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# STM32WB Video Series – Getting Started

#12 STM32CubeMX & STM32CubeIDE lab

T.O.M.A.S. Team

Matching Network

15HS3N6S02  
L3



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# STM32WB Video Series – Getting Started

#12a STM32CubeMX & STM32CubeIDE lab  
Introduction

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# Prerequisites

## What we'll use

- [STM32CubeMX](#) V6.3.0 + download STM32CubeWB V1.12.1 from the package manager
- [CubeIDE](#) V1.7.0
- [STM32CubeProgrammer](#) V2.8.0
- [Android](#) or [iOS](#) phone with ST BLE Toolbox app V1.0.0
- 1x micro USB cable
- STM32WB Nucleo (P-NUCLEO-WB55)
- Install latest FUS and BLE Full Stack. From [STM32CubeWB](#) V1.12.1 Installation instruction are provided as a homework before the session
- Tera Term (or similar terminal app, only for optional task)

# Goal

- What are we going to do?
- How are we going to do that?

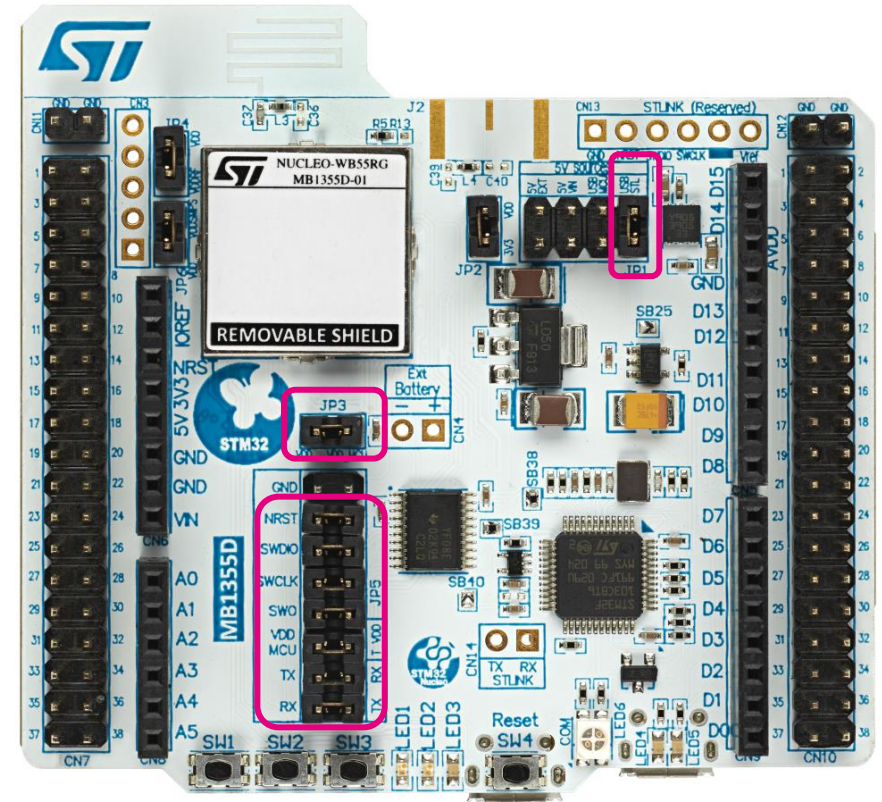


ST BLE Toolbox



GATT Client

GAP central



GATT Server

GAP peripheral

# Goal in more details

- Create custom BLE Service with two characteristics
  - CHARACTERISTIC 1 has Write property
  - CHARACTERISTIC 2 has Notify property
- Writing to CHARACTERISTIC 1 (LED control) will toggle green LED
- Pressing SW1 button on Nucleo board will send some data to the phone (Button 1 notification)



Write



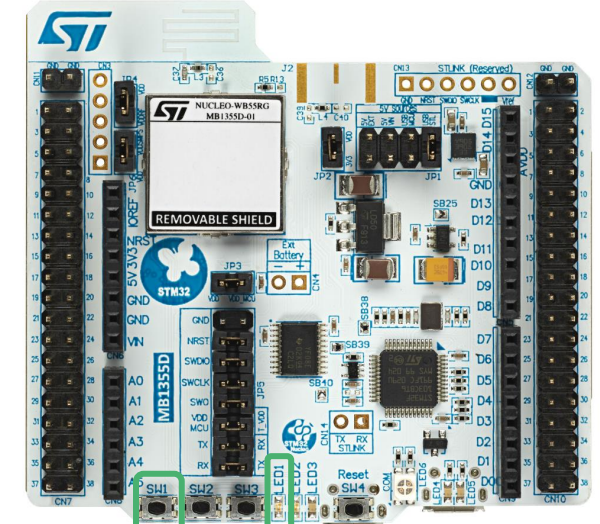
Notification



## Custom SERVICE

Custom CHARACTERISTIC 1  
**W** LED control

Custom CHARACTERISTIC 2  
**N** Button 1 state



Button 1

Green LED



# Creating BLE template project in CubeMX

Reference part 1

- Open CubeMX
- Start new project for Nucleo WB55RG (Initialize all peripherals in default mode? NO)
- System Core -> RCC: Enable HSE and LSE – Crystal/Ceramic Resonator
- System Core -> HSEM - Check Activated
- System Core -> IPCC – Check activated and enable both interrupts
- Timers -> RTC – Activate Clock, Enable internal WakeUp, enable interrupt
- Connectivity -> RF – Activate RF1
- Middleware -> STM32\_WPAN – Check BLE
  - BLE Application and Services
    - Disable Custom P2P Server
    - Enable Custom Template

# Creating BLE template project in CubeMX

## Reference part 2

- Middleware -> STM32\_WPAN
  - BLE Advertising
    - Include AD\_TYPE\_COMPLETE\_LOCAL\_NAME Yes
  - BLE GATT
    - Number of services = 1
    - Service long name = "My\_SVC"
    - Service short name = "My\_SVC"
  - My\_SVC
    - Characteristic long name = "My char"
    - Characteristic short name = "My char"
    - CHAR\_PROP\_BROADCAST NO
    - CHAR\_PROP\_READ YES
    - GATT\_NOTIFY\_READ\_REQ\_AND\_WAIT\_FOR\_APPL\_RESP No
- Clock configuration
  - Set RTC clock to LSE
  - Set RFWKP clock to LSE
- Project Manager: Generate code for CubeIDE or any other supported IDE
- Add some user application code (LED, Button handling)

# Optional tasks

- For those of you who finish early you might follow the instructions at the end of this presentation
- Optional task 1: Parse data input written to the characteristic by phone
- Optional task 2: Enable application traces over USART and display them in terminal console



```
COM10 - Tera Term VT
File Edit Setup Control Window Help
Successfully Start Fast Advertising
HCI_LE_CONNECTION_COMPLETE_SUBEVT_CODE for connection handle 0x801
```



# NUCLEO-WB55 in detail

## RF area

- 2.4GHz PCB antenna
- impedance matching
- ext. LP filter (IPD)
- (space for SMA connector and RF switch)

## MCU area

- STM32WB55RC
- HSE & LSE crystals
- Decoupling
- SMPS ext. parts

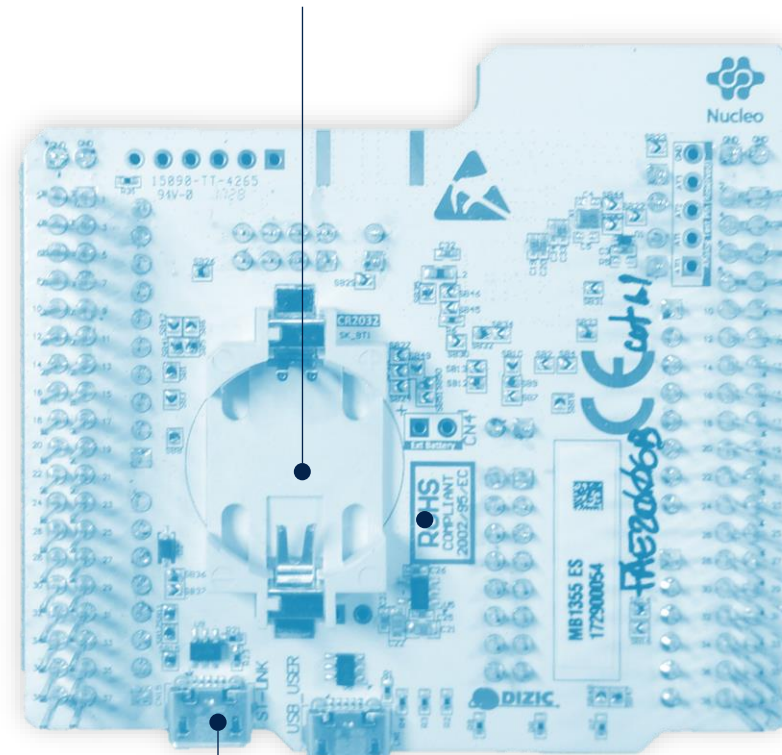
## ST-Link area

- ST-Link/V2-1
- SWD debugger
- Virtual COM Port
- USB MSC (.bin flashing)

## UI Area

- 3x Button
- 3x LED
- Reset Button

Space for **CR2032** battery **socket**



**ST-Link connector**  
(micro-USB Type B)

**User USB FS Device**  
(micro-USB Type B)



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# STM32WB Video Series – Getting Started

#12b STM32CubeMX & STM32CubeIDE lab  
Receiving data from the phone

T.O.M.A.S. Team

Matching Network

15HS3N6S02  
L3

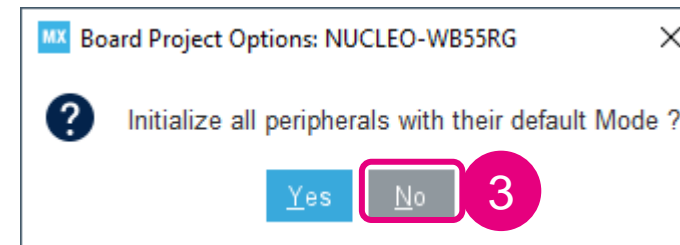
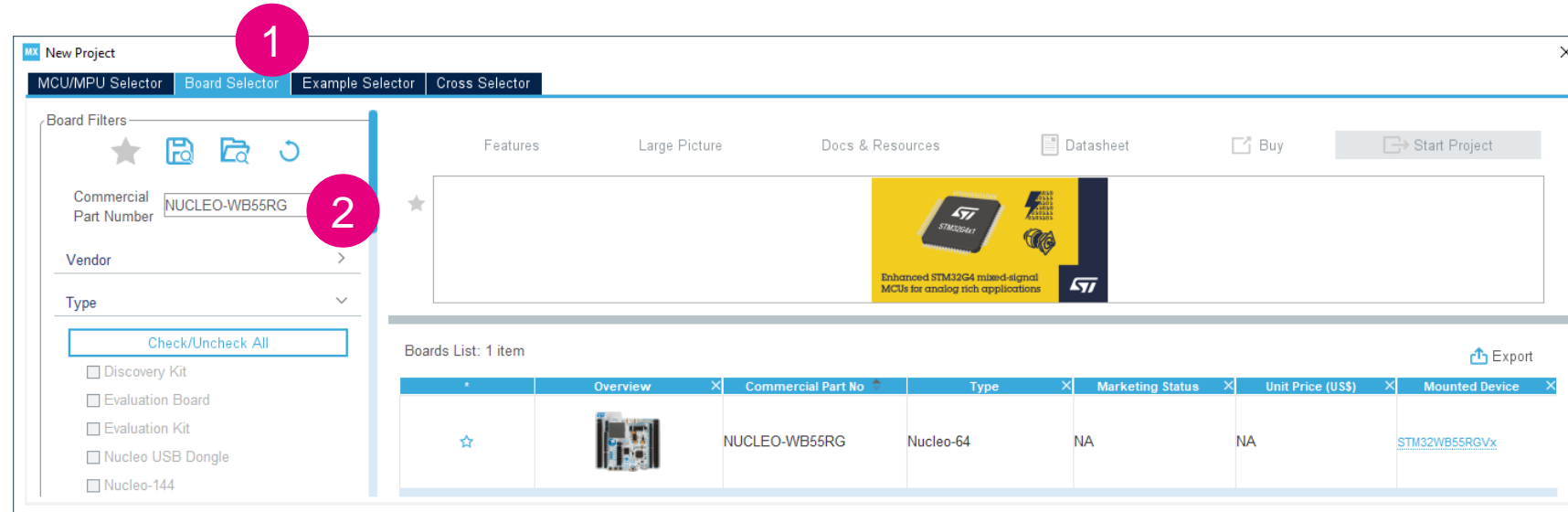
# Hands-On

