This application note provides details on developing Dynamic Multiprotocol applications using Bluetooth and Zigbee. Using the examples described in QSG155: Using the Silicon Labs Dynamic Multiprotocol Demonstration Applications, this document describes how to configure applications in Simplicity Studio using the EmberZNet PRO SDK. It then provides a detailed walkthrough on how the underlying code functions. For details on Dynamic Multiprotocol Application development that apply to all protocol combinations see UG305: Dynamic Multiprotocol User’s Guide.

KEY POINTS

- Generating and loading dynamic multi-protocol example applications.
- Adding dynamic multiprotocol functionality to an existing project.
- Details on the application User Interface.
- How the Zigbee example applications function.
- How the Bluetooth application functions.
1 Introduction

QSG155: *Using the Silicon Labs Dynamic Multiprotocol Demonstration Applications* describes how to control:

- A dynamic multiprotocol light application
- A dynamic multiprotocol sleepy end device (SED) light application

The applications can be controlled either from a protocol-specific switch application or from a Bluetooth-enabled smartphone app. This application note provides details on how these examples are designed and implemented. It also describes how to generate, compile, and load example application code, and how to add dynamic multiprotocol functionality to an existing Zigbee project. The application note is intended to be used when developing your own Zigbee/Bluetooth dynamic multiprotocol implementations.

**Note:** The Zigbee dynamic multiprotocol solution is currently only supported for SoC architectures. Support for NCP architectures is not yet available. Please contact Silicon Labs Sales for more information on our multiprotocol software roadmap.

1.1 Resources

- **UG305: Dynamic Multiprotocol User’s Guide** provides details on:
  - Dynamic Multiprotocol Architecture
  - Radio Scheduler operation (with examples)
  - Task Priority management
- **AN1135: Using Third Generation Non-Volatile Memory (NVM3) Data Storage** explains how NVM3 can be used as non-volatile data storage in Dynamic Multiprotocol applications with Zigbee and Bluetooth.

1.2 Development Environment Requirements

The required hardware for the example implementation is described in QSG155: *Using the Silicon Labs Dynamic Multiprotocol Demonstration Applications*. Along with the Simplicity Studio development environment, required software tools are:

- EmberZNet SDK version 6.4.0 or higher
- Bluetooth SDK version 2.10.0 or higher
- Micrium OS-5 kernel version 5.3. or higher (installed automatically with EmberZNet SDK in Simplicity Studio)
- An EFR32 chip with at least 512 kB of flash (required to run all the necessary software components)
- IAR Embedded Workbench for ARM (IAR-EWARM) version compatible with your SDK.
2 Working with the Zigbee/Bluetooth Examples

This section describes

- How to build and flash the dynamic multiprotocol applications supplied with the EmberZNet SDK.
- How to configure a Zigbee project into a dynamic multiprotocol project.

2.1 Application Generation

To work with Zigbee/Bluetooth dynamic multiprotocol applications you must install both the EmberZNet SDK version 6.4.0.0 or higher, and the Bluetooth SDK version 2.10.0 or higher. The Micrium kernel is installed along with the EmberZNet SDK. IAR Embedded Workbench for ARM (IAR-EWARM) 8.30 must be installed and used as your compiler. See QSG106: Getting Started with EmberZNet PRO for information on installing the SDKs and IAR-EWARM.

Dynamic multiprotocol applications are generated, built, and uploaded in the same way as other applications. If you are not familiar with these procedures, see QSG106: Getting Started with EmberZNet PRO for details. The dynamic multiprotocol applications included with EmberZNet SDK 6.6.0.0 and higher are:

- **DynamicMultiprotocolLight** is an application designed to demonstrate a DMP device with FFD (Full Function Device) capabilities.
- **DynamicMultiprotocolLightSed** is an application designed to demonstrate a DMP device with SED capabilities.

**DynamicMultiprotocolSwitch** is a Zigbee-only application designed to work with the two Zigbee/Bluetooth applications.

The following summary procedure uses the **DynamicMultiprotocolLight** example application.

1. In Simplicity Studio, start a new project.
2. In the new project dialogs, select Silicon Labs Zigbee, then the EmberZNet SoC stack, then either begin with a working Zigbee application like one of the samples or, as in this procedure, select the **DynamicMultiprotocolLight** example.
3. Name the project, then click **Finish**.
4. If your project General tab still shows GNU-ARM as a compiler, change to IAR EWARM.
5. Click **Generate** to generate project files.
6. Click **** to build the application image.
7. Note the board and part number for your device and the directory for generated files.

