensor](#) device are displayed on the OLED C click.



OLED C click features the PSP27801 OLED display, with the resolution of 96x96 pixels. The graphics driver used on this OLED display is the SSD1351, the display driver IC from Solomon Systech with embedded 128x128x18 bit SRAM display buffer. The SSD1351 driver is designed to work with the common cathode type OLED displays.

2. Bill of materials

TOOLS	QUANTITY
PIC32CX-BZ2 and WBZ451 Curiosity Development Board	2
OLED C CLICK	1
TEMP&HUM 13 CLICK	1

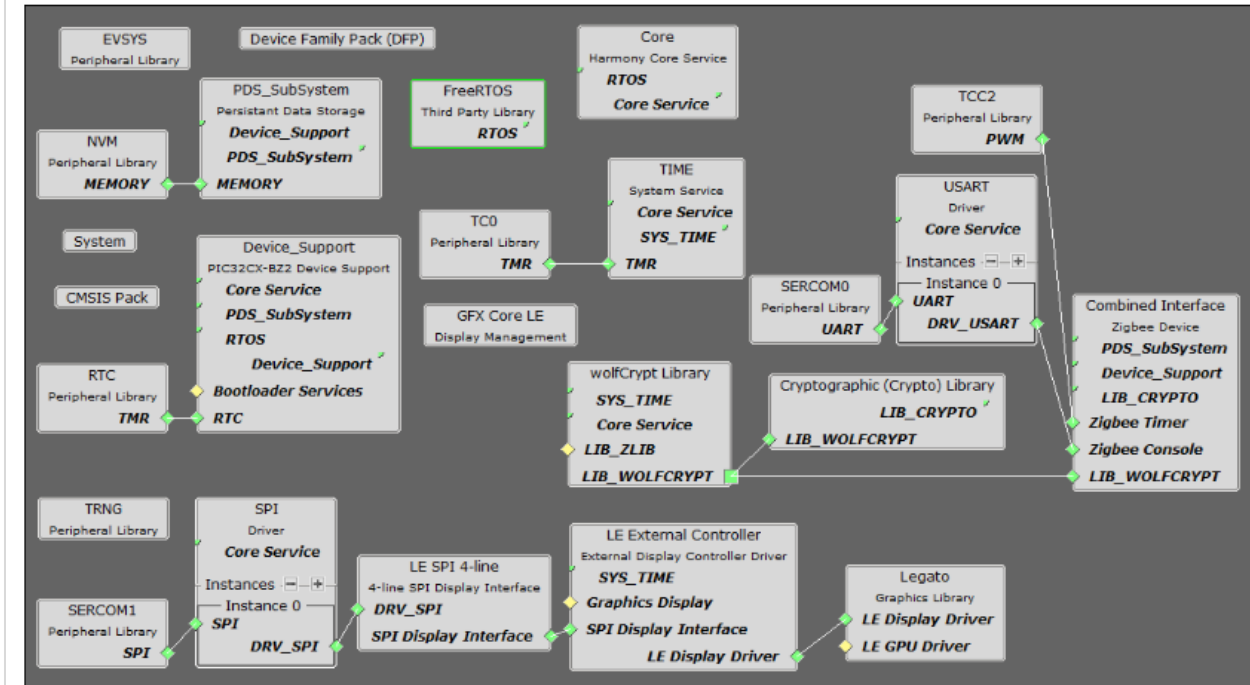
MicrochipTech / PIC32CXBZ2_WBZ451_ZIGBEE_CI_OLED_Display Public

Getting started with ZIGBEE CI and OLED DISPLAY with WBZ451 CURIOSITY BOARD.

