Introduction

The beacon application in the X-CUBE-BLE1 STM32 Cube package is an implementation of the Google Eddystone beacon profile, built on the STM32Cube™ software platform. The package comes with code examples for the X-NUCLEO-IDB05A1, NUCLEO-L053R8, NUCLEO-L476RG and NUCLEO-F401RE.

The application features:

- BLE profile running on a Google Eddystone beacon platform
- Support for the UID and URL frame types
- Portability across different STM32 device families thanks to STM32Cube™
Contents

1 Acronyms and abbreviations ............................................................ 4
2 Description ....................................................................................... 5
3 Eddystone beacon demonstration application ................................. 6
   3.1 Initialization .............................................................................. 6
   3.2 Define advertising data ............................................................. 6
   3.3 Entering non-connectable mode ................................................... 7
   3.4 Modifying eddystone_beacon.h ................................................. 8
4 Limitations and known issues .......................................................... 9
5 References ...................................................................................... 10
6 Revision history ............................................................................ 11
List of tables

Table 1: Acronym description ..................................................................................................................... 4
Table 2: BlueNRG-MS Eddystone beacon advertising service data .......................................................... 6
Table 3: Document revision history .......................................................................................................... 11
# Acronyms and abbreviations

## Table 1: Acronym description

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACI</td>
<td>Application controller interface</td>
</tr>
<tr>
<td>ATT</td>
<td>Attribute protocol</td>
</tr>
<tr>
<td>BLE</td>
<td>Bluetooth low energy</td>
</tr>
<tr>
<td>BSP</td>
<td>Board support package</td>
</tr>
<tr>
<td>BT</td>
<td>Bluetooth</td>
</tr>
<tr>
<td>GAP</td>
<td>Generic access profile</td>
</tr>
<tr>
<td>GATT</td>
<td>Generic attribute profile</td>
</tr>
<tr>
<td>HAL</td>
<td>Hardware abstraction layer</td>
</tr>
<tr>
<td>HCI</td>
<td>Host controller interface</td>
</tr>
<tr>
<td>IDE</td>
<td>Integrated development environment</td>
</tr>
<tr>
<td>MCU</td>
<td>Micro controller unit</td>
</tr>
<tr>
<td>PCI</td>
<td>Profile command interface</td>
</tr>
<tr>
<td>UUID</td>
<td>Universally unique identifier</td>
</tr>
</tbody>
</table>
2 Description

The BLE Eddystone beacon uses the following hardware and software components available for download at www.st.com:

- NUCLEO-L053R8: STM32 Nucleo-64 development board with STM32L053R8 MCU, supports Arduino and ST morpho connectivity
- NUCLEO-L476RG: ultra-low-power with FPU ARM Cortex-M4 MCU 80 MHz with 1 Mbyte Flash, LCD, USB OTG
- NUCLEO-F401RE: STM32 dynamic efficiency MCU, ARM Cortex-M4 core with DSP and FPU, up to 512 Kbytes Flash, 84 MHz CPU, Art accelerator
- X-NUCLEO-IDB05A1: BLE expansion board based on SPBTLE-RF module for STM32 Nucleo
- STM32CubeL0 HAL support package
- STM32CubeL4 HAL support package
- STM32CubeF4 HAL support package
- X-CUBE-BLE1 driver package, BLE software expansion for STM32Cube™
- Custom Eddystone compliant profile supporting UID and URL frame types.

The STM3Cube™ platform aims at reducing the development effort, time and cost associated with using STM32 devices in your design. It mainly consists in the following components:

- STM32CubeMX: the graphical software configuration tool for C initialization code generation
- STM32Cube HAL: the STM32 hardware abstraction layer, ensuring portability across the STM32 microcontroller portfolio
- Middleware: RTOS, USB, TCP/IP & graphics libraries.