8. Right-click the target J-Link under Devices, and select Upload Application.

9. Browse to `<folder on General tab>\IAR ARM - <qualifier>\<project name>` and select the .gbl file.

10. Silicon Labs strongly recommends that, if you have not already loaded a bootloader onto your device, you do so now. Check Erase chip before uploading image. Check Bootloader image, then browse to the following folder:

    C:\SiliconLabs\SimplicityStudio\v4\developer\sdks\gecko_sdk_suite\<version>\platform\bootloader\sample-apps\bootloader-storage-spiflash-single\

    Open the folder that corresponds to your board and part number and select the .s37 file, for example:

    \efr32mg12p432f1024gl125-brd4161a\bootloader-storage-spiflash-single-combined.s37
11. When both images are selected, the dialog should resemble the following figure. Click OK.

![Application image upload dialog](image)

12. Application load success indicators are code-dependent. With the DynamicMultiprotocolLight example, the LCD should display the following before changing over to the light bulb display:

![DynamicMultiprotocolLight LCD](image)

Whether the application is a full function or a sleepy end device is determined by the Device Type on the ZNet tab.
2.2 Converting a Zigbee Application to a Zigbee/Bluetooth LE Dynamic Multiprotocol Application

This section describes the configuration changes required to convert a working Zigbee application into a Zigbee/Bluetooth LE Dynamic Multiprotocol application. The instructions assume you have started with a non-DMP Zigbee sample application or your own Zigbee project, and that the application is working correctly.

Requirements:

- Zigbee application set up to build with IAR ARM v8.30.1 (for these instructions we use Z3 Light)
- EFR32MG12 or other EFR32 with sufficient memory (for these instructions we assume BRD4161 (EFR32MG12P432F1024GL125))

**Note:** The Dynamic Multiprotocol sample applications supplied with Simplicity Studio are already correctly defined and do not require modification before project generation unless performing an OTA update. There is a potential conflict with the DMP sample app LCD screen and the external flash. If you need to perform OTA updates, check the **Dynamic Multiprotocol UI Demo Code Stub** plugin as described in the following section.

2.2.1 Generate and Build the Zigbee Application

The purpose of this procedure is to verify that the base application had loaded and is working correctly, and that output is printing to the console. This example uses the Z3Light sample application in EmberZNet SDK version 6.6.1.0. It begins with the default settings, so that the configuration changes are clear.
Generate and build the project, load it to the board and check the Serial 1 output to make sure it's up and running.

2.2.2 Reconfigure the Project

The search bar at the top of the Plugins and other tabs is helpful when modifying the configuration. For plugins, the description explains its utility for DMP. The following figure illustrates finding the Micrium RTOS plugin and its description.
1. On the Plugins tab, check the following:

- **Micrium RTOS**

- **BLE**

- **Idle/Sleep**

- **mbed TLS Multiprotocol Configuration**

- **(optional) Dynamic Multiprotocol UI Demo Code Stub**

The USART used to communicate with the external flash on Silicon Labs radio boards is the same USART that communicates with the LCD display on the WSTK. In order to perform an OTA update on a sample app that uses the LCD display, check **Dynamic Multiprotocol UI Demo Code Stub**. This disables the LCD display but allows the OTA to take place.
2. On the Plugins tab, uncheck (disable) the following:
   - **Simple Main**

3. On the Plugins tab, change settings for the following:
   - **HAL**
     - Uncheck **Simulated EEPROM version 1 Library**.
     - Check **Simulated EEPROM Version 2 to NVM3 Upgrade Library** (this will also enable the NVM plugin).
   - **RAIL**
     - Uncheck **RAIL Library**.
     - Check **RAIL Library Multiprotocol**.
• **UTILITY**
  - In the CCM* Encryption plugin, uncheck **AES-CCM Software Implementation** and check **mbedTLS Implementation**.

4. Define the mbedTLS path:

   On the **Includes** tab, add a Macro for `mbedtls_config` with a value of "util\third_party\mbedtls\configs\config-multiprotocol.h".
5. Add Bluetooth GATT elements:

On the Bluetooth GATT tab, Services tab, drag and drop the following into the Custom BLE GATT window:

- Device Information
- Generic Access

6. Add an identifiable name for your device to advertise by modifying the Generic Access > Device Name Value. Be sure to increase the Length 1 byte per character.
7. Add BLE callback code:

In the Callbacks tab, enable Plugin-specific callbacks: Event.