Tip New users of MPLAB Code Configurator are recommended to go through the [overview](#)

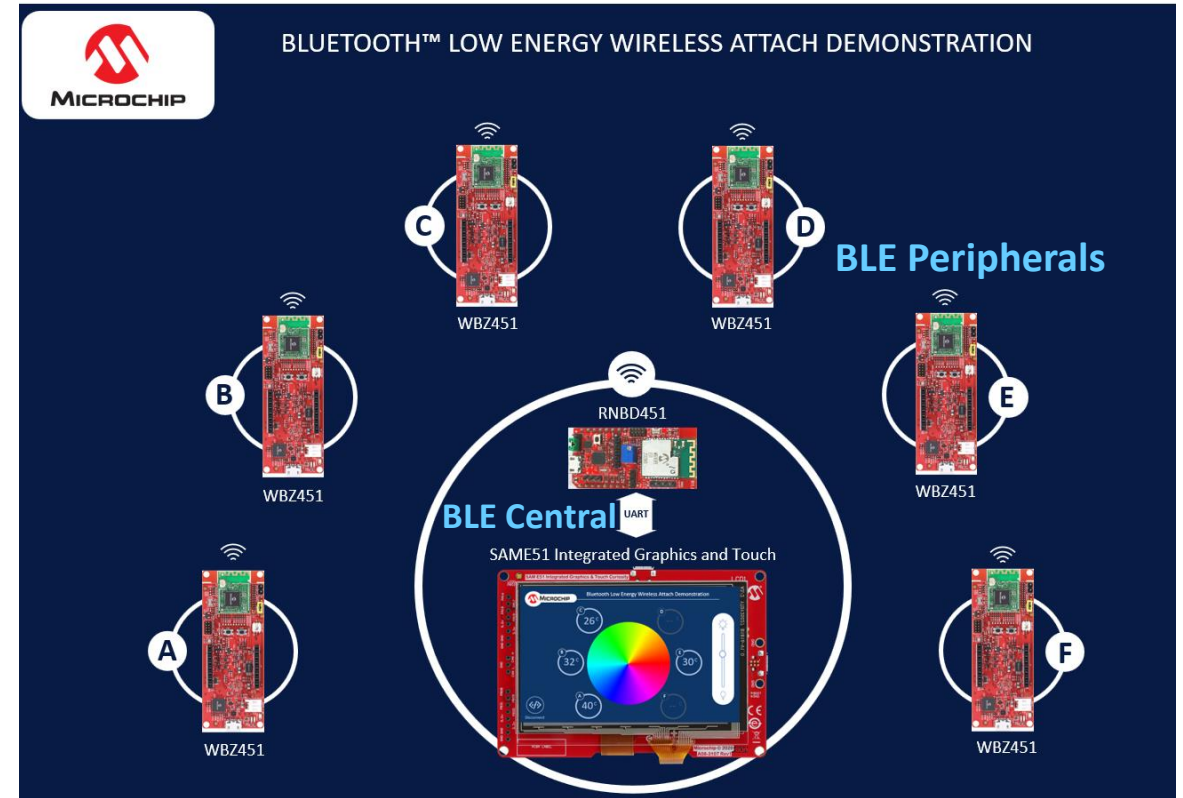
Step 1 - Connect the WBZ451 CURIOSITY BOARD to the device/system using a micro-USB cable.

Step 2 - The project graph of the ZIGBEE CI and OLED application is shown below.



Application Examples

Multi-Link (1:6)



