Project Univet L002 – Remote Control

Document Revision			
Version	*Date*	*Author*	*Description*
1.00	29th November 2016	EP	First release.
1.01	21st February 2017	SZ	Added RF spectrum occupation diagrams.

Introduction

The purpose of the present document is to supply the general description of the software architecture, designed to satisfy both the functionalities defined into the product specifications and the hardware design specifications.

Project Univet L002

The project L002 has the main target to realize a Central (or Control) Unit which drives an high brightness LED with intensity control, and a Remote Unit that controls the Central Unit, throughout BLE communication Protocol.

The HW architecture for both two devices is based on a single integrated unit for logic, both for the radio device BLE, enclosed in Microcontroller Texas Instruments CC2640.
On the other hand, the SW architectures of the two devices will be different, both in the part of OS, either in part of application.

The software architecture for the Microcontroller Texas CC2640 is composed of 2 parts:
1) A component that performs the OS function, which deals with the allocation of low-level resources. Inside TI Integrated Development Environment this component is referred to as a Stack. The Stack implemented follows the samples supplied by Texas Instruments for these parts.
2) A component that performs the functions of the application, which uses the low-level functions provided by the OS.

The Bluetooth LE protocol defines a class of devices called "Peripheral", which can be detected by the Advertising Process (temporarily or permanently on).
Once detected, the Peripheral devices publish various attributes, readable and controlled remotely; each attribute can also have different properties that are software configurable.

The CC2640 microcontroller manufacturer makes available the sample project "SimpleBLEPeripheral", which covers the functionalities attributed to the Peripheral class.
The software written for the Central Unit Univet closely follows this example.

The Bluetooth LE protocol also defines a second class of devices called "Central", the purpose of which is to communicate with the corresponding Peripherals.
The main operations carried out by the Central class are functions of Discovery, Pairing with remote peripheral, send or collect data, or activate events on these devices.
Part SW unit Remote or Remote follows the sample code "SimpleBLECentral", provided to communicate with the corresponding SW "SimpleBLEPeripheral

Application for simple Remote unit BLE

This application designed for the remote control L002 presents less functions than the project for the L002 central unit.

Specifically the remote control is a Client device in the net BT; the Client unit makes therefore operations of Discovery, Pairing (very simplified compared to the standard operation provided by the Texas environment), Connection and writing/reading of the attributes on the Peripheral devices BT (specifically in the central unit L002 Univet)

The applicative is coming from the project code TI simple BLE central, which makes a dialogue with the correspondent simple BLE peripheral, offered by the manufacturer of the Microcontroller CC2640 which mounts the remote control card. .

As a basis the central loop is managing the potential connection with the remote object, central unit Univet, by means of the call to the following functions:

```
GesPairing()            to call the connection procedure
ConnectToDevice()       to be connected with the associated remote device
SendToDevice()          to broadcast a control to the remote unit
DisconnectToDevice()    to disconnect the object to which we are connected
```

Many features and functions written for the applicative of the central unit are brought from the applicative to the Univet central unit.

Tolopogy connection between Control Unit and Remote Control L002

The transmission from the remote control L002 takes place only when a dedicated connection with a second unit is made, specifically a control unit L002. Such dedicated connection is defined as a connection Central – Peripheral
With reference to stack BLE, the role of Central is given to the devices Remote Control L002, while the role of Peripheral is given to the devices Control Unit 002.

The connection Central – Peripheral is given going through processes of Advertising and Connect, through which 2 units L002 are brought to a state of a combined functioning.

From the radio spectrum the processes of Advertising, Connect and combined Functioning are equal, therefore only the last is described, being the process more complete when using the RF resources.

The topology of the net made of Connection Central – Peripheral and generated from the Connect process is represented in Figure 1.

With reference to Figure 1, 2 Dedicated Connections Dedicated Central – Peripheral are outlined, made respectively of the following devices:

- TLC “1” (Central “1”) and CTRL UNIT “A” (Peripheral “A”), outlined with a pale blue contour.

- TLC “2” (Central “2”) and CTRL UNIT “A” (Peripheral “A”), outlined with an orange contour.

In the dedicated Connection, only a single unit Peripheral (Control Unit L002) may be connected to s single unit Central (Remote Control L002) at the time.

