Application note

The Architecture of SW

WISOL

November 22, 2017

Introduction

Device Model & Firmware Version

Model	Firmware
SFM20R	EVBSFM20R_V200
	EVBSFM20R_V204(SDK)

The architecture of SW documentation includes descriptions to help you understand and develop SW in the module. Scenario mode and test mode are provided for development purposes only and should always be tested with your design.

Getting Started

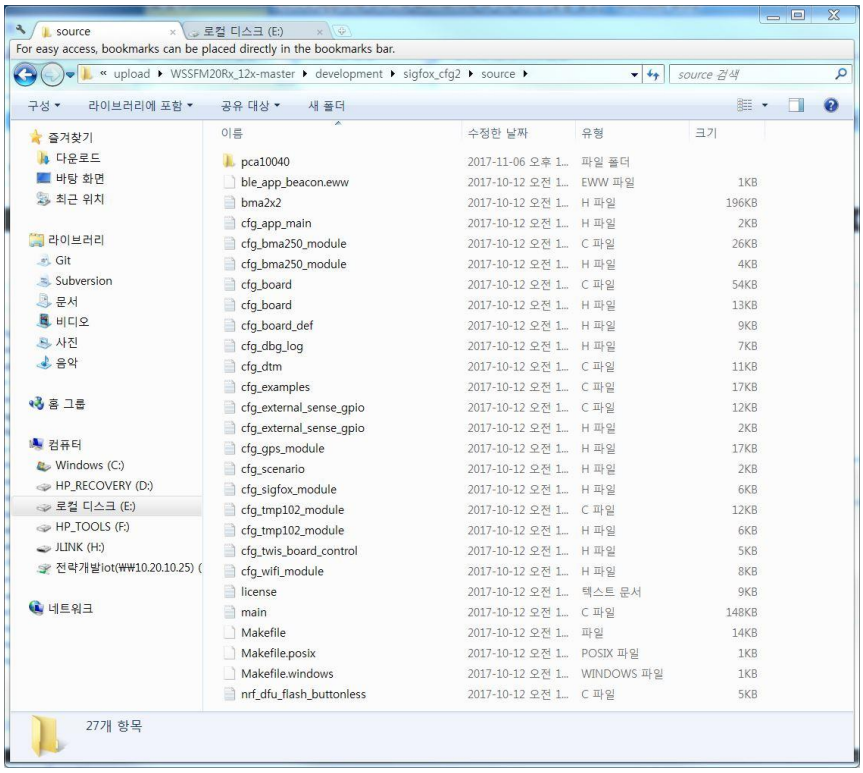
We provide the manual of setting up the development kit based on Nordic.

Refer to ₩WSSFM20Rx_12x-master₩development₩sigfox_cfg2₩documentation₩manual
₩[WISOL]Development_Environment_Setup_Guide_V202.pdf

For more details

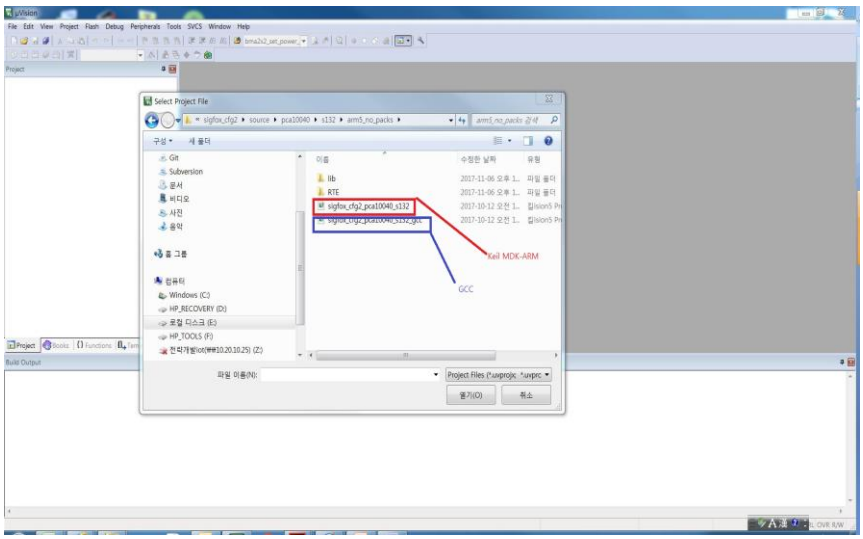
Refer to Software Development Kit > nRF5 SDK > nRF5 SDK v12.1.0 in http://infocenter.nordicsemi.com/