1. Connect USB cable between PC and ST-LINK (right connector from top view)
2. Open STM32CubeMX

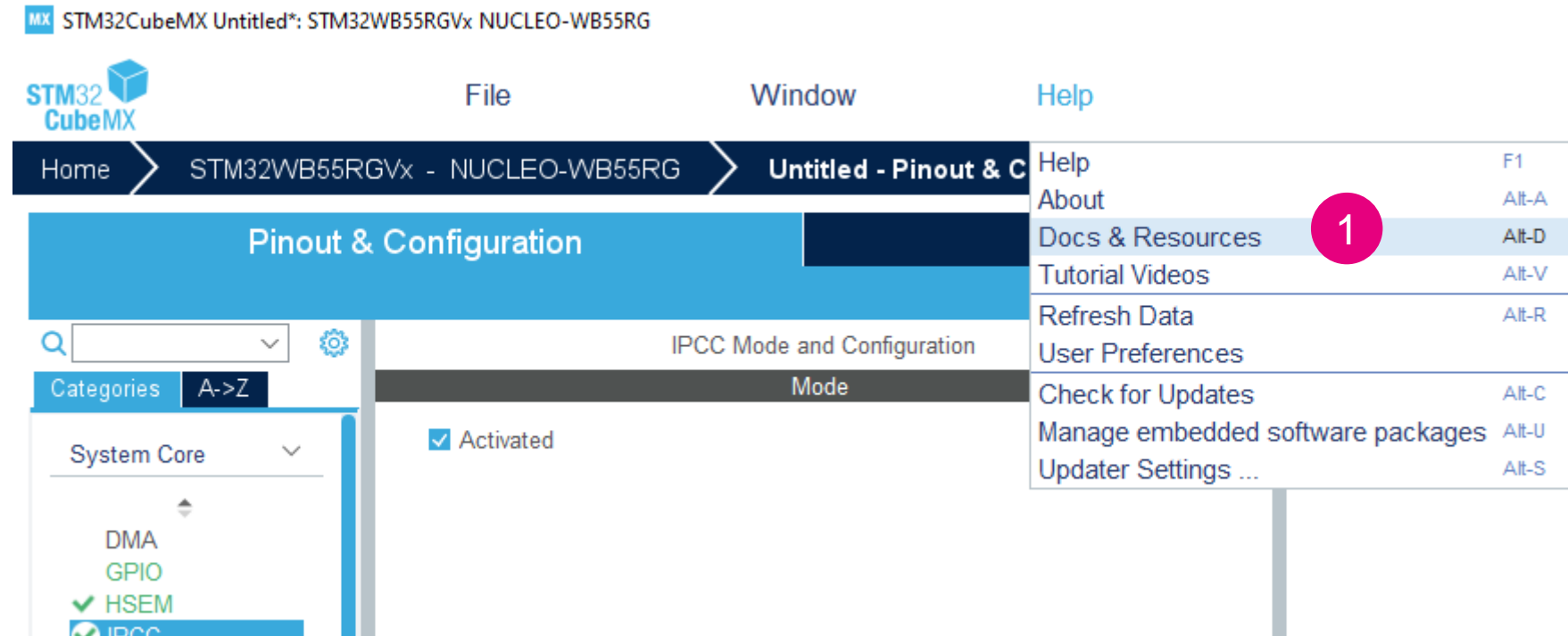


# Hands-On

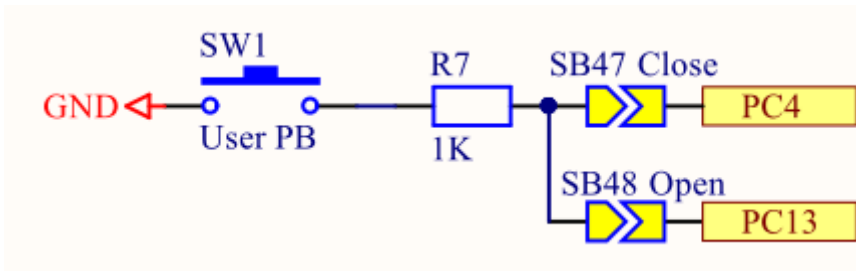
- Start new project
- Select Board selector
- Type “WB55RG” and select NUCLEO-WB55RG
- Start Project
- Initialize all peripherals with their default Mode? **No**  
This will only initialize GPIO for LEDs and buttons



- To access reference manual for the board or for the MCU, datasheet, errata sheet or application notes you may go to Help -> Docs & Resources



- Select GPIO under System Core tab
- Find PC4
- Enable internal pull-up



STM32CubeMX WB\_EURO2021\_proj.ioc: STM32WB55RGVx: NUCLEO-WB55RG

File Window Help

Home > STM32WB55RGVx - NUCLEO-WB55RG > WB\_EURO2021\_proj.ioc - Pinout & Configuration

Pinout & Configuration Clock Configuration Project Manager

Software Packs Pinout

GPIO Mode and Configuration

Configuration

Group By Peripherals

GPIO Single Mapped Signals RCC RF USART

Search Signals

Search (Ctrl+F) ☐ Show only Modified Pins

Pin Na...	Signal on ...	GPIO outp...	GPIO mode	GPIO Pull...	Maximum ...	Fast ...	User Label	Modified
PB0	n/a	Low	Output Pu...	No pull-up ...	Low	n/a	LD2 [Green L...	<input checked="" type="checkbox"/>
PB1	n/a	Low	Output Pu...	No pull-up ...	Low	n/a	LD3 [Red Led]	<input checked="" type="checkbox"/>
PB5	n/a	Low	Output Pu...	No pull-up ...	Low	n/a	LD1 [Blue Led]	<input checked="" type="checkbox"/>
PC4	n/a	n/a	Input mode	Pull-up	n/a	n/a	B1 [Push But...	<input checked="" type="checkbox"/>
PD0	n/a	n/a	Input mode	No pull-up ...	n/a	n/a	B2 [Push But...	<input checked="" type="checkbox"/>
PD1	n/a	n/a	Input mode	No pull-up ...	n/a	n/a	B3 [Push But...	<input checked="" type="checkbox"/>

PC4 Configuration :

GPIO mode Input mode

GPIO Pull-up/Pull-down Pull-up

User Label B1 [Push Button]



- Hover the cursor on STM32 WPAN Middleware. It will give you contextual help on what to do. We will do each step together

## STM32\_WPAN:

Bluetooth Low Energy 5, 802.15.4 OpenThread and Zigbee 3.0

### Status:

Not available:

Zigbee mode is active only if RF, RTC, IPCC & HSEM are enabled and if FreeRTOS is disabled

Not available with STM32WB10xxx and STM32WB15xxx or/and

BLE and Thread modes are active only if RF, RTC IPCC & HSEM are enabled

Not available with STM32WB10xxx and STM32WB15xxx or/and

BLE and Thread modes are active only if RF, RTC, IPCC & HSEM are enabled

[details and documentation \(Ctrl+d\)...](#)

STM32CubeMX Untitled\*: STM32WB55RGVx - NUCLEO-WB55RG

File Window Help

Home > STM32WB55RGVx - NUCLEO-WB55RG > Untitled - Pinout & Configuration >

Pinout & Configuration Clock Configuration

Software Pack

Categories A->Z

System Core

- DMA
- GPIO
- HSEM**
- IPCC
- IWDG
- NVIC
- RCC
- SYS
- TSC
- WWDG

Analog >

Timers >

Connectivity >

Multimedia >

Security >

Computing >

Middleware

FATFS

FreeRTOS

**STM32\_WPAN**

TOUCHSENSING

USB\_DEVICE

HSEM Mode and Configuration

Mode

☒ Activated

Configuration

Reset Configuration

Parameter Settings NVIC Settings

NVIC Interrupt Table	Enabled	Preemption Priority	Sub Priority
HSEM global interrupt	<input checked="" type="checkbox"/>	0	0

1

STM32\_WPAN:

Bluetooth Low Energy 5, 802.15.4 OpenThread and Zigbee 3.0

Status:

Not available:

Zigbee mode is active only if RF, RTC, IPCC & HSEM are enabled and if FreeRTOS is disabled

Not available with STM32WB10xxx and STM32WB15xxx or/and

BLE and Thread modes are active only if RF, RTC IPCC & HSEM are enabled

Not available with STM32WB10xxx and STM32WB15xxx or/and

BLE and Thread modes are active only if RF, RTC, IPCC & HSEM are enabled

[details and documentation \(Ctrl+d\)...](#)

# Hands-On

- Select RCC under System Core tab
- Enable HSE (High speed external crystal 32 MHz) and LSE (Low speed external crystal) 32768Hz
- HSE 32 MHz is directly used by the radio PHY.
- LSE is used as a low-speed clock by radio PHY. It is used to time events such as connection or advertising interval

STM32CubeMX Untitled\*: STM32WB55RGVx NUCLEO-WB55RG

File Window Help

Home STM32WB55RGVx - NUCLEO-WB55RG Untitled - Pinout & Configuration

Pinout & Configuration Clock Configuration Project Manager

Software Packs Pinout

Pinout view System view

RCC Mode and Configuration

Mode

High Speed Clock (HSE) Crystal/Ceramic Resonator 2

Low Speed Clock (LSE) Crystal/Ceramic Resonator

☐ Master Clock Output

☐ LSCO Clock Output

☐ SAI1 Extern Clock

CRS SYNC Disable

Categories A-Z

System Core

DMA

GPIO

HSEM

IPCC

IWDG

NVIC 1

☒ RCC

☐ SYS

☐ TSC

☐ WWDG

Analog >

Timers >

Connectivity >

Multimedia >

Security >

Computing >

Middleware >

Utilities >

Reset Configuration

☒ User Constants ☒ NVIC Settings ☒ GPIO Settings

☒ Parameter Settings

Search Signals

Search (Ctrl+F)

Pin Na...	Signal on ...	GPIO outp...	GPIO mode	GPIO Pull...	Maximum ...	Fast
OSC_IN	RCC_OSC...	n/a	n/a	n/a	n/a	n/a
OSC_OUT	RCC_OSC...	n/a	n/a	n/a	n/a	n/a
PC14-OS...	RCC_OSC...	n/a	n/a	n/a	n/a	n/a
PC15-OS...	RCC_OSC...	n/a	n/a	n/a	n/a	n/a

STM32WB55RGVx VQFPN68

ST

VBAT

PC13

PC14

PC15

PH3...