If a second unit Central (TLC “2”) is coupled to the same Peripheral (Control Unit “A”) and you try to make a mode of Connect TLC”2” – CTRL “A”, the already activated connection TLC”1” – CTRL “A” will not allow it.

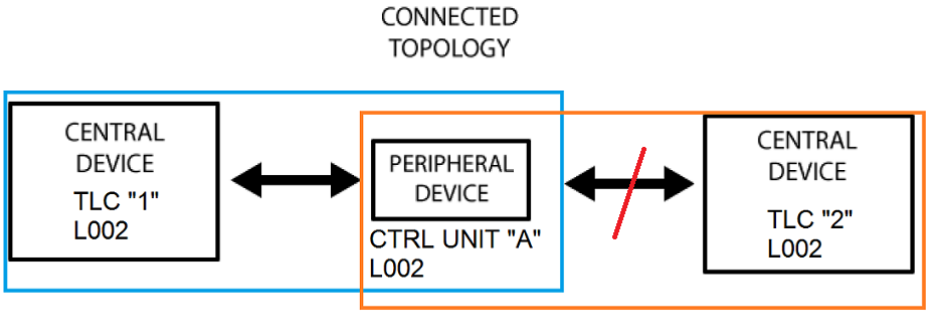


Fig.1: topology of a dedicated net Central - Peripheral

Process of information encapsulation within the stack BLE

The transmission of the controls from the unit Remote Control L002 towards the Central Unit L002 is made using the Transaction level Transaction GATT (Generic Attribute Profile) available from the stack BLE to the applicative software.

The transaction GATT is a master - slave process, in order to encapsulate the information exchanged among units in the suitable formats provided by the BLE stack levels.

Please take note of the following definitions:

- **unit Master GATT** = unit “Central” defined within the net Central – Peripheral. In the specific case the master is represented by the unit Remote Control L002.

  The unit Master takes the role of “GATT client”, during the transaction GATT, this because when sending a pack “Request GATT” it receives as a reply one or more packs, “Reply GATT”, containing the required information.

- **unit Slave GATT** = unit “Peripheral” defined within the net Central – Peripheral. In the specific case the Slave is represented by the unit Remote Control L002.

  The unit Slave takes the role of “GATT server”, during the transaction GATT. The GATT Server contains inside a Look Up Table composed of a 16 bit Identifier with which it’s possible to identify Services, Features (organized data framework) and data to be sent to the unit master GATT, according to the received enquiries. Such service is made from the Attribute Protocol (ATT), available from the stack BLE.

In Figure 2 it's represented a Transaction GATT between Client and Server GATT.