Application Examples



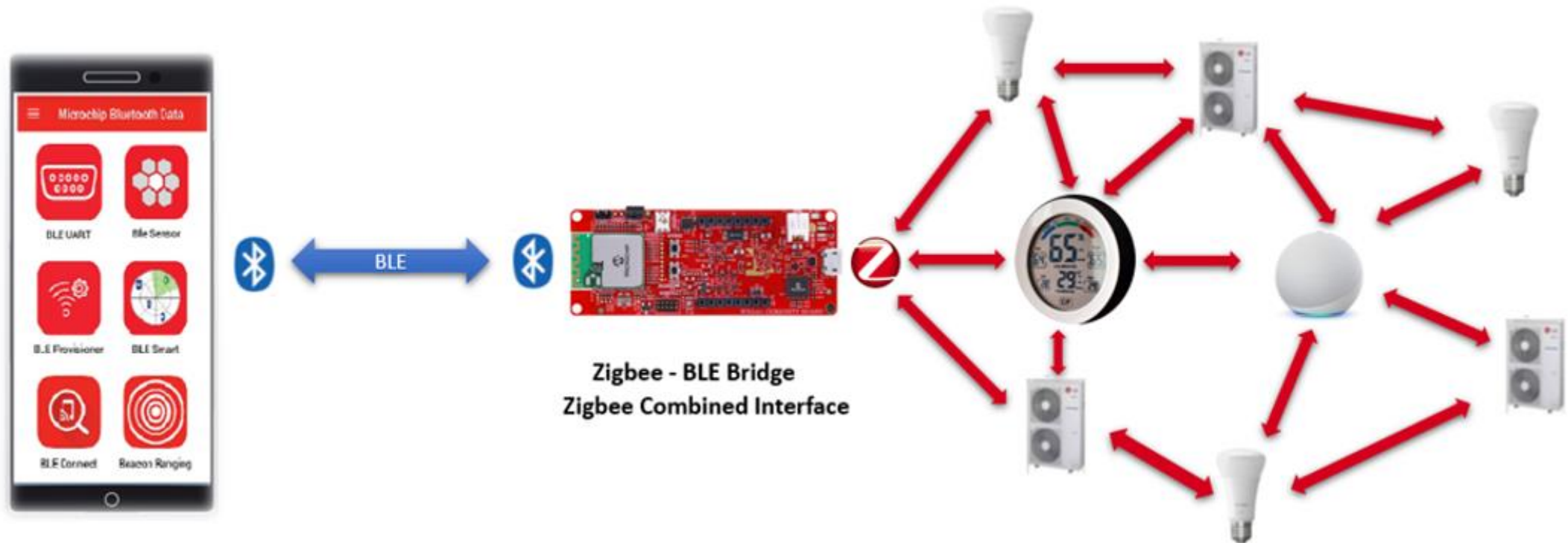
RNBD451(BLE Multilink)_WBZ451(6 Slaves)