PB8

PB9

NRST

PC0

PC1

PC2

PC3

VRE

VDDA

PA0

PA1

PA2

PA3

PA4

PA5

PA6

PA7

PA8

PA9

PC4

PC5

PB2

PB10

PB11

PB12

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PC1228

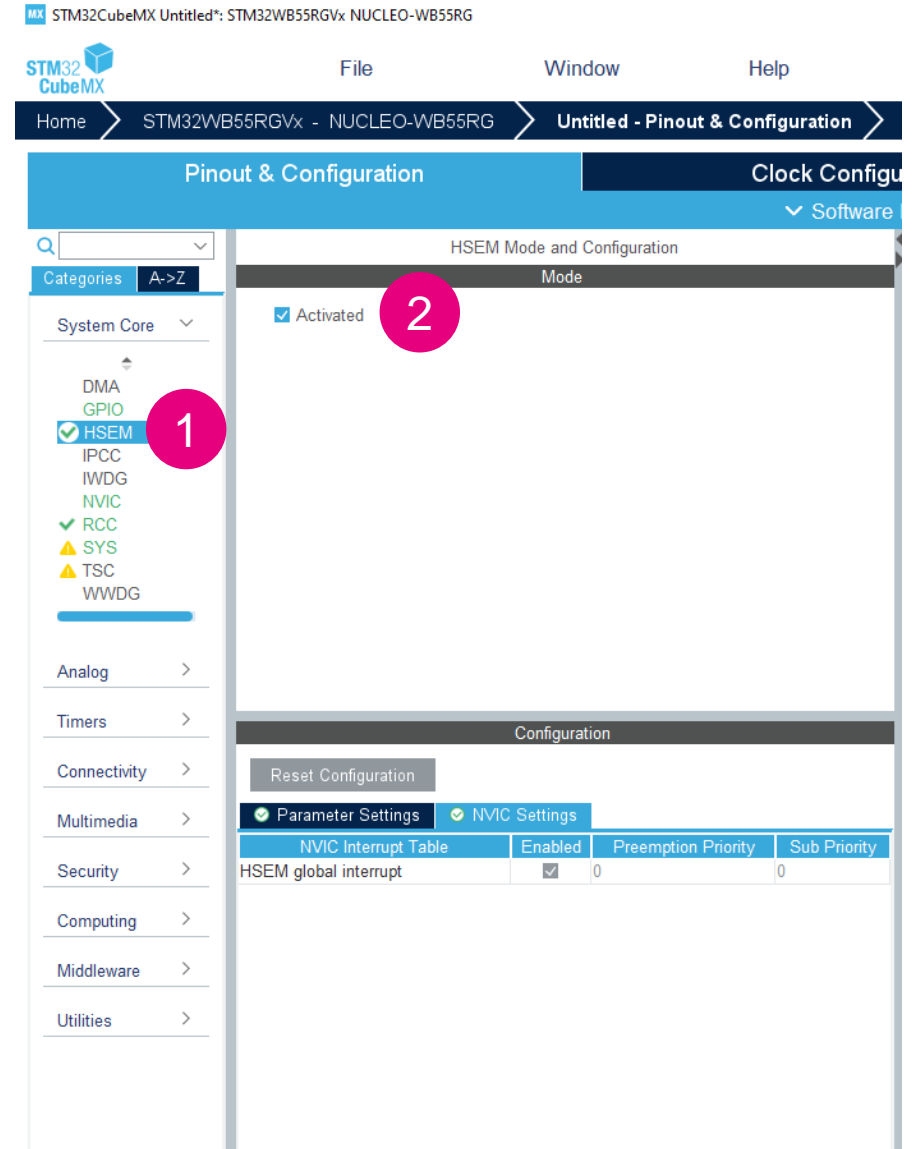
PC1229

PC1230

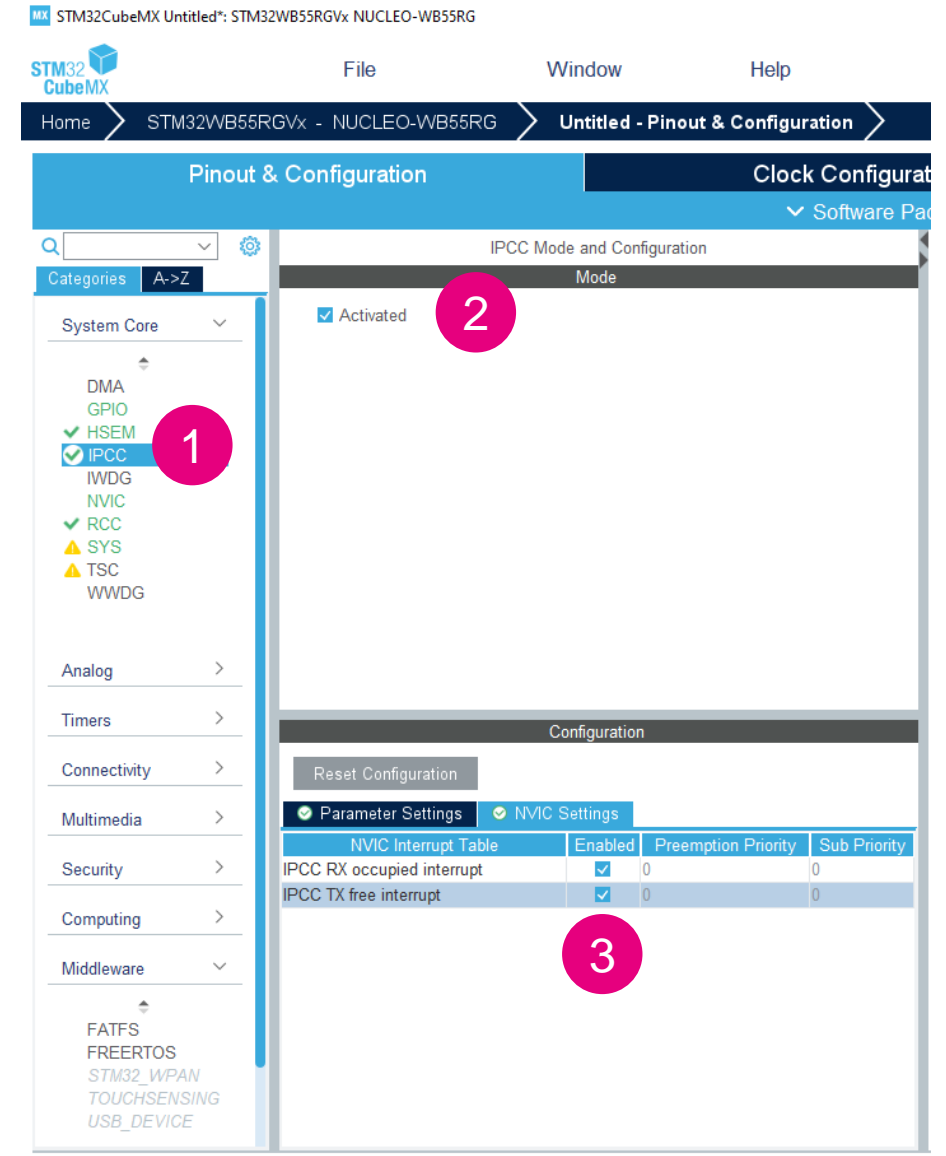
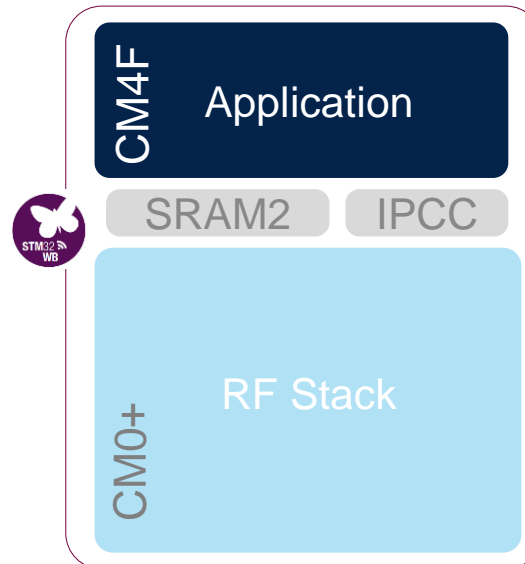
PC1231

<

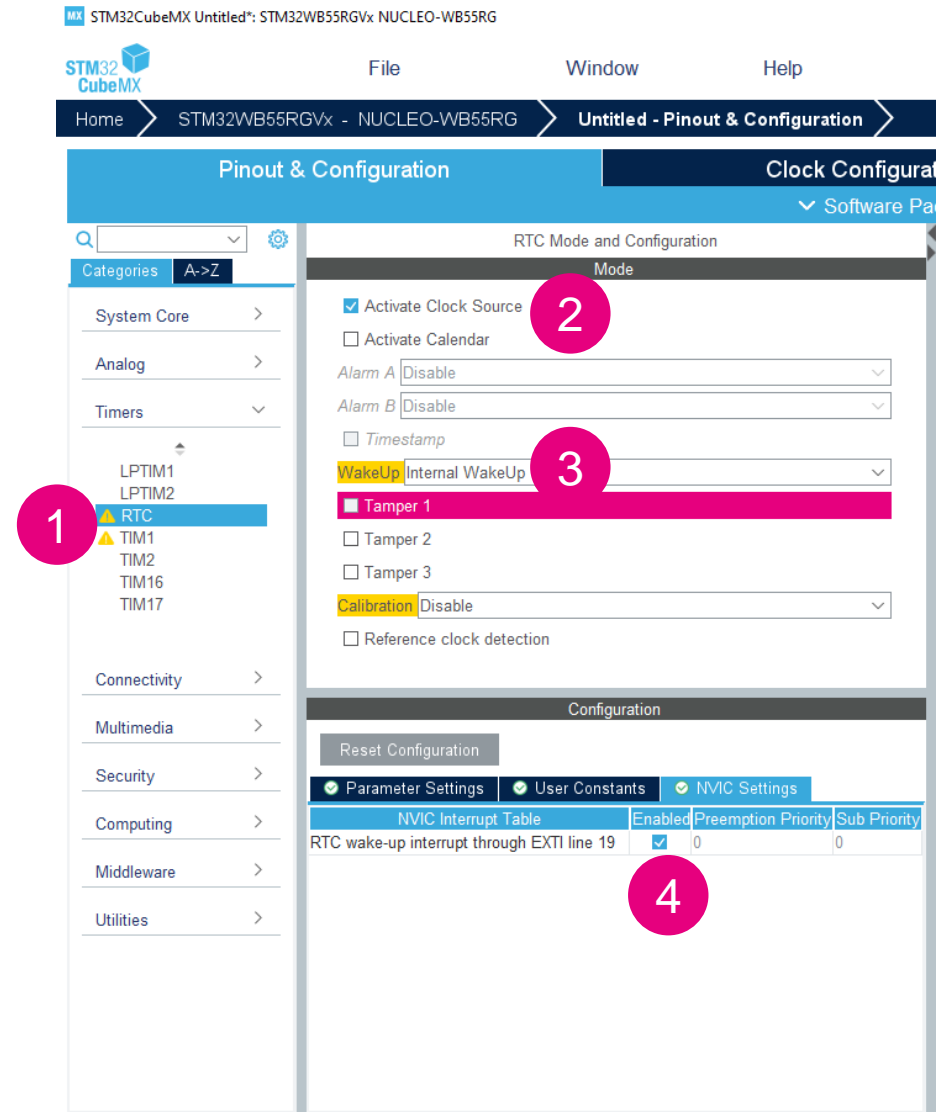
- Select HSEM (Hardware semaphores) and tick activate
- HSEM provides synchronization between CM0+ and CM4 when using shared resources (ex. Clock tree registers, RNG etc.)



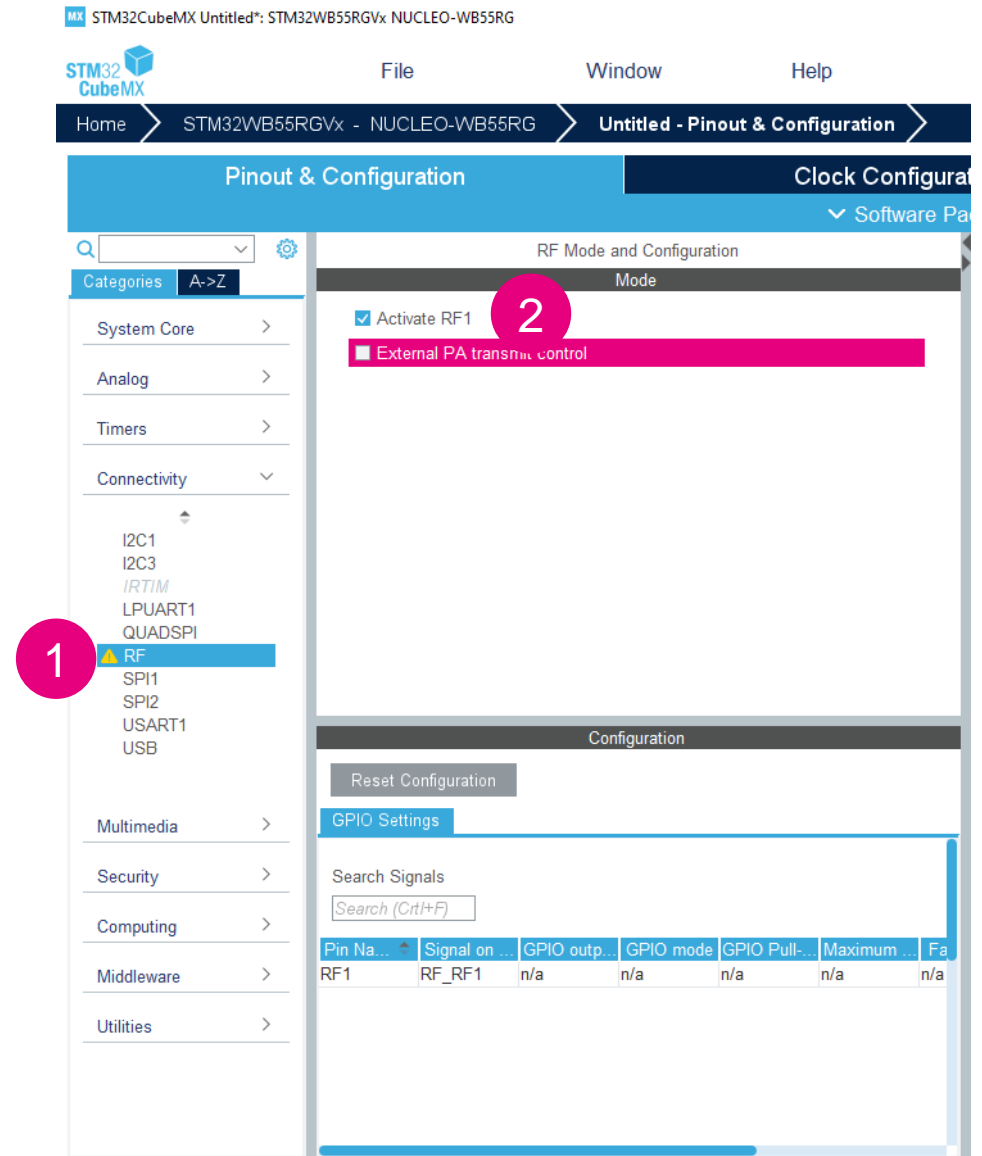
- Select IPCC (Inter-processor communication controller)
- Tick activate
- Enable both interrupts in NVIC
- IPCC provides asynchronous messaging mechanism between CM4 and CM0+
- Part of SRAM2 is shared



- Select RTC under Timers tab
- Tick Activate Clock Source
- Enable Internal WakeUp
- Enable interrupt in NVIC
- Required due to Virtual timer server FW component. (we will not use it in this hands on)