8. Generate the project.

9. Add the following `emberAfPluginBleEventCallback` code in the `[project_name]_callbacks.c` file with:

```c
/** @brief
 * This function is called from the BLE stack to notify the application of a
 * stack event.
 * In this case it will provide simple advertising for the BLE component of the Z3Light DMP app
 */

void emberAfPluginBleEventCallback(struct gecko_cmd_packet* evt){

    switch (BGLIB_MSG_ID(evt->header)) {

    case gecko_evt_system_boot_id:
        gecko_cmd_le_gap_start_advertising(0, le_gap_general_discoverable, le_gap_connectable_scannable);
        emberAfCorePrintln("BLE Advertising started");
        break;

    case gecko_evt_le_connection_opened_id:
        emberAfCorePrintln("BLE connection opened"); //Will cause advertising to stop
        break;

    case gecko_evt_le_connection_closed_id:
        emberAfCorePrintln("BLE connection closed");
        gecko_cmd_le_gap_start_advertising(0, le_gap_general_discoverable, le_gap_connectable_scannable); // restarting advertising
        break;

    default :
        emberAfCorePrintln("unhandled BLE event\r\n");
        break; 
    }
```
10. Build and flash your project and look for your device in the Bluetooth Browser screen of the Blue Gecko cell phone app.

You can also see comments for the BLE activity in the Serial 1 window among the Zigbee prints.
This is very basic Bluetooth functionality. To learn more about programming BLE functionality, check the Simplicity Studio Launcher for the training documents, including QSG139: Getting Started with Bluetooth Software Development.
3 About the Zigbee/Bluetooth LE Examples

The Zigbee/Bluetooth LE Dynamic Multiprotocol examples demonstrate a light that can be controlled from both Bluetooth and a Zigbee network. Software is included both as compiled demonstrations and as example code in the EmberZNet SDK version 6.4.0. Demonstration functionality is illustrated in QSG155: Using the Silicon Labs Dynamic Multiprotocol Demonstration. The purpose of the examples is to show the way of implementing a dynamic multiprotocol application using the Silicon Labs EmberZNet stack.

The Dynamic Multiprotocol Demo application has three main components.
1. User Interface (LCD and Buttons)
2. Zigbee application (FFD and/or SED)
3. Bluetooth application

3.1 User Interface

The user interface is developed specifically for the dynamic multiprotocol demonstration, and APIs to update the text and graphic on the LCD are called directly from Zigbee and Bluetooth event handlers. The implementation to manipulate the LCD is contained in the following files,

- bitmaps.h //Contains the arrays containing the bitmap of the graphics drawn on the LCD
- dmp_ui.c //Contains the functions to change the state of the display based on the state of the application
- dmp_ui.h //Header file exporting functions implemented in the dmp_ui.c

The above uses the display driver library supplied by Silicon Labs to update the content on the LCD display mounted on the WSTK.

3.2 Zigbee Application

The example DynamicMultiprotocolLight is set up to be a light and a coordinator on the Zigbee network.

The following cluster set is supported by both the DynamicMultiprotocolLight and DynamicMultiprotocolLightSed applications.

<table>
<thead>
<tr>
<th>Supported Clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
</tr>
<tr>
<td>Identify</td>
</tr>
<tr>
<td>Scenes</td>
</tr>
<tr>
<td>Groups</td>
</tr>
<tr>
<td>On/Off</td>
</tr>
<tr>
<td>ZLL Commissioning</td>
</tr>
</tbody>
</table>

The DynamicMultiprotocolLight example also supports Green Power Proxy Basic behavior. Please note that the examples were developed with a focus on demonstrating dynamic multiprotocol features and may not be Zigbee-certifiable.

The On/Off cluster controls the LEDs and the bulb icon on the WSTK board to represent the state of the light.

The dynamic multiprotocol applications make use of Micrium OS and the Zigbee applications are run as a task of Micrium OS.

The hardware and peripherals of the chip are initialized before any tasks are created. A Zigbee task is created after initialization, which then creates the application tasks and Bluetooth task.