The structure of the example files(tracker)



The tracker example is located in

₩WSSFM20Rx_12x-master₩development₩sigfox_cfg2₩source



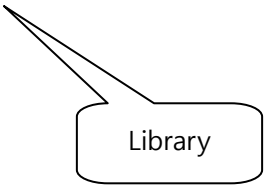
The project files of the tracker are located in

WSSFM20Rx_12x-master₩development₩sigfox_cfg2₩source₩pca10040₩s132₩arm5_no_packs

The developers can choose one of two project files(KEIL, GCC)

Module

- ✓ Main : main.c
- ✓ BLE : main.c
- ✓ Accelerometer : cfg_bma250_module.c
- ✓ Temperature : cfg_tmp102_module.c
- ✓ Board support, Utility, Boot Mode ctl : cfg_board.c
- ✓ examples : cfg_examples.c
- ✓ GPIO trigger(keys, magnetic) : cfg_external_sense_gpio.c
- ✓ GPS : cfg_gps_module.h
- ✓ WIFI : cfg_wifi_module.h
- ✓ SIGFOX : cfg_sigfox_module.h
- ✓ Definition of scinario : cfg_scenario.h
- ✓ DBG control over I2C, RTT : cfg_twis_board_control.h



Mode

Introduction

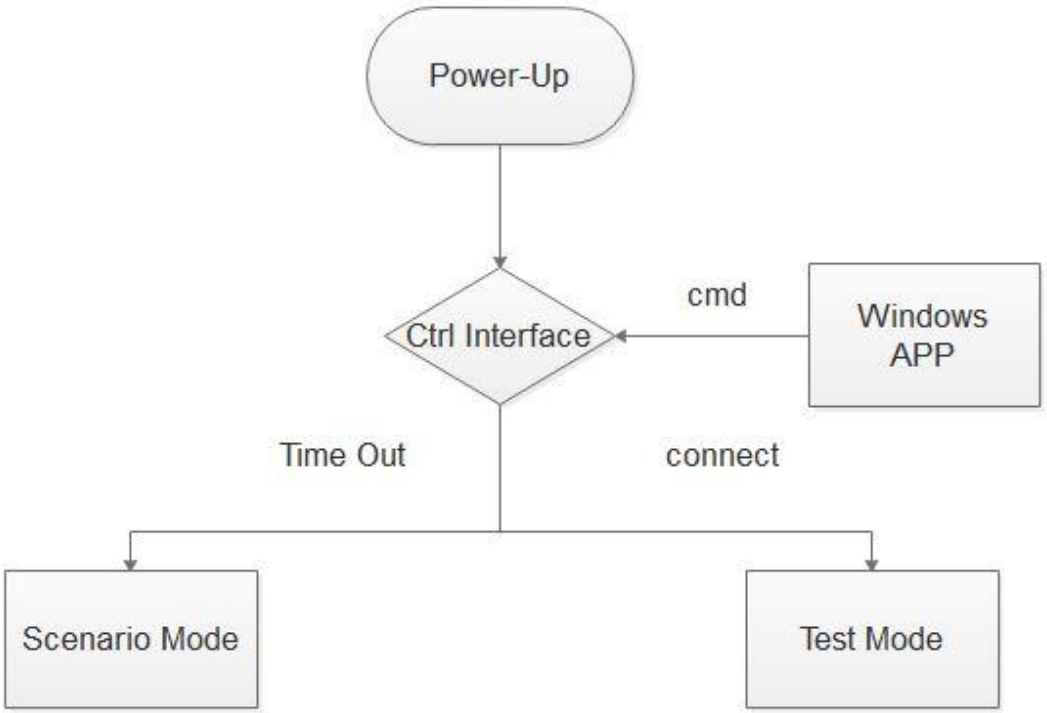
Examples are consist of two modes.