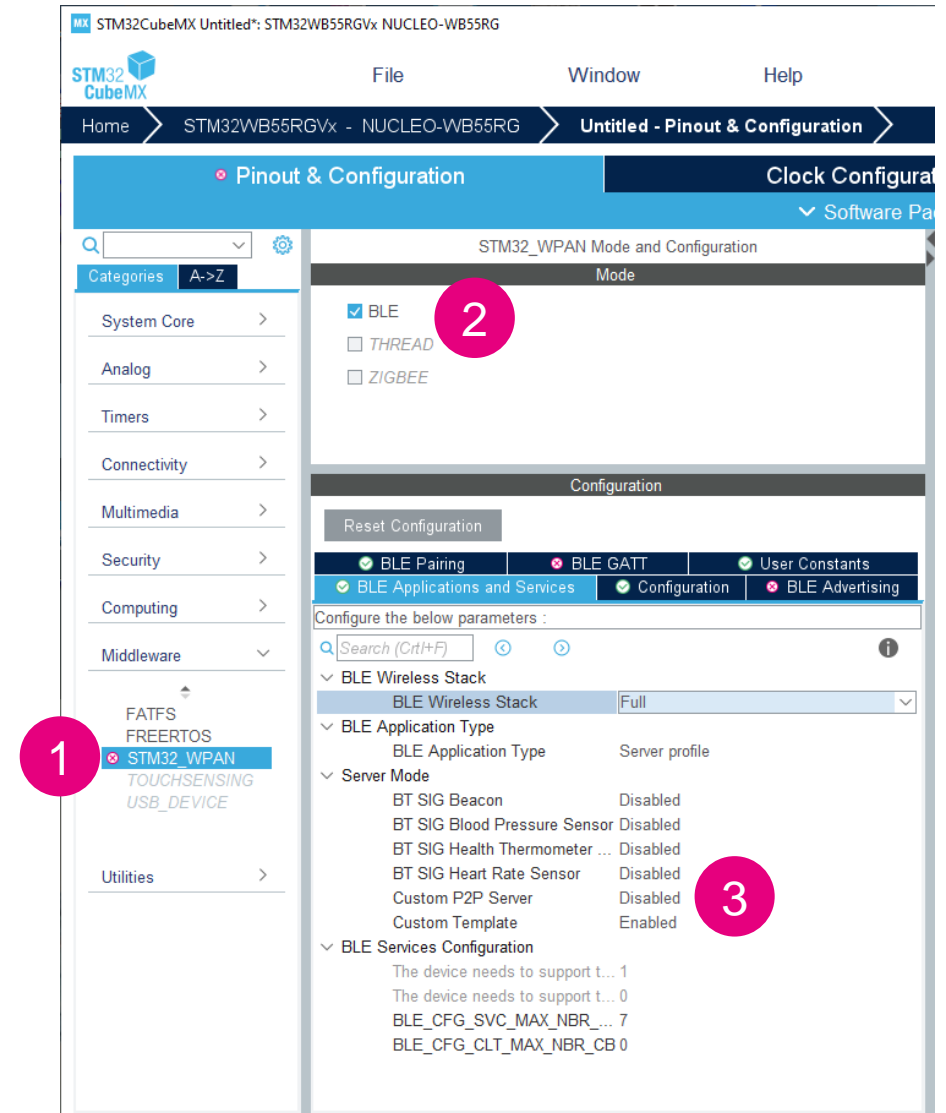


- Select RF under Connectivity tab
- Tick Activate RF1

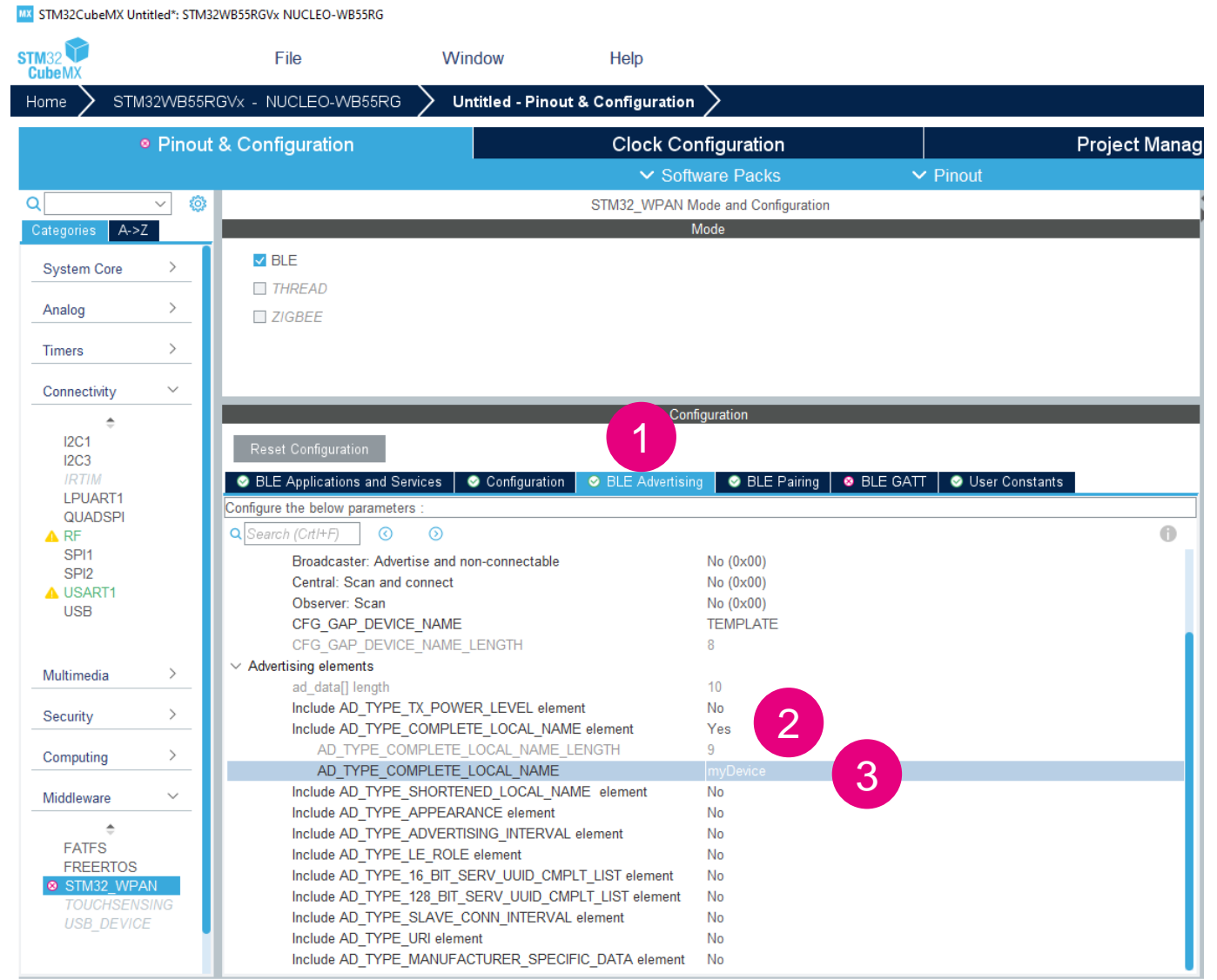




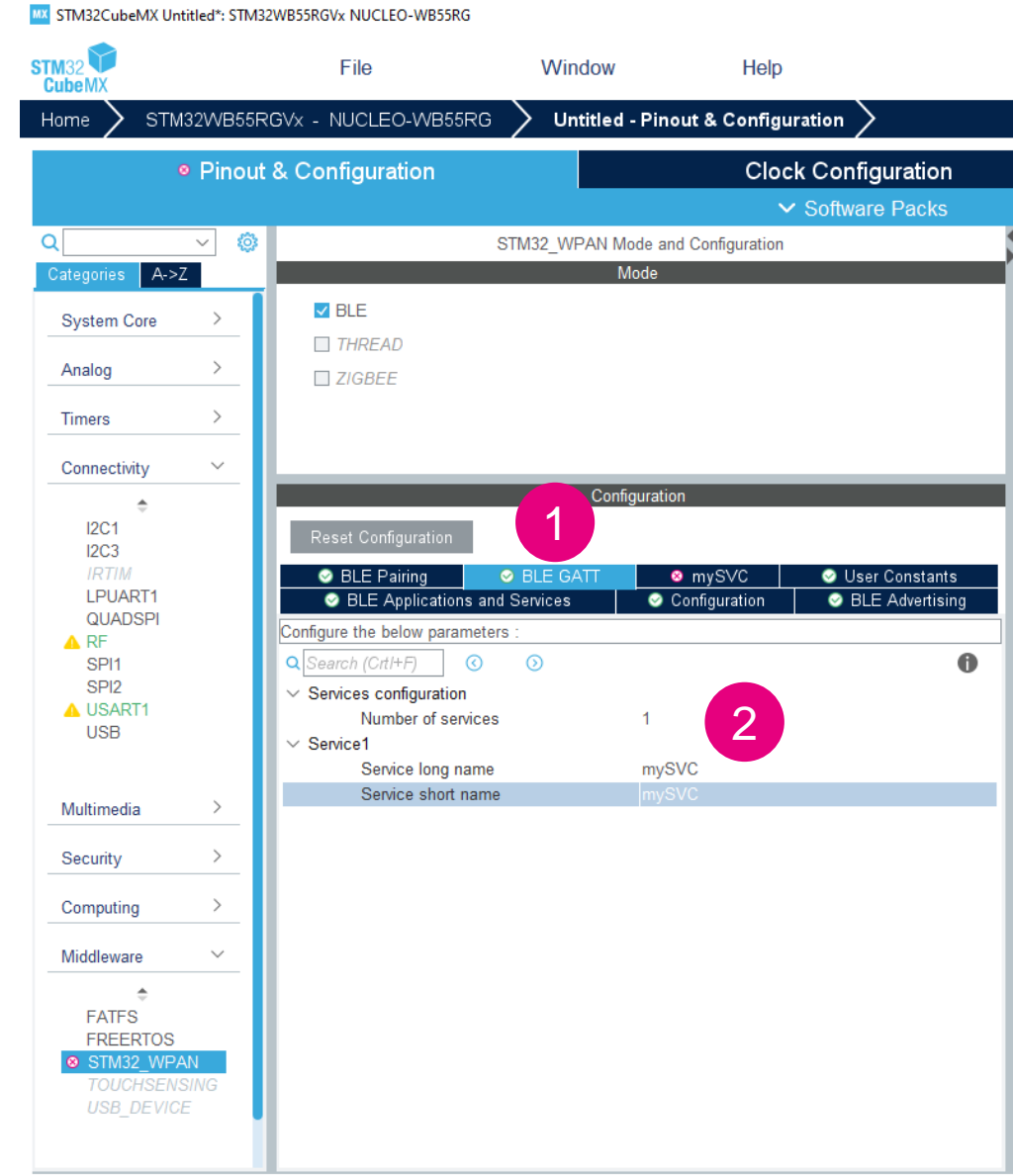
- Select STM32 WPAN Middleware under Middleware tab
- Tick BLE
- Disable Custom P2P Server
- Enable Custom Template



- Select BLE Advertising tab
- Include  
AD\_TYPE\_COMPLETE\_LOCAL\_NAME  
Yes
- Name your device uniquely



- Select BLE GATT tab
- Set number of services to 1
- Name your BLE service, both long and short name



- Select 'mySVC' tab. The exact name depends on your previous selection
- Name you characteristic 'myCharWrite' as both long and short name
- Notice UUID - universally unique identifier

STM32CubeMX WB\_EURO2021\_proj.ioc\*: STM32WB55RGVx NUCLEO-WB55RG

File Window Help

Home > STM32WB55RGVx - NUCLEO-WB55RG > WB\_EURO2021\_proj.ioc - Pinout & Configuration >

Pinout & Configuration Clock Configuration Project Manager

Software Packs Pinout

STM32\_WPAN Mode and Configuration

Mode

☒ BLE  
☐ THREAD  
☐ ZIGBEE

Configuration

Reset Configuration

☒ BLE Pairing ☒ BLE GATT **☒ mySVC** ☒ User Constants  
☒ BLE Applications and Services ☒ Configuration ☒ BLE Advertising

Configure the below parameters :

Search (Ctrl+F)

Service1

Number of characteristics	1
UUID type	128 bits UUID(0x02)
UUID 128 input type	reduced
UUID	00 00
Type	Primary Service(0x01)
Service max attributes record(s)	3