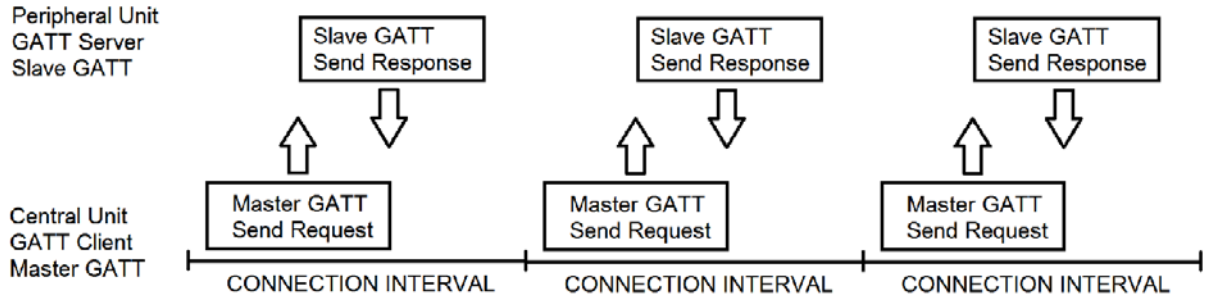


Fig.2: example of Transaction GATT

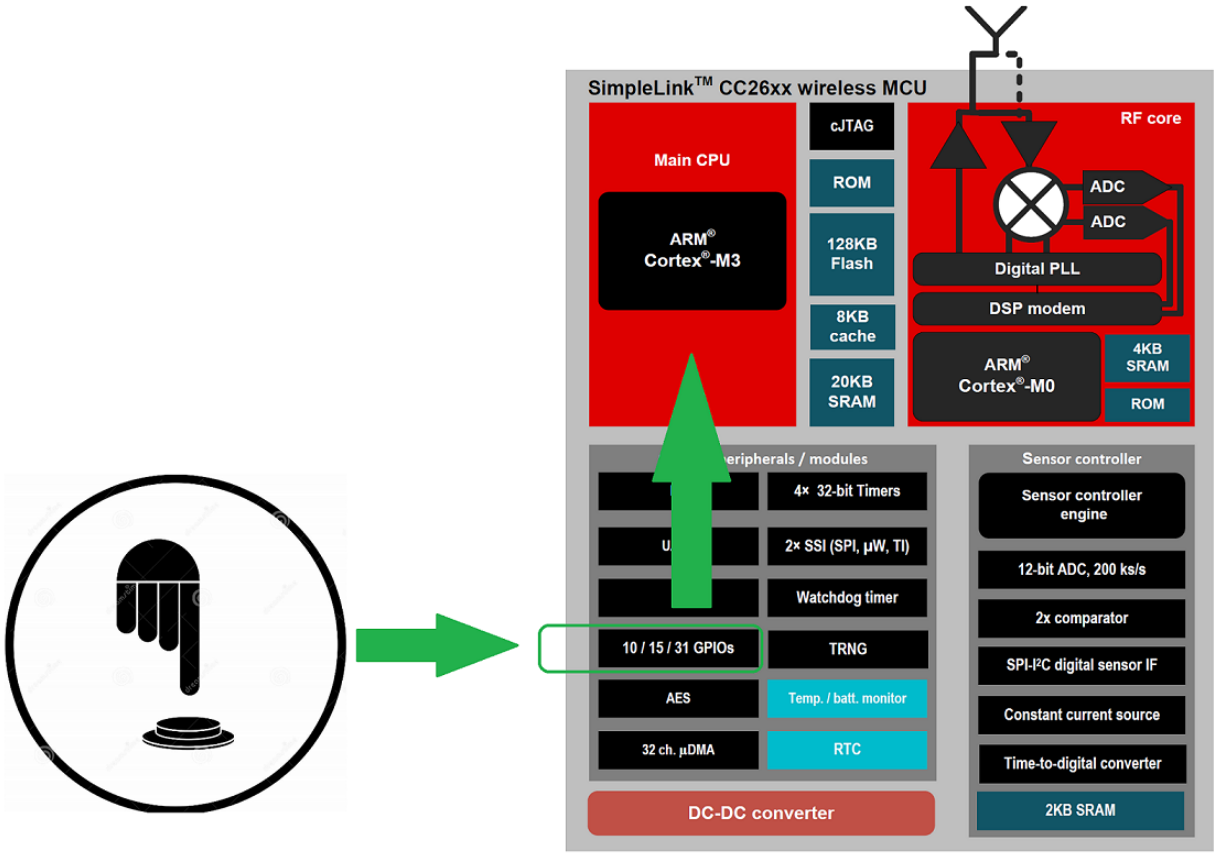
In the specific project Univet L002, there is the need to transfer an information in a unidirectional way, from the Central unit (remote Control) to the Peripheral (Control Unit). In such specific case therefore the process GATT, is made only through the submission of enquiries from the Master GATT (= unit "Central", i.e. Remote Control L002), which contains the controls of the Control unit L002 (unit Peripheral) to be done (switch on, switch off, change of head light intensity), without getting a return information.