Further details on STM3Cube™ can be found at http://www.st.com/stm32cube.
3 Eddystone beacon demonstration application

The software development kit contains a BlueNRG-MS configuration example which advertises specific service data and allows another BLE device to recognize if it is in the range of the BlueNRG-MS beacon device.

This section describes how to configure a BlueNRG-MS device to be used as an Eddystone beacon device.

3.1 Initialization

The BlueNRG-MS stack must be correctly initialized as follows:

- Initialize the GATT (general attribute profile) server in the device (ACI_GATT_INIT);
- Initialize the GAP (general access profile) in the device in peripheral mode (ACI_GAP_INIT: peripheral).

3.2 Define advertising data

The BLE Eddystone beacon application advertises the following service data:

<table>
<thead>
<tr>
<th>Mode</th>
<th>Data field</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>UID</td>
<td>Tx Power</td>
<td>Calibrated Tx power at 0 m</td>
<td>The best way to determine this value is to measure the beacon actual output at 1 meter and add 41 dBm (signal loss over 1 meter).</td>
</tr>
<tr>
<td></td>
<td>Namespace ID</td>
<td>10-byte ID Namespace</td>
<td>Unique self-assigned beacon namespace.</td>
</tr>
<tr>
<td></td>
<td>Beacon ID</td>
<td>6-byte ID Instance</td>
<td>Unique ID within the namespace.</td>
</tr>
<tr>
<td>URL</td>
<td>Tx power</td>
<td>Calibrated Tx power at 0 m</td>
<td>The best way to determine this value is to measure the beacon actual output at 1 meter and add 41 dBm (signal loss over 1 meter).</td>
</tr>
<tr>
<td>URL scheme</td>
<td>Encoded Scheme Prefix</td>
<td>See the Eddystone github for details.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Encoded URL</td>
<td>Encoded URL (max 17 char.)</td>
<td>The URL scheme is defined by RFC-1738. It is recommended to use a URL shortening service if the desired URL is longer than 17 characters.</td>
</tr>
</tbody>
</table>
### 3.3 Entering non-connectable mode

In order to set a static MAC address, the device uses the ACI HAL to write the desired MAC address in BlueNRG-MS_Init() function:

```c
aci_hal_write_config_data(CONFIG_DATA_PUBADDR_OFFSET, CONFIG_DATA_PUBADDR_LEN, SERVER_BDADDR)
```

where SERVER_BDADDR is the 6-byte MAC address.

The BLE beacon device uses the GAP ACI command to enter non-connectable, undirected mode:

```c
aci_gap_set_discoverable(ADV_NONCONN_IND, /*< Advertise as non-connectable, undirected. */
AdvertisingInterval, AdvertisingInterval, /*< Set the advertising interval min and max (0.625 us increment). */
PUBLIC_ADDR, /*< Use the public address. */
NO_WHITE_LIST_USE, /*< Do not set any connection white list. */
0, NULL, /*< Do not use a local name. */
0, NULL, /*< Do not include the service UUID list. */
0, 0); /*< Do not set a slave connection interval. */
```