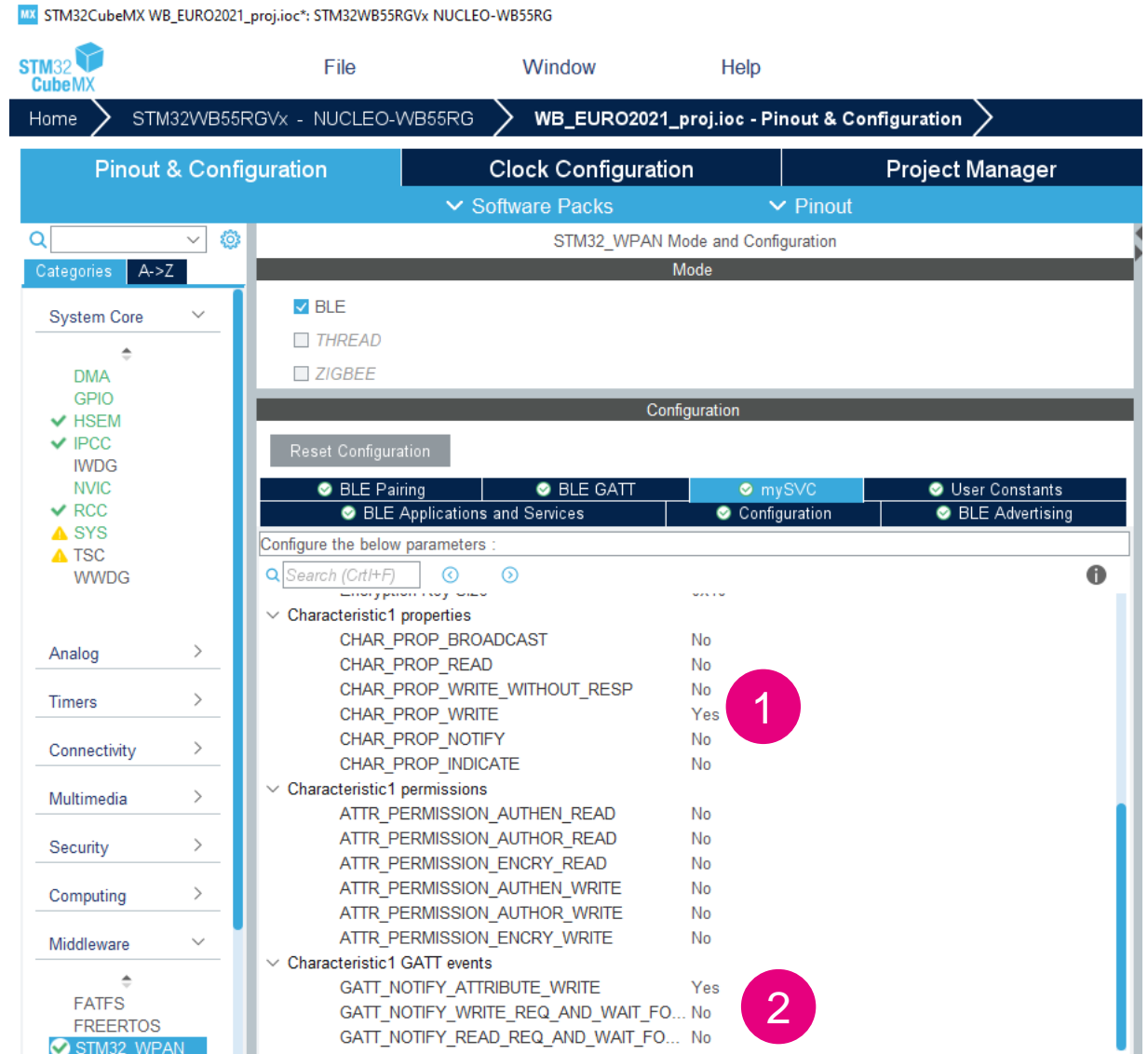
Characteristic1 general

Characteristic long name	myCharWrite
Characteristic short name	myCharWrite
UUID type	128 bits UUID(0x02)
UUID 128 input type	reduced
UUID	00 00
Value length	1
Length characteristic	Constant
Encryption Key Size	0x10

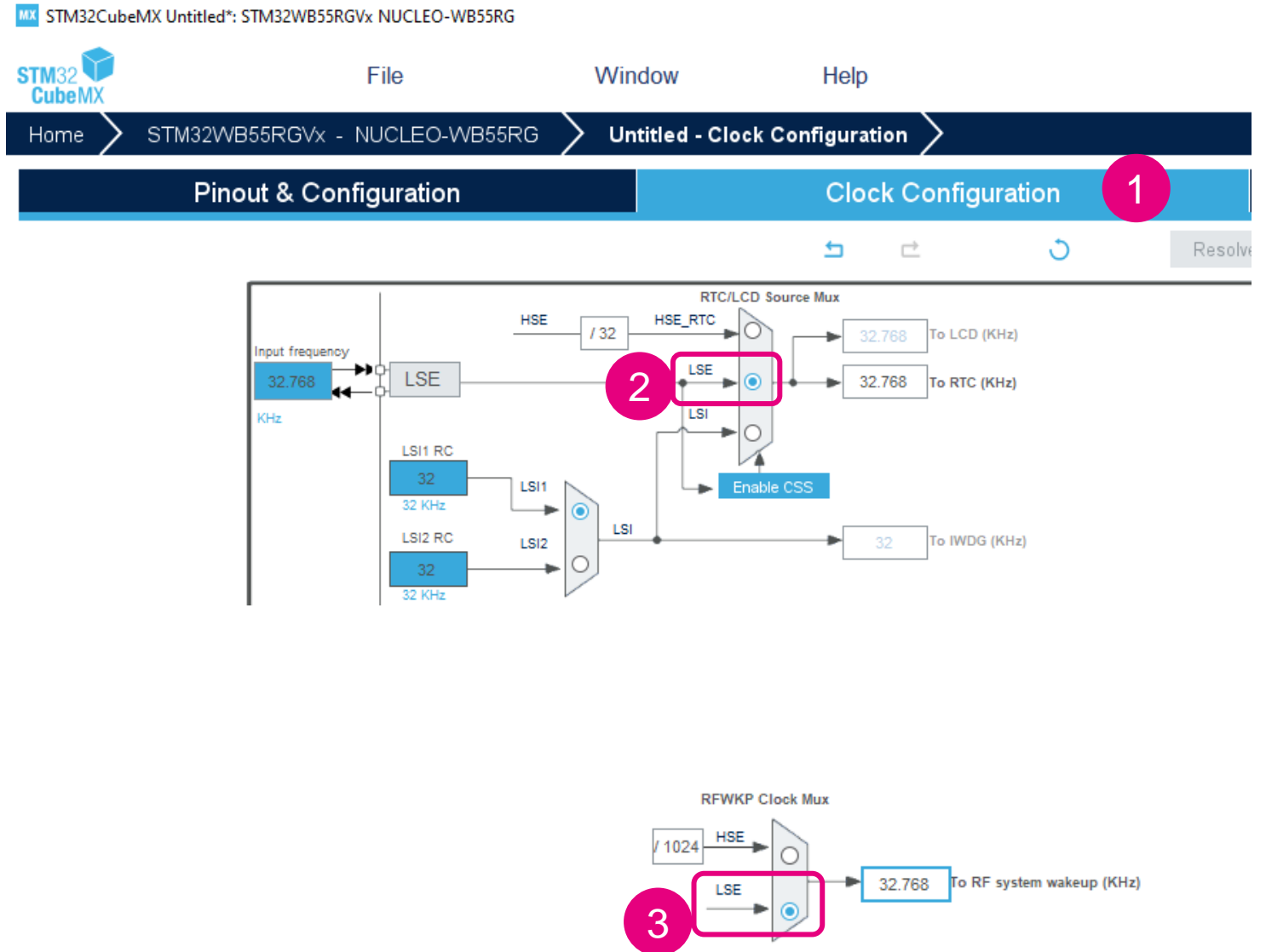
Characteristic1 properties

CHAR_PROP_BROADCAST	No
CHAR_PROP_READ	..

- Enable CHAR\_PROP\_WRITE property
- Disable all GATT events except GATT\_NOTIFY\_ATTRIBUTE\_WRITE



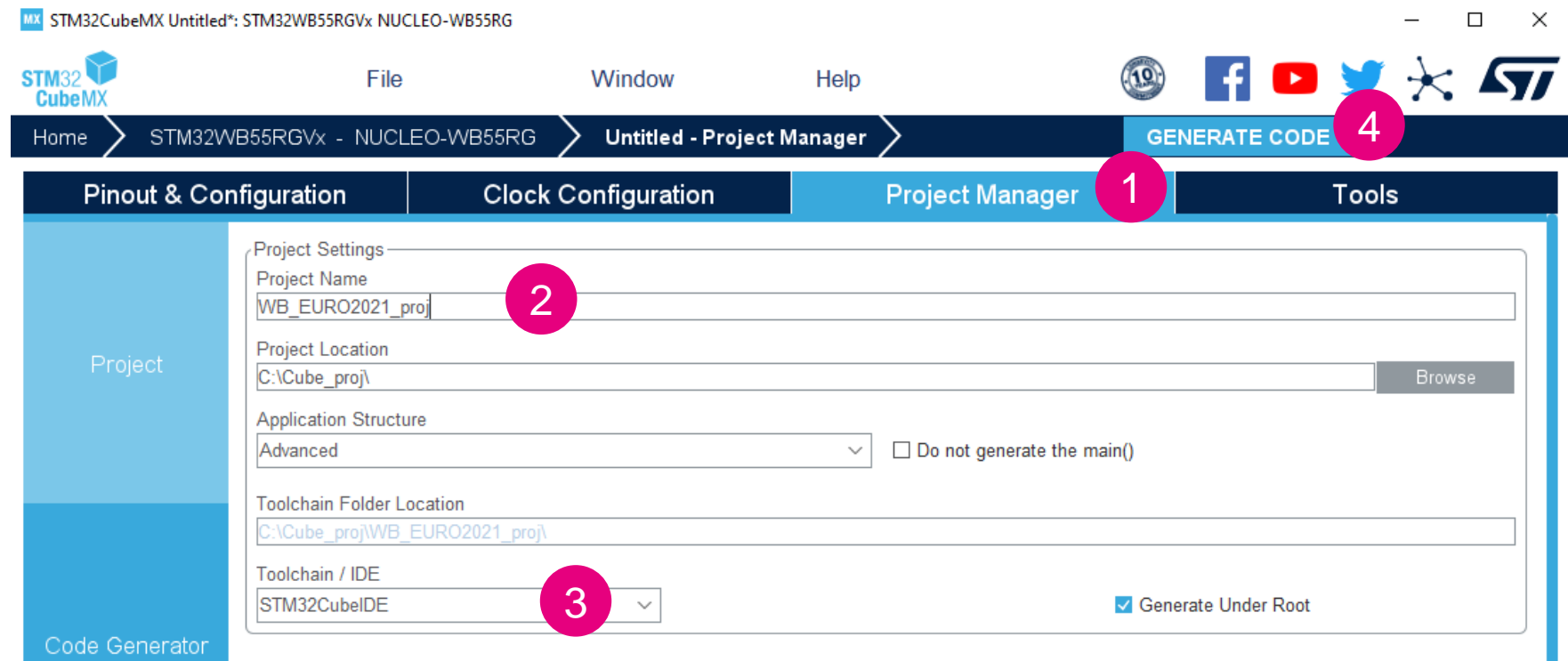
- Go to Clock configuration tab
- Set RTC clock to LSE
- Set RFWKP Clock to LSE



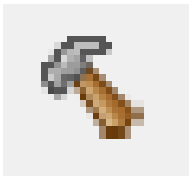
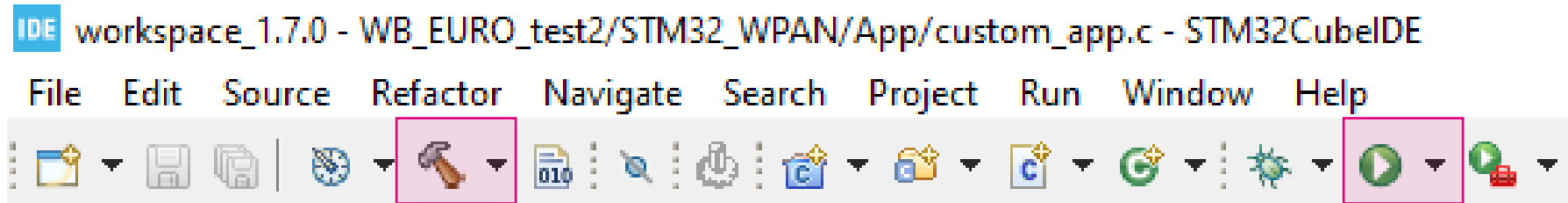


# Hands-On

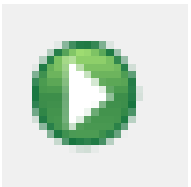
- Got to Project Manager
- Name your project
- Select Toolchain STMCubeIDE
- Generate code