The Micrium plugin also includes the source file micrium-rtos-sleep.c, which enables the sleepy DMP application to manage the sleep functionality.
From: micrium-rtos-main.c

```c
#include <hal.h>
#include <micrium.h>
#include <ember.h>

OSTaskCreate(&zigbeeTaskControlBlock,
             "Zigbee Stack",
             zigbeeTask,
             NULL,
             ZIGBEE_STACK_TASK_PRIORITY,
             zigbeeTaskStack[0],
             EMBER_AF_PLUGIN_MICRIUM_RTOS_ZIGBEE_STACK_SIZE / 10,
             EMBER_AF_PLUGIN_MICRIUM_RTOS_ZIGBEE_STACK_SIZE,
             0, // Not receiving messages
             0, // Default time quanta
             NULL, // No TCB extensions
             OS_OPT_TASK_STK_CLR | OS_OPT_TASK_STK_CHK,
             &err);

bluetooth_start_task(BLE_LINK_LAYER_TASK_PRIORITY,
                     BLE_STACK_TASK_PRIORITY);
```
About the Zigbee/Bluetooth LE Examples

From: af-main-soc.c

```c
Af-main-soc.c

status=emberInit();

emAfInitializeNetworkIndexStack();
// Initialize messageSentCallbacks table
emAfInitializeMessageSentCallbackArray();
emberAfEndpointConfigure();
emAfInit();
// The address cache needs to be initialized and used with the
// code for the trust center to operate properly.
securityAddressCacheInit(EMBER_AF_PLUGIN_ADDRESS_TABLE_SIZE,
// offset
EMBER_AF_PLUGIN_ADDRESS_TABLE_TRUST_CENTER_CACHE_SIZE);
// size
EM_AF_NETWORK_INIT();

while (true) {
    halResetWatchdog();  // Periodically reset the watchdog.
    emberTick();          // Allow the stack to run.
    // Allow the ZCL clusters and plugin ticks to run. This
    // should go
    // immediately after emberTick
    // Skip these ticks if a crypto operation is ongoing
    if (0 == emAfIsCryptoOperationInProgress()) {
        emAfTick();
    }
    emberSerialBufferTick();
    emberAfRunEvents();
}
On either DMP light application, once the Zigbee stack is set up to run, subsequent interactions with the stack occur via event handlers, as shown in the following figures. The following figure shows the event handlers in the full function light application.

**Figure 3-1. DMP Full Function Light Event Handler Definition**

- **emberAfStackStatusCallback**
  - Start permit Join and identify for 180 s
  - Restart the reporting for On/Off attribute

- **emberAfOnOffClusterServerAttributeChangeCallback**
  - Update the LED state.
  - Send an indication to mobile device for light state and trigger source.

- **emberAfTrustCenterJoinCallback**
  - if (status = DEVICE_LEFT)\n    - Clear Binding table entry
  - if (status = DEVICE_JOIN)\n    - Disable permit join

- **buttonEventHandler**
  - if (button = BUTTON0)\n    - Toggle the ON_OFF_ATTRIBUTE
  - if ((button = BUTTON1)\n    - if(noNwk) -> formNwk
    - else if(longPress) -> LeaveNwk
    - else -> start pjoin and identify for 180s.

**Note:** Whenever the light starts pjoin, it starts identifying and also puts all the connected lights in identify mode. This helps the joining switch to identify all the lights present in the network.
The following figure shows the application interaction with the stack with the event handlers used for the sleepy light application.

Figure 3-2 DMP Sleepy Light Event Handler Definition

**Note:** To avoid the risk of shared resources, if you want to send Zigbee messages from a task other than the Zigbee Stack Task, we advise you to schedule a custom event from within the non-Zigbee Stack task. In the corresponding event handler function for the custom event the Zigbee stack APIs can be used, as the event handler will be called from the Zigbee Stack Task context.
3.3 Bluetooth Application

The Bluetooth application supports following services and characteristics. These are pre-selected in the GATT editor during project generation.

<table>
<thead>
<tr>
<th>Service</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Information</td>
<td>Manufacturer Name String</td>
</tr>
<tr>
<td></td>
<td>Model Number String</td>
</tr>
<tr>
<td></td>
<td>Serial Number String</td>
</tr>
<tr>
<td></td>
<td>Firmware Revision String</td>
</tr>
<tr>
<td>Generic Access</td>
<td>Device Name</td>
</tr>
<tr>
<td></td>
<td>Appearance</td>
</tr>
<tr>
<td>Silabs DMP Light</td>
<td>Light</td>
</tr>
<tr>
<td></td>
<td>Trigger Source</td>
</tr>
</tbody>
</table>

3.3.1 Silabs DMP Light Service

In the above table the Silabs DMP Light is a custom service with a UUID of bae55b96-7d19-458d-970c-50613d801bc9. This custom UUID is used to uniquely identify the Light by the Wireless Gecko application.

The Service has two characteristics,

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
</table>
| Light          | 8bit Boolean | Used to get and set the light state  
                |            | 1 = Light On  
                |            | 0 = Light Off |
| Trigger Source | 8bit enum | Indicates the source of the Light state  
                |            | change command.  
                |            | 0 = Bluetooth  
                |            | 1 = Zigbee  
                |            | 2 = Button Press |

3.3.2 Beacons

The application implements both an iBeacon as well as an Eddystone beacon. The default behavior is to transmit each beacon at 100 mS intervals.
3.3.3 Bluetooth Event Handling

The Bluetooth stack is initialized as part of the Zigbee Task, as shown in the Zigbee implementation section. The Bluetooth task handles the Bluetooth LE link layer messaging and management. The Bluetooth stack’s interaction with the user application is through a framework plugin. A number of events that are called in the context of the Zigbee task allow the user application to interact with the Bluetooth stack. The following diagram describes the Bluetooth-related events.

**Note:** Bluetooth event handling is same for both DMP demos.

![Figure 3-3 DMP Bluetooth Event Handler Definition](image)

3.3.4 Bluetooth and Zigbee Interaction

The primary purpose of the example applications is to show Zigbee and Bluetooth working together on a device. For this purpose, when the Light receives a command to change its state through one protocol, it executes the command and sends out a notification to the other devices using the other protocol to keep everything in sync. Their interaction is the same in both examples.

Two basic operations are described below, first a write to Light characteristics from a Bluetooth connected device (shown in the following figure) and then a change in the Light state from a Zigbee device.
Write from the Bluetooth Connected Device

The application’s services and characteristics are pre-selected in the GATT editor in Simplicity Studio. Upon generation the characteristics are #define in the gatt_db.h. Using the #define reference, the characteristics can then be coupled to read and write Bluetooth requests. For example the Light characteristic is reference from GATT as `gatt_light_state` which is then tied to an application specific write API of `writeLightState` in the `AppCfgGattServerUserWriteRequest` as shown below.