Scenario mode is based on Software Marketing Specification by SIGFOX.

Test mode enables user to test and debug each modules like a GPS module, a WIFI module, and so on.

Selecting Mode

- Scenario mode is automatically selected in power-up.
- It can enter the test mode using the PC tool.
  PC tools only support windows. (development₩sigfox_cfg2₩tools₩EXE_CONFIG2_v013_1.zip)
- Test mode needs pc tool and connecting to the used usb port. (use I2C)
  Run PC tool -> Connect with I2C in PC tool
- Instead of I2C, you can connect PC tool with J-Link (use SWD).
  Run RTT Viewer -> Run PC tool -> Connect with TCP in PC tool



Code review

```
int main(void)
{

....

    cTBC_init(dbg_i2c_user_cmd_proc, true);  //If i2c is not used, set the second argument to false
    cTBC_OVER_RTT_init(tbc_over_rtt_sec_tick_proc); //for use test mode over RTT

....

    cTBC_check_N_enter_bypassmode(200, main_bypass_enter_CB, main_bypass_exit_CB);  //for enter test mode
    if(m_hitrun_test_flag)NVIC_SystemReset();

....
}
```

Boot Mode

Introduction

Supports boot mode for RF regulatory certification.

For RF regulatory certification, see RF_regulatory_certification_guide_REV00_eng_171021.doc.

See the cfg_board_check_bootmode() function for more information.

It able to change the setting value with PC tool or RTT viewer.

Unless "normal mode", it can not use the PC tool.

And it can switch to "normal mode" by sending "CF" command with RTT.

When the setting value is saved, the setting is retained.

Code review

see define FEATURE_CFG_CHECK_NV_BOOT_MODE

```
int main(void)
{
    bool    erase_bonds = 0;

    cPrintLog(CDBG_MAIN_LOG, "\n====== %s Module Started Ver:%s bdtype:%d======\n", m_cfg_model_name, m_cfg_sw_ver, m_cfg_board_type);
    cPrintLog(CDBG_MAIN_LOG, "build date:%s, %s\n", m_cfg_build_date, m_cfg_build_time);
    module_parameter_early_read(); //load setting value

    cfg_examples_check_enter();
    cfg_board_early_init();
void cfg_board_early_init(void)
{
    cfg_board_check_reset_reason();
#ifdef FEATURE_CFG_CHECK_BOOTSTRAP_PIN
    cfg_board_check_bootstrap_pin();
#else
    cfg_board_check_wifi_downloadmode();
#endif
#ifdef FEATURE_CFG_CHECK_NV_BOOT_MODE
    cfg_board_check_bootmode();
#endif
```

It is executed if boot mode is set.

Kind of boot mode

Normal mode : 0 (default, The mode setting is possible with SWD)

Sigfox test mode : 6 (via SWD), 7(via UART)

WIFI test mode : 1 (via WIFI UART), *WIFI download mode -> DL_EN/INT_WIFI to GND

BLE test mode : 3 (via SWD and via UART)

GPS test mode : 4 (via SWD and via UART)

*** Extended commands for RTT (uppercase, end of line is none)**

"CC" -> Connect PC tool over RTT (Only available early in the boot)