# Compile and run



Build



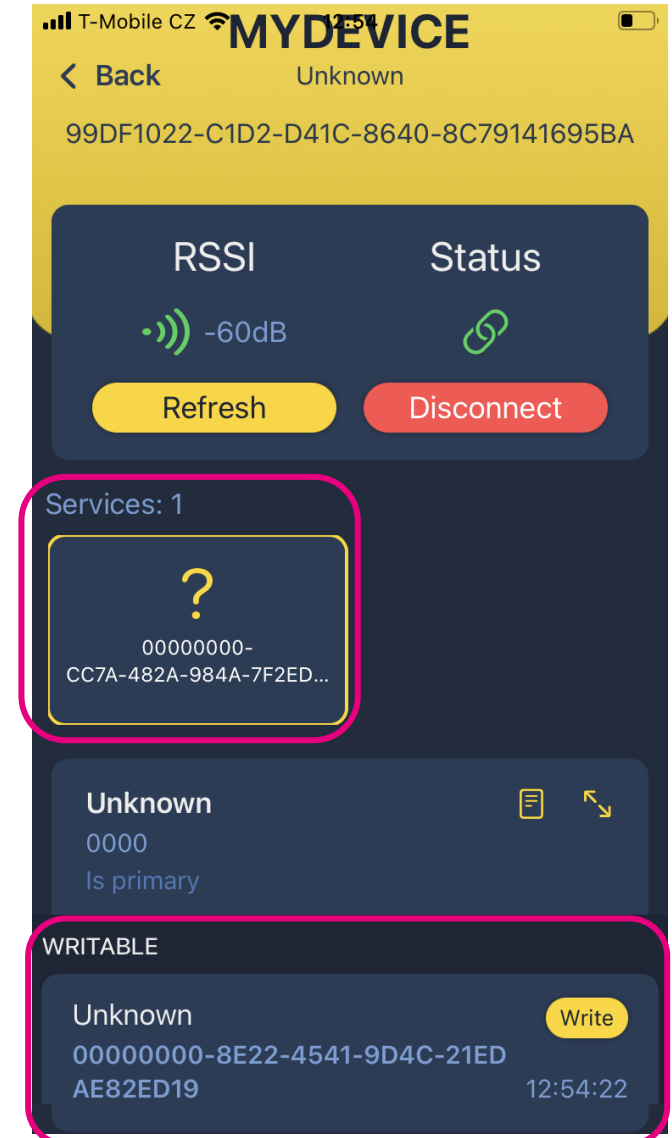
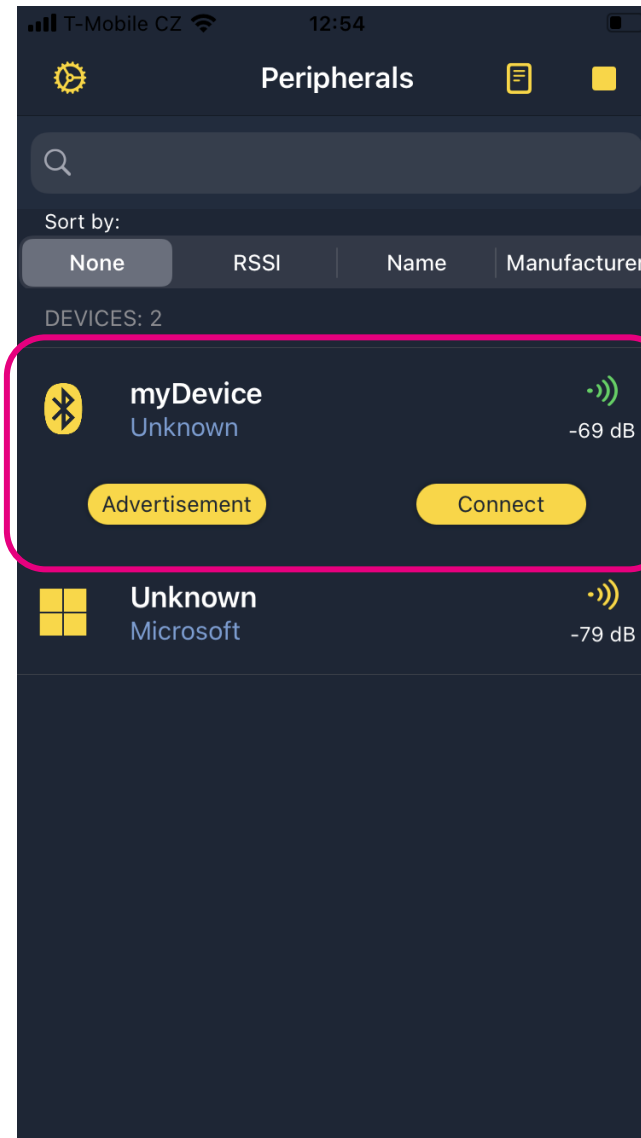
Run

# Hands-On

- Open ST BLE Toolbox on your phone



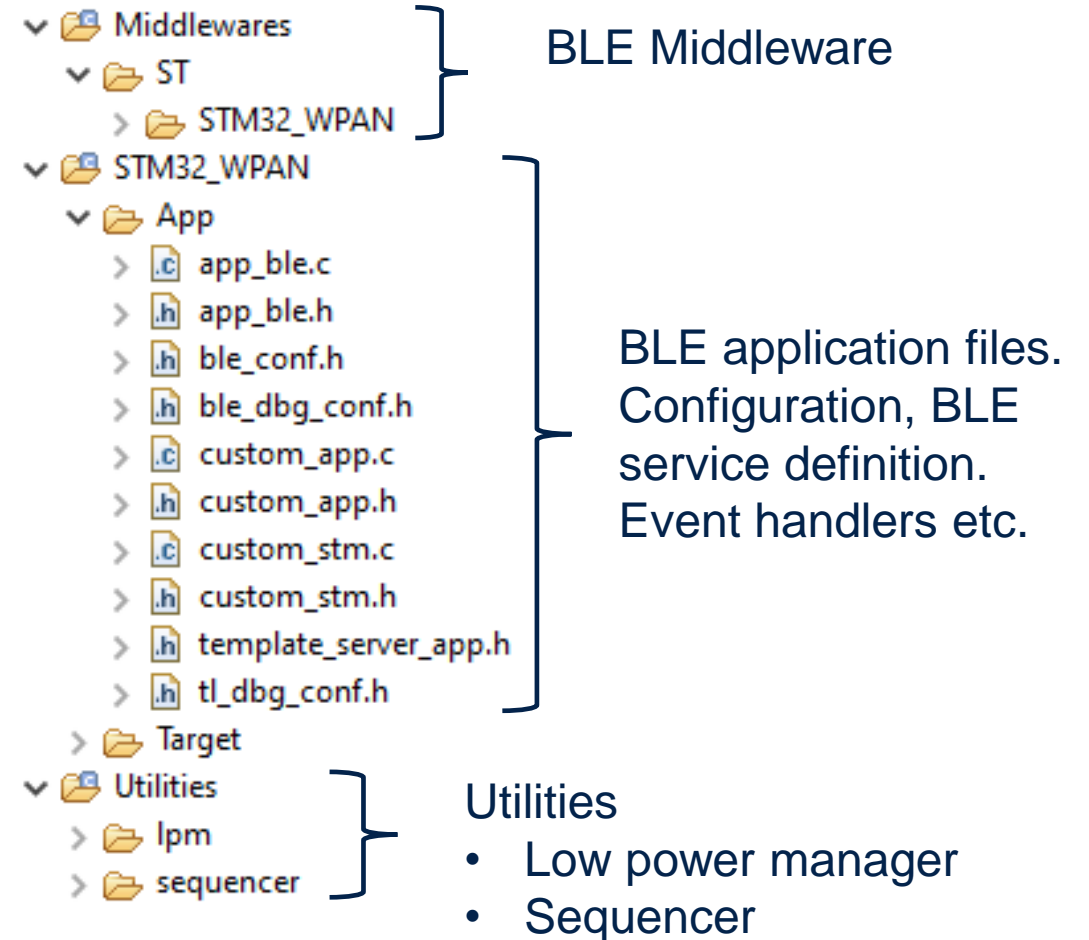
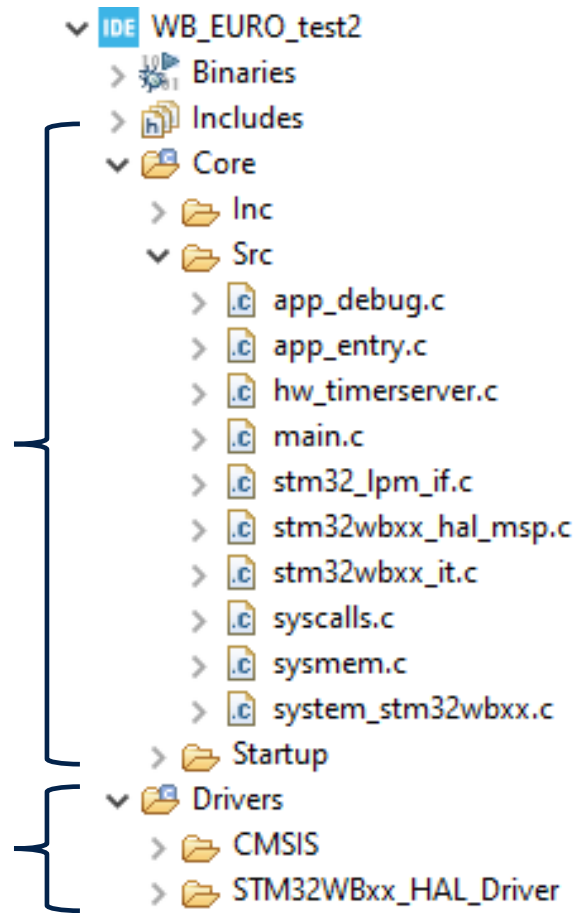
- Connect to your device



# Project structure

Application and  
system initialization +  
Interrupt service  
routines

CMSIS and HAL  
Drivers



- Toggle Green LED when BLE Stack reports that characteristic was written by the phone
- Open `custom_stm.c` and add highlighted code
- Compile and run

`custom_stm.c`

```
26 /* USER CODE BEGIN Includes */
```

```
27 #include "main.h"
```

```
28 /* USER CODE END Includes */
```

```
...
```

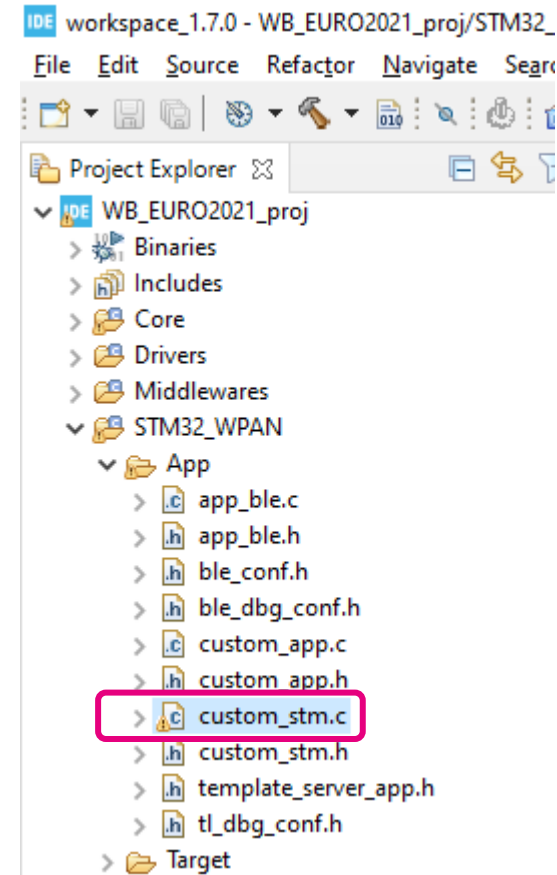
```
144         else if(attribute_modified->Attr_Handle == (CustomContext.CustomMycharwriteHdle + CHARACTERISTIC_VALUE_ATTRIBUTE_OFFSET))
```

```
145         {
```

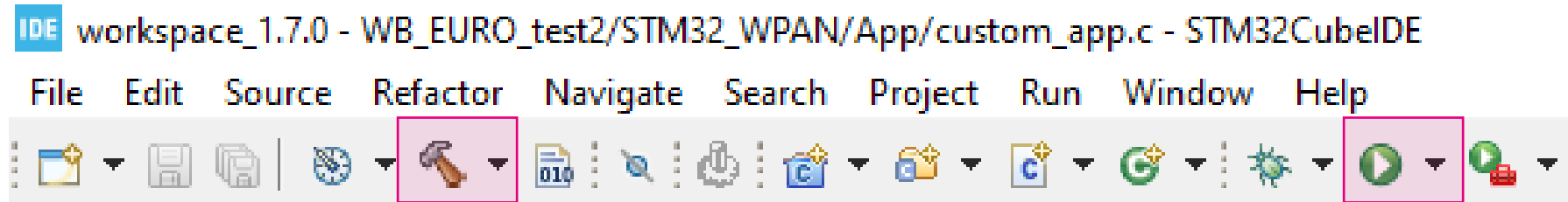
```
146             return_value = SVCCTL_EvtAckFlowEnable;
```

```
147             /* USER CODE BEGIN CUSTOM_STM_Service_1_Char_1_ACI_GATT_ATTRIBUTE_MODIFIED_VSEVT_CODE */
```

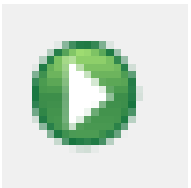
```
148             HAL_GPIO_TogglePin(LD2_GPIO_Port, LD2_Pin);
```