```c
static const AppCfgGattServerUserWriteRequest_t appCfgGattServerUserWriteRequest[] =
{
    { gattdb_light_state, writeLightState },
    { 0, NULL }
};
```

The application implements the Zigbee attribute write and a Bluetooth write response in the `writeLightState` function as follows:

```c
static void writeLightState(uint8_t connection, uint8array *writeValue)
{
    lightDirection = DMP_UI_DIRECTION_BLUETOOTH;
    emberAfWriteAttribute(emberAfPrimaryEndpoint(),
        ZCL_ON_OFF_CLUSTER_ID,
        ZCL_ON_OFF_ATTRIBUTE_ID,
        CLUSTER_MASK_SERVER,
        (int8u *)&writeValue->data[0],
        ZCL_BOOLEAN_ATTRIBUTE_TYPE);
    gecko_cmd_gatt_server_send_user_write_response(
        connection,
        gattdb_light_state,
        ES_WRITE_OK
    );
}
```

The `emberAfWriteAttribute()` is used to write the attribute table of the Zigbee application with the value supplied by the Bluetooth connected device above. Since the on-off attribute of the on-off server cluster is a reportable attribute it is reported to all devices setup in the binding table of the Light.

The `emberAfOnOffClusterServerAttributeChangedCallback()` is then used to change the state of the LEDs and the LCD to indicate the state of the light on the WSTK main board.

Write from the Zigbee Connected Device

The flow in the other direction, that is a change in the Light state from Zigbee connected device, is shown in the following figure.
Any on-off client on the same network as the Light can send an on-off cluster’s On, Off or Toggle command to the Light to change its state. Once such a command is received over the Zigbee interface the Silicon Labs Zigbee framework interprets it and calls an appropriate handler to change the value of on-off attribute of the on-off server cluster. In the example `DynamicMultiprotocolSwitch` application the on-off client sends a Toggle command to the Light, which toggles the value of the on-off attribute and triggers the `emberAfOnOffClusterServerAttributeChangedCallback()`. The callback is then used to change the state of the light as well as send notifications for both Trigger Source and Light characteristics to the connected Bluetooth devices and to update the LEDs and the LCD to indicate the change in the Light state.