Use of dedicated radio frequency channels

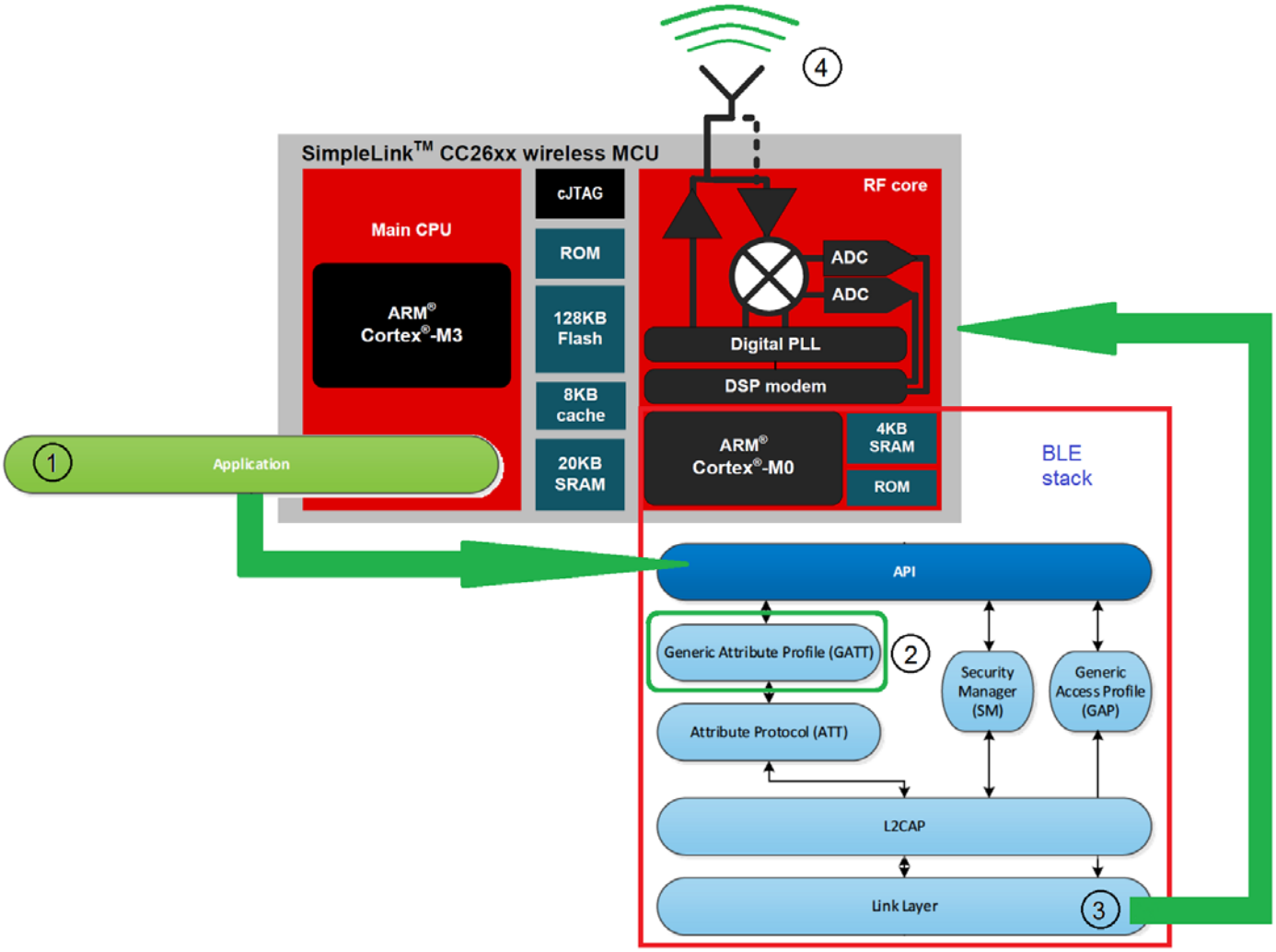
At a physical level, the transaction GATT between the two units L002 generates an electromagnetic spectrum of a data channel BLE at the time, from the Central unit (Remote Control), while the unit Peripheral remains in the listening mode and therefore the band is not occupied.

In Figure 3 it's represented the emission process of a control from the Central unit L002 towards the corresponding and previously coupled Peripheral.