In order to advertise the specific selected service data, the BLE beacon application uses the GAP ACIs in EddystoneUID_Init() or EddystoneURL_Init() functions:

```c
/* Remove TX power level field from the advertising data: it may be necessary to have enough space for the beacon service data */
ret = aci_gap_delete_ad_type(AD_TYPE_TX_POWER_LEVEL);/* Define the beacon service payload for UID data */
uint8_t service_data[] =
|
23, /*< Length. */
AD_TYPE_SERVICE_DATA, /*< Service Data data type value. */
0xAA, 0xFE, /*< 16-bit Eddystone UUID. */
0x00, /*< UID frame type. */
EddystoneUID_Init->CalibratedTxPower, /*< Ranging data. */
EddystoneUID_Init->NamespaceID[0], /*< 10-byte ID Namespace. */
EddystoneUID_Init->NamespaceID[1],
EddystoneUID_Init->NamespaceID[2],
EddystoneUID_Init->NamespaceID[3],
EddystoneUID_Init->NamespaceID[4],
EddystoneUID_Init->NamespaceID[5],
EddystoneUID_Init->NamespaceID[6],
EddystoneUID_Init->NamespaceID[7],
EddystoneUID_Init->NamespaceID[8],
EddystoneUID_Init->NamespaceID[9],
EddystoneUID_Init->BeaconID[0], /*< 6-byte ID Instance. */
EddystoneUID_Init->BeaconID[1],
EddystoneUID_Init->BeaconID[2],
EddystoneUID_Init->BeaconID[3],
EddystoneUID_Init->BeaconID[4],
EddystoneUID_Init->BeaconID[5],
0x00, /*< Reserved. */
0x00 /*< Reserved. */
|);
/* Set the beacon service data on the advertising packet */
ret = aci_gap_update_adv_data(sizeof(service_data), service_data);
/* Define the beacon service uuid list */
uint8_t service_uuid_list[] =
|
3, /*< Length. */
AD_TYPE_16_BIT_SERV_UUID_CMPLT_LIST, /*< Complete list of 16-bit Service UUIDs data type value. */
0xAA, 0xFE /*< 16-bit Eddystone UUID. */
|);
/* Set the beacon service data on the advertising packet */
ret = aci_gap_update_adv_data(sizeof(service_uuid_list), service_uuid_list);
```
3.4 Modifying eddystone_beacon.h

Beacon configuration can be performed easily by modifying the relevant fields within eddystone_beacon.h:

```c
#define MAC_ADDRESS 0x12, 0x34, 0x00, 0xE1, 0x80, 0x03
#define EDDYSTONE_UID_BEACON_TYPE (0x01u)
#define EDDYSTONE_URL_BEACON_TYPE (0x02u)
#define ADVERTISING_INTERVAL_IN_MS (10000)
#define CALIBRATED_TX_POWER_AT_0_M ((uint8_t) (-22))
#define NAMESPACE_ID 'w', 'w', 'w', '.', 's', 't', '.', 'c', 'o', 'm'
#define BEACON_ID 0, 0, 0, 0, 0, 1
#define URL_PREFIX HTTP
#define PHYSICAL_WEB_URL "goo.gl/viVrdi"
```

The MAC_ADDRESS field must be modified with the desired MAC address, in MAC-48 format. The ordering is in LSB.

ADVERTISING_INTERVAL_IN_MS is a common field for all beacon types and must be specified.

CALIBRATED_TX_POWER_AT_0_M can be determined by measuring the transmission power (in dBm) at 1 m and adding 41 dBm, which is the standard loss over 1 m. This field is required for UID and URL beacons.

NAMESPACE_ID and BEACON_ID are specific to the EddystoneUID beacon. Refer to Table 2: "BlueNRG-MS Eddystone beacon advertising service data" for details.

URL_PREFIX specifies the prefix of the desired URL:

- HTTP, if the address begins with "http://"
- HTTPS, if the address begins with "https://"
- HTTP_WWW, if the address begins with "http://www."
- HTTPS_WWW, if the address begins with "https://www."

PHYSICAL_WEB_URL is the remainder of the URL after the prefix.

There is a 17 character limit to this URL.
4 Limitations and known issues

Currently, multi-beacons are not supported: only a single Eddystone beacon frame type can be exposed at any given point in time.

Eddystone advertising interval must be less than 40959 milliseconds.
5 References

2. UM1873: Getting started with the X-CUBE-BLE1 Bluetooth Low Energy software expansion for STM32Cube
3. AN4642: Overview of the BLE Profiles application for X-CUBE-BLE1, expansion for STM32Cube
## 6 Revision history

Table 3: Document revision history

<table>
<thead>
<tr>
<th>Date</th>
<th>Version</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-Dec-2016</td>
<td>1</td>
<td>Initial release.</td>
</tr>
</tbody>
</table>