```c
void emberAfOnOffClusterServerAttributeChangedCallback(int8u endpoint,
            EmberAfAttributeId attributeId)
{
    EmberStatus status;
    int8u data;

    if (attributeId == ZCL_ON_OFF_ATTRIBUTE_ID) {
        status = emberAfReadAttribute(endpoint,
            ZCL_ON_OFF_CLUSTER_ID,
            ZCL_ON_OFF_ATTRIBUTE_ID,
            CLUSTER_MASK_SERVER,
            (int8u*)&data,
            sizeof(data),
            NULL);

        if (status == EMBER_ZCL_STATUS_SUCCESS) {
            if (data == 0x00) {
                halClearLed(BOARDLED0);
                halClearLed(BOARDLED1);
                dmpUiLightOff();
                notifyLight(currentConnection, 0);
            } else {
                halSetLed(BOARDLED0);
                halSetLed(BOARDLED1);
                dmpUiLightOn();
            }
            if ( (lightDirection == DMP_UI_DIRECTION_BLUETOOTH) || (lightDirection == DMP_UI_DIRECTION_SWITCH) ) {
                dmpUiUpdateDirection(lightDirection);
            } else {
                lightDirection = DMP_UI_DIRECTION_ZIGBEE;
                dmpUiUpdateDirection(lightDirection);
            }
            ble_lastEvent = lightDirection;
            lightDirection = DMP_UI_DIRECTION_INVALID;

            if (ble_lastEvent != DMP_UI_DIRECTION_INVALID) {
                if ( (ble_lightState_config != GAT_RECEIVE_INDICATION) && (ble_lastEvent_config == GAT_RECEIVE_INDICATION) ) {
                    notifyTriggerSource(currentConnection, ble_lastEvent);
                }
            } else {
                if (ble_lightState_config != GAT_RECEIVE_INDICATION) {
                    notifyTriggerSource(currentConnection, ble_lastEvent);
                }
            }
        } else {
        }
    }
}
```
Simplicity Studio

One-click access to MCU and wireless tools, documentation, software, source code libraries & more. Available for Windows, Mac and Linux!

IoT Portfolio
www.silabs.com/IoT

SW/HW
www.silabs.com/simplicity

Quality
www.silabs.com/quality

Support and Community
community.silabs.com

Disclaimer
Silicon Labs intends to provide customers with the latest, accurate, and in-depth documentation of all peripherals and modules available for system and software implementers using or intending to use the Silicon Labs products. Characterization data, available modules and peripherals, memory sizes and memory addresses refer to each specific device, and "Typical" parameters provided can and do vary in different applications. Application examples described herein are for illustrative purposes only. Silicon Labs reserves the right to make changes without further notice to the product information, specifications, and descriptions herein, and does not give warranties as to the accuracy or completeness of the included information. Without prior notification, Silicon Labs may update product firmware during the manufacturing process for security or reliability reasons. Such changes will not alter the specifications or the performance of the product. Silicon Labs shall have no liability for the consequences of use of the information supplied in this document. This document does not imply or expressly grant any license to design or fabricate any integrated circuits. The products are not designed or authorized to be used within any FDA Class III devices, applications for which FDA premarket approval is required or Life Support Systems without the specific written consent of Silicon Labs. A "Life Support System" is any product or system intended to support or sustain life and/or health, which, if it fails, can be reasonably expected to result in significant personal injury or death. Silicon Labs products are not designed or authorized for military applications. Silicon Labs products shall under no circumstances be used in weapons of mass destruction including (but not limited to) nuclear, biological or chemical weapons, or missiles capable of delivering such weapons. Silicon Labs disclaims all express and implied warranties and shall not be responsible or liable for any injuries or damages related to use of a Silicon Labs product in such unauthorized applications.

Trademark Information
Silicon Laboratories Inc.® , Silicon Laboratories®, Silicon Labs®, SiLabs® and the Silicon Labs logo®, Bluegiga®, Bluegiga Logo®, ClockBuilder®, CMEMS®, DSPLL®, EFM®, EFM32®, EFR, Ember®, Energy Micro, Energy Micro logo and combinations thereof, "the world’s most energy friendly microcontrollers", Ember®, EZLink®, EZRadio®, EZRadioPRO®, Gecko®, Gecko OS, Gecko OS Studio, ISOModem®, Precision32®, ProSLIC®, Simplicity Studio®, SiPHY®, Telegesis, the Telegesis Logo®, USBXpress®, Zentri, the Zentri logo and Zentri DMS, Z-Wave®, and others are trademarks or registered trademarks of Silicon Labs. ARM, CORTEX, Cortex-M3 and THUMB are trademarks or registered trademarks of ARM Holdings. Keil is a registered trademark of ARM Limited. Wi-Fi is a registered trademark of the Wi-Fi Alliance. All other products or brand names mentioned herein are trademarks of their respective holders.

http://www.silabs.com