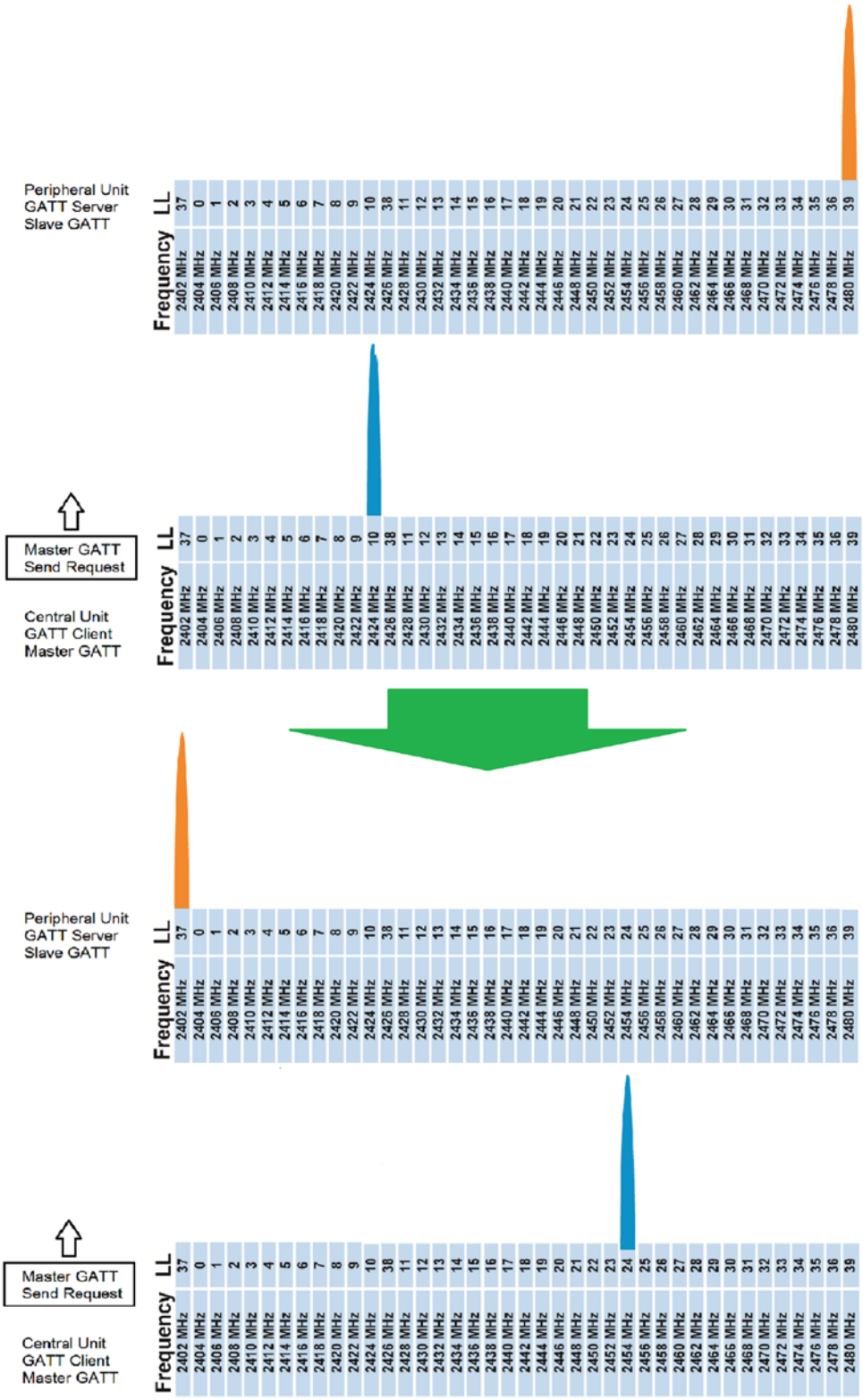
Fig.3: process of emission of a package from the Central unit L002 to the coupled unit Peripheral, by means of the Transaction GATT



step 1: the pressure of the button is converted from the card HW into an electric signal which is read and processed by the firmware onto the board of the Micro Controller CC2640 which is onto the Central Unit L002.



step 2: The applicative firmware (1) generates event GATT in the stack BLE (2), which through the lower layer (3) of the protocol, emits the package (4) in a determined data channel from the radio peripheral integrated on board of the Micro controller CC2640



step 3: representation of the occupation of RF spectrum from the Central units (Remote Control) and Peripheral (Control Unit) L002 during the normal functioning. The single channel engaged from the units has a maximum band of 2 MHz.