Application Examples

Zigbee to BLE Bridge

- Provisioning to Zigbee topology via BLE

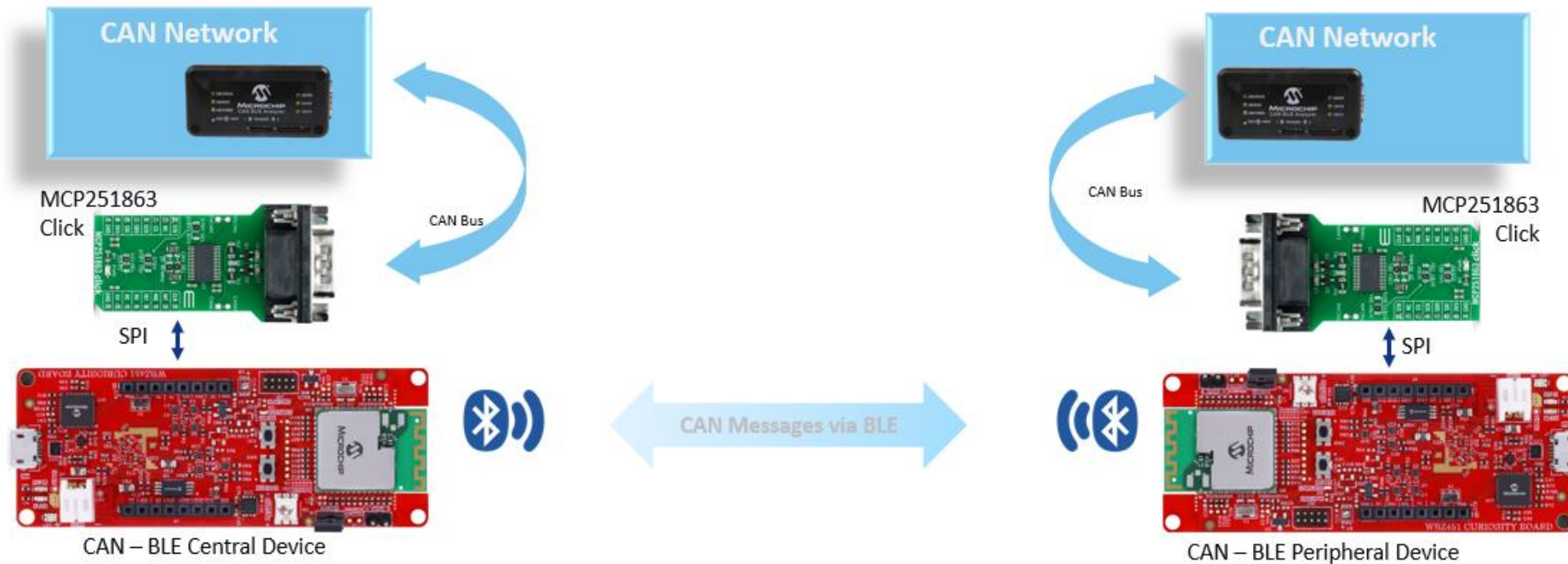


https://github.com/MicrochipTech/PIC32CXBZ2_WBZ45x_ZIGBEE_BLE_BRIDGE

Application Examples

CAN to BLE Bridge

- Transmitting CAN message via BLE

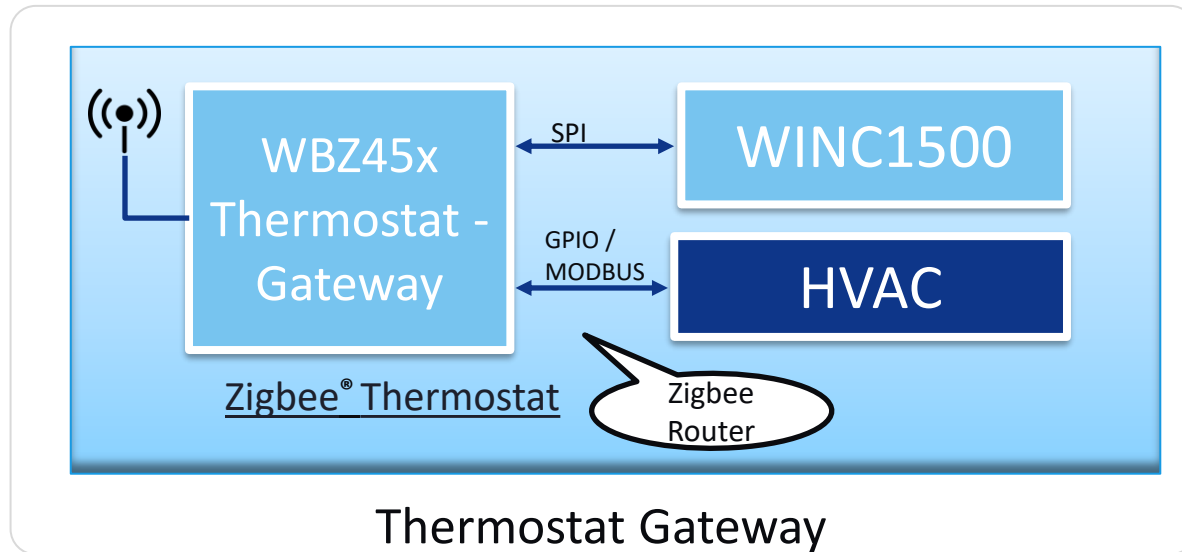


https://github.com/MicrochipTech/pic32cxbz2_wbz45x_ble_can_bridge

Application Examples

Wi-Fi to BLE Bridge

- Transmitting WLAN Data via BLE



https://github.com/MicrochipTech/PIC32CXBZ2_WBZ45x_BLE_WINC1500

Thank You