# Compile and run



Build

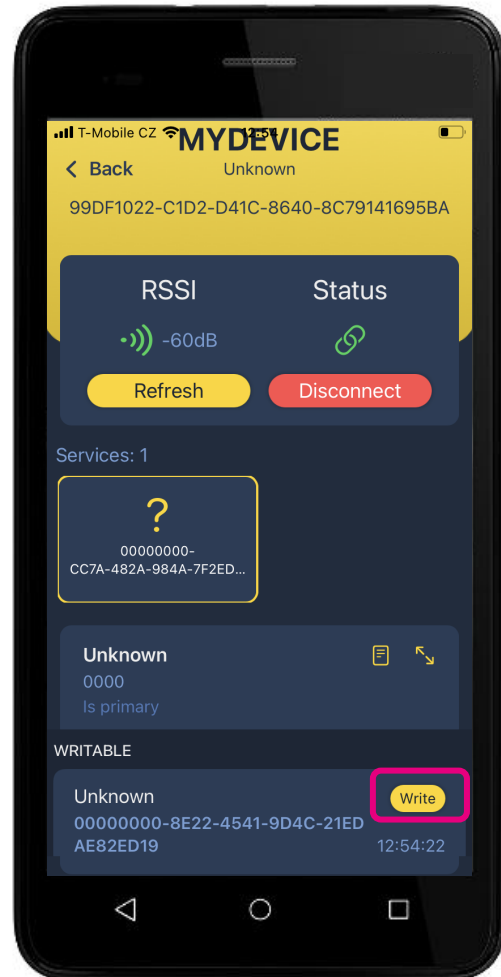


Run



# Hands-On

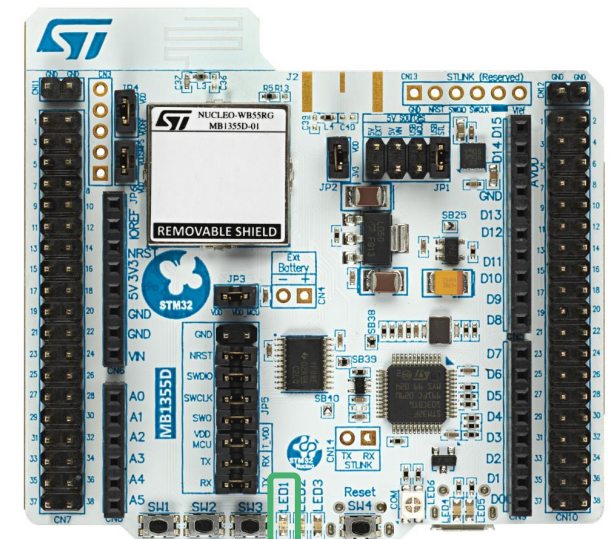
- Write a single arbitrary byte to the characteristic.
- Green LED will toggle
- Parsing the input value is shown as optional hands-on at the end of this presentation



Write

Custom SERVICE

Custom CHARACTERISTIC 1  
**W** LED control



Green LED



life.augmented

# STM32WB Video Series – Getting Started

#12c STM32CubeMX & STM32CubeIDE lab  
Sending notifications to the phone

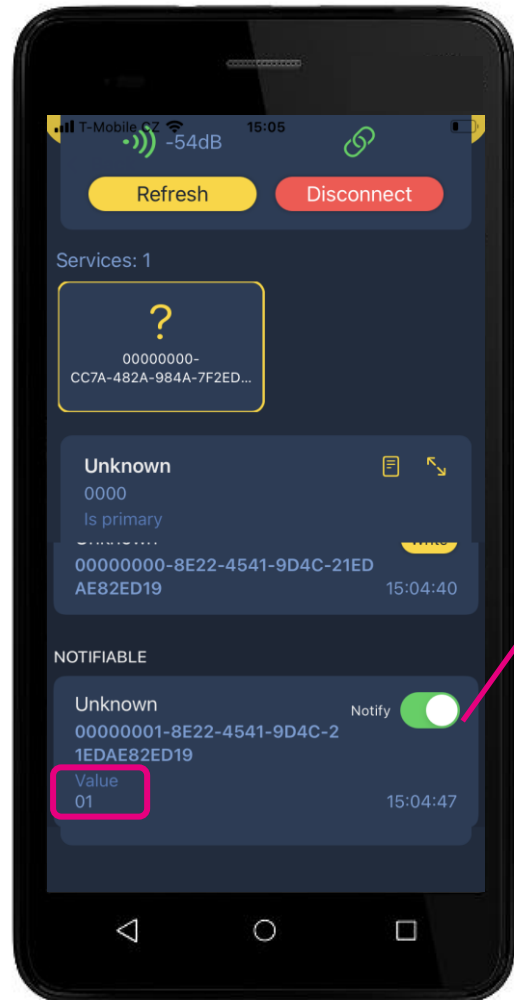
T.O.M.A.S. Team

Matching Network

15HS3N6S02  
L3

# Hands-On part 2

## Add Button 1 notification characteristic

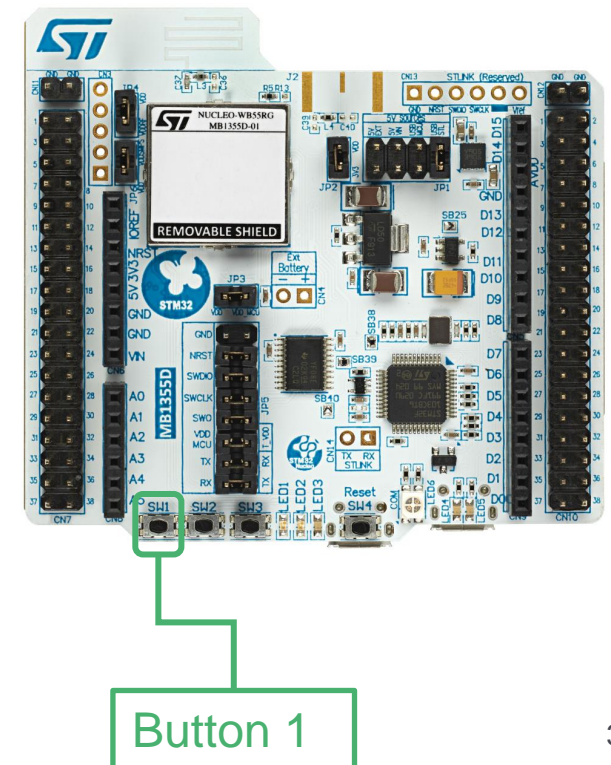


Enable notification  
On Button 1 press notification will  
be send to the phone

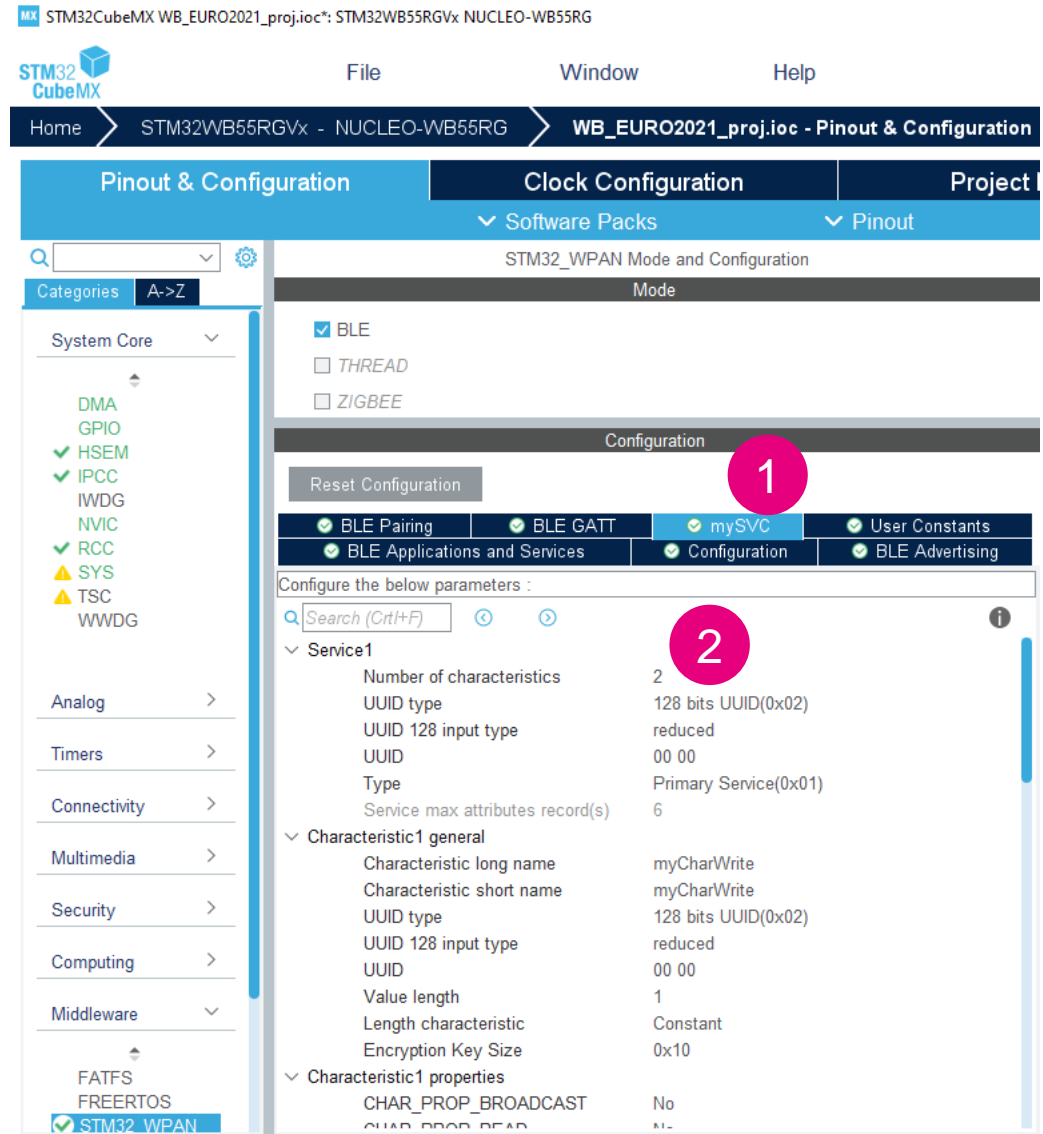
Custom SERVICE

Custom CHARACTERISTIC 1  
**W** LED control

Custom CHARACTERISTIC 2  
**N** Button 1 notification



- Go back to CubeMX
- Select 'mySVC' tab. The exact name depends on your previous selection
- Add a second Characteristic.  
Set Number of characteristic to 2



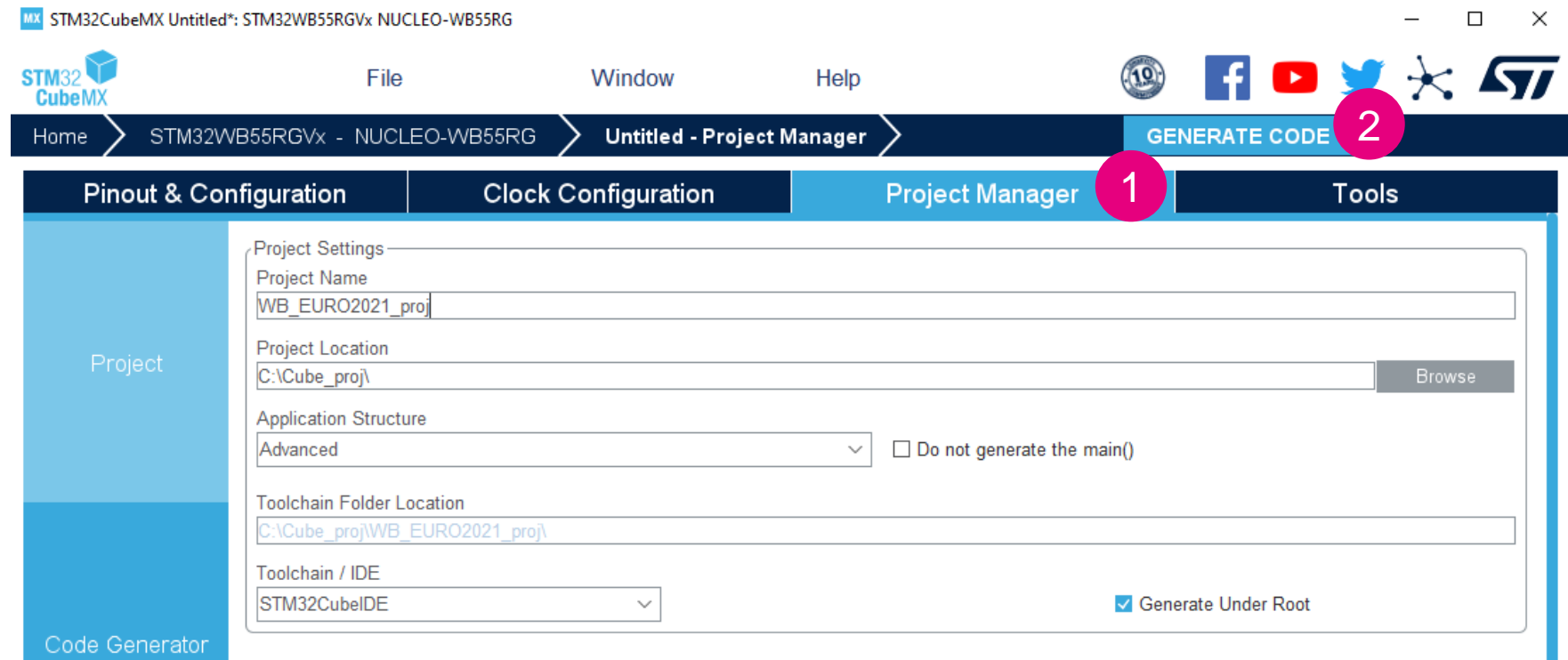
- Name the second characteristic 'myCharNotify' as both long and short name
- Increment the UUID to 00 01
- Enable CHAR\_PROP\_NOTIFY property

The screenshot shows the 'Configuration' window of a development tool. At the top, there's a 'Reset Configuration' button. Below it, a row of tabs includes 'BLE Pairing', 'BLE GATT', 'mySVC' (selected), 'User Constants', 'BLE Applications and Services', 'Configuration', and 'BLE Advertising'. A search bar with the placeholder 'Search (Ctrl+F)' is present. The main area is titled 'Configure the below parameters :'. It lists parameters for 'Characteristic2 general' and 'Characteristic2 properties'. Red circles with numbers 1 and 2 highlight specific changes: circle 1 points to the 'Characteristic long name' and 'Characteristic short name' fields, both set to 'myCharNotify'; circle 2 points to the 'UUID' field, which is set to '00 01'. Another red circle with the number 1 points to the 'CHAR\_PROP\_NOTIFY' property, which is set to 'Yes'.