"CR" -> Target reset

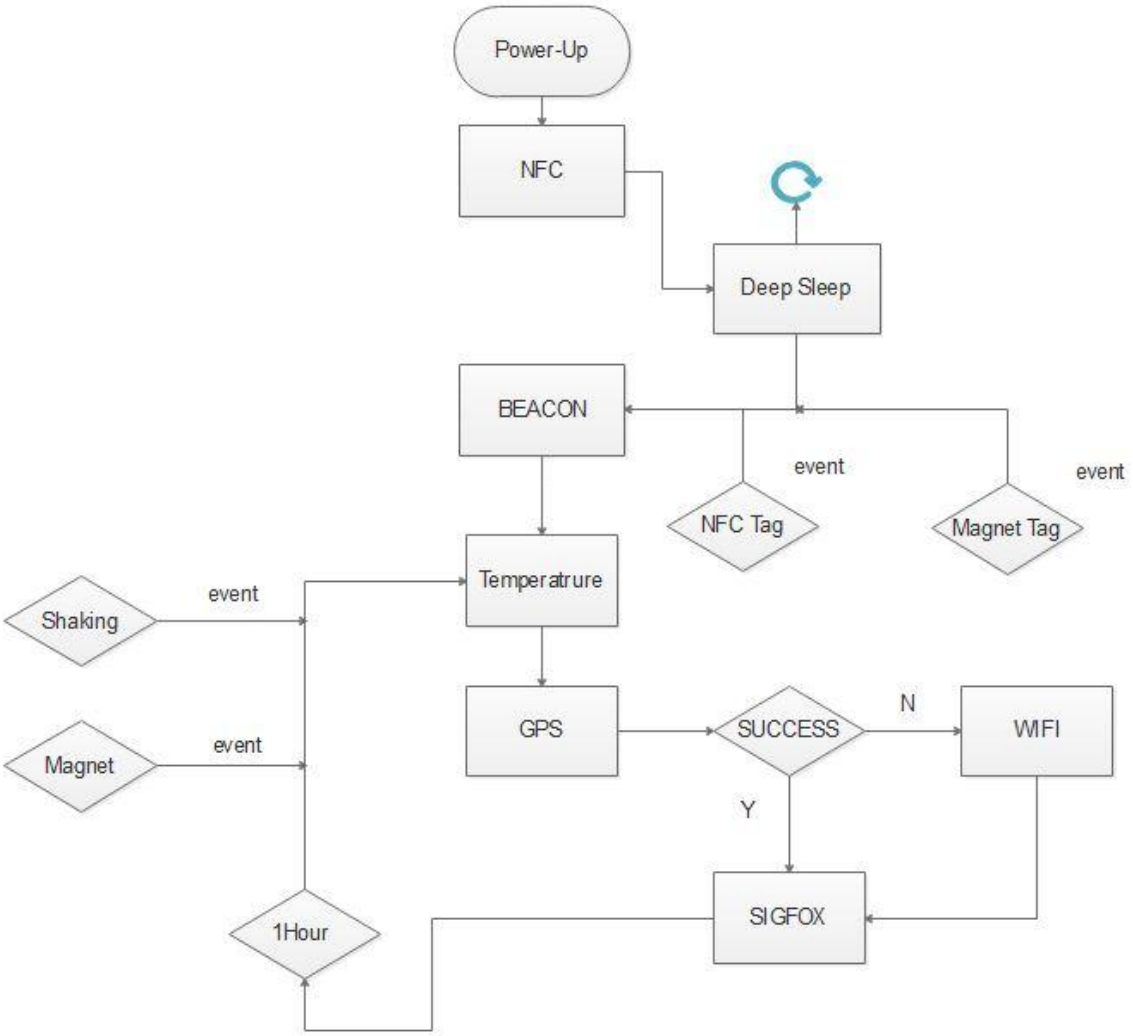
"CF" -> Change setting value to default

"CMx" -> Set boot mode (x is value of mode)

Scenario of Tracker

Introduction

The target application for the scenario mode is a low power tracking device.
The application use WIFI or GPS to determine location. It will then transmit the location information via SIGFOX. It also will transmit other information like temperature, accelerometer, and so on.



Wake-up Device

- The device go to deep sleep state when power on
- Touching the NFC antenna with a smartphone or a tablet can wake up device.
- Touching magnetic sensor with magnetic tag can also wake up it.

Bluetooth

- The default payload for the beacon advertisement will be the Model name(WISOL_SFM21R).
- In Power-up or touching the NFC antenna with a smartphone, smartphone app will try to connect to the device with MAC of the device from NFC.
- Users can download firmware via FOTA, and get the information of device.

Determining location