Configuration	
Reset Configuration	
✓ BLE Pairing	✓ BLE GATT
✓ BLE Applications and Services	✓ mySVC
	✓ Configuration
	✓ User Constants
	✓ BLE Advertising
Configure the below parameters :	
Search (Ctrl+F)	
GATT_NOTIFY_READ_REQ_AND... No	
Characteristic2 general	
Characteristic long name	myCharNotify
Characteristic short name	myCharNotify
UUID type	128 bits UUID(0x02)
UUID 128 input type	reduced
UUID	00 01
Value length	1
Length characteristic	Constant
Encryption Key Size	0x10
Update char value offset	0
Characteristic2 properties	
CHAR_PROP_BROADCAST	No
CHAR_PROP_READ	No
CHAR_PROP_WRITE_WITHOUT_...	No
CHAR_PROP_WRITE	No
CHAR_PROP_NOTIFY	Yes
CHAR_PROP_INDICATE	No

# Hands-On

- Got to Project Manager
- Regenerate code



- Now we want to call `aci_gatt_update_char_value(...)` API on button press. This will send a CMD to CM0+ passing the value as an argument
- This cannot be done from interrupt context, because it is not safe (ACI interface is not not reentrant).
- We need to create a task that runs in the background.



# Hands-On

app\_conf.h

1

```
543 /* USER CODE BEGIN Defines */
544 void myTask(void);
545 /* USER CODE END Defines */

...
558 /**< Add in that list all tasks that may send a ACI/HCI command */
559 typedef enum
560 {
561     CFG_TASK_ADV_CANCEL_ID,
562 #if (L2CAP_REQUEST_NEW_CONN_PARAM != 0 )
563     CFG_TASK_CONN_UPDATE_REG_ID,
564 #endif
565     CFG_TASK_HCI_ASYNC_EVT_ID,
566 /* USER CODE BEGIN CFG_Task_Id_With_HCI_Cmd_t */
567     CFG_TASK_MY_TASK,
568 /* USER CODE END CFG_Task_Id_With_HCI_Cmd_t */
```

app\_ble.c

2

```
253 /* Functions Definition -----*/
254 void APP_BLE_Init( void )
255 {
256 /* USER CODE BEGIN APP_BLE_Init_1 */
257     UTIL_SEQ_RegTask( 1<<CFG_TASK_MY_TASK, UTIL_SEQ_RFU, myTask);
258     UTIL_SEQ_SetTask(1 << CFG_TASK_MY_TASK, CFG_SCH_PRIO_0);
```

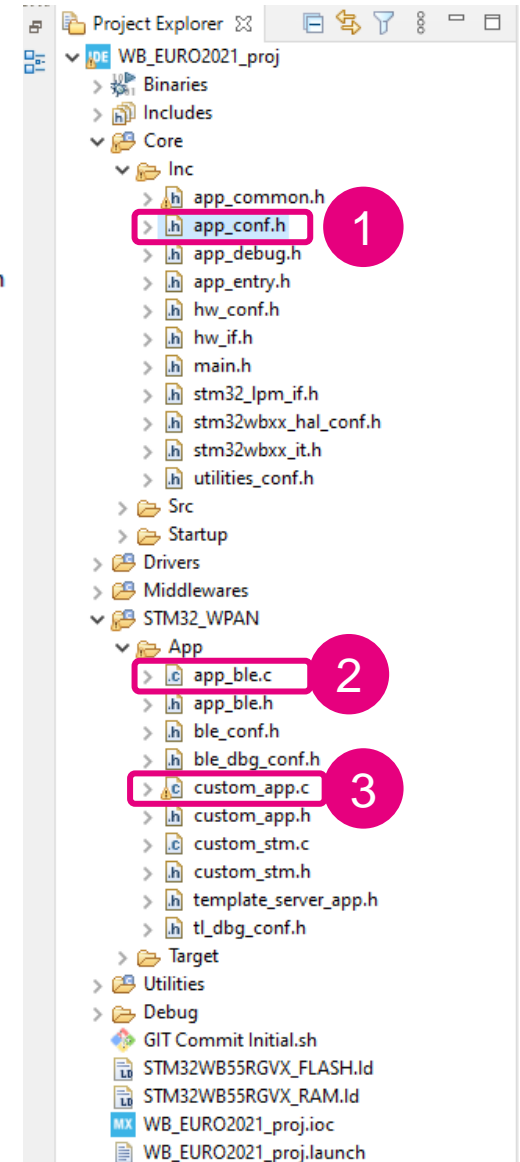
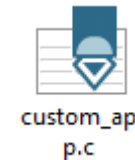
custom\_app.c

3

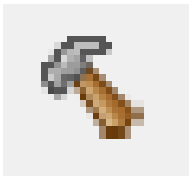
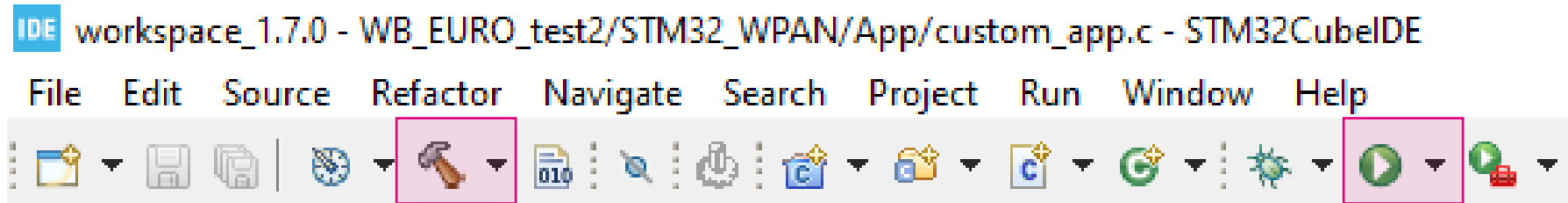
```
85 /* USER CODE BEGIN PFP */
86 void myTask(void)
87 {
88     if(!HAL_GPIO_ReadPin(B1_GPIO_Port, B1_Pin))
89     {
90         UpdateCharData[0] ^= 0x1;
91         Custom_Mycharnotify_Update_Char();
92     }
93     UTIL_SEQ_SetTask(1 << CFG_TASK_MY_TASK, CFG_SCH_PRIO_0);
94 }
95 /* USER CODE END PFP */
```

Right click to open finished file and copy paste, CTRL + A, CTRL + C/V

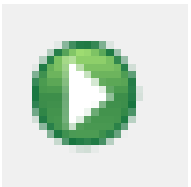
Careful!!! The function name depends on your naming. You might need to modify



# Compile and run



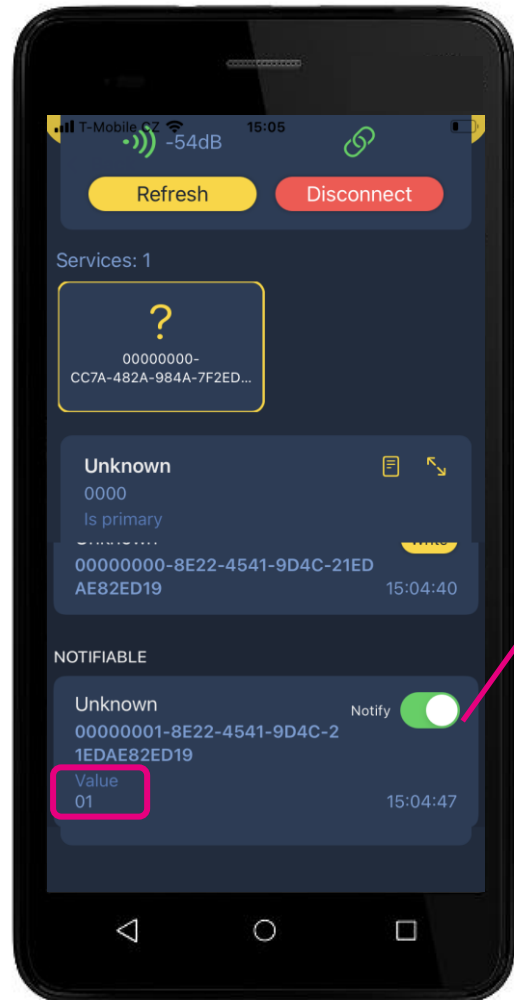
Build



Run

# Hands-On part 2

## Add Button 1 notification characteristic



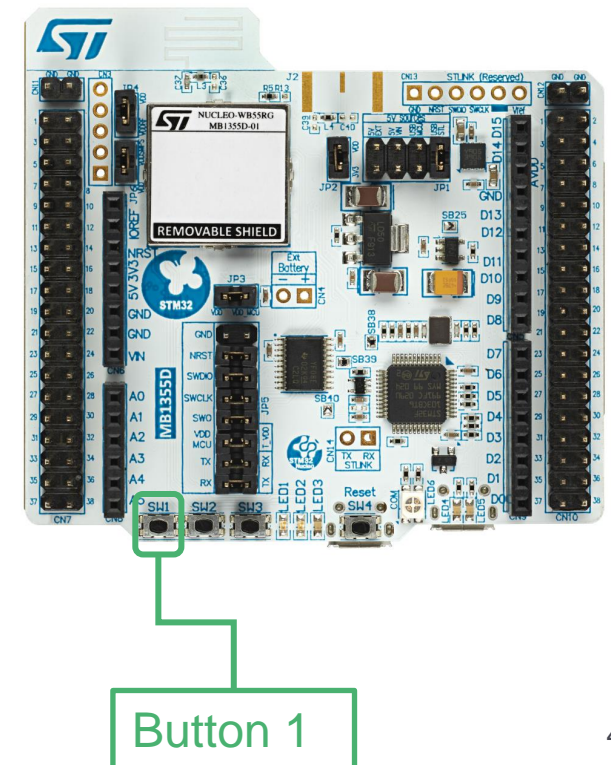
Enable notification  
On Button 1 press notification will  
be send to the phone

Custom SERVICE

Custom CHARACTERISTIC 1  
**W** LED control

Custom CHARACTERISTIC 2  
**N** Button 1 notification

Notification



# What we learned?

- How to create BLE project from scratch in CubeMX
- Which peripherals are required by BLE Middleware
- How to define Custom BLE Service and how to add characteristics
- How to process events generated by BLE Stack
- How to call BLE Stack API safely



Write



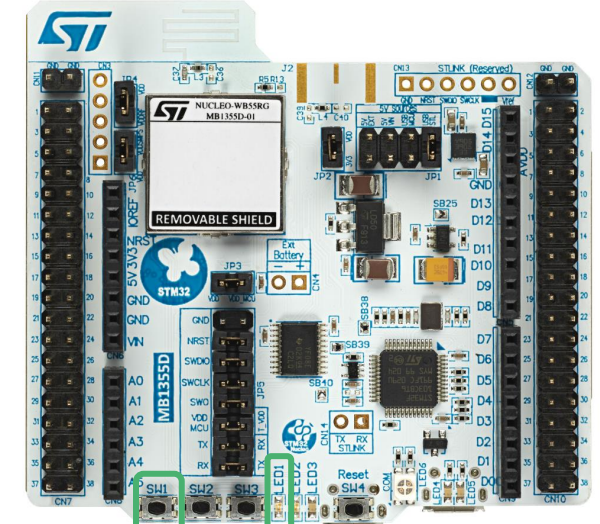
Notification



## Custom SERVICE

Custom CHARACTERISTIC 1  
**W** LED control

Custom CHARACTERISTIC 2  
**N** Button 1 state



Button 1

Green LED

# Thank you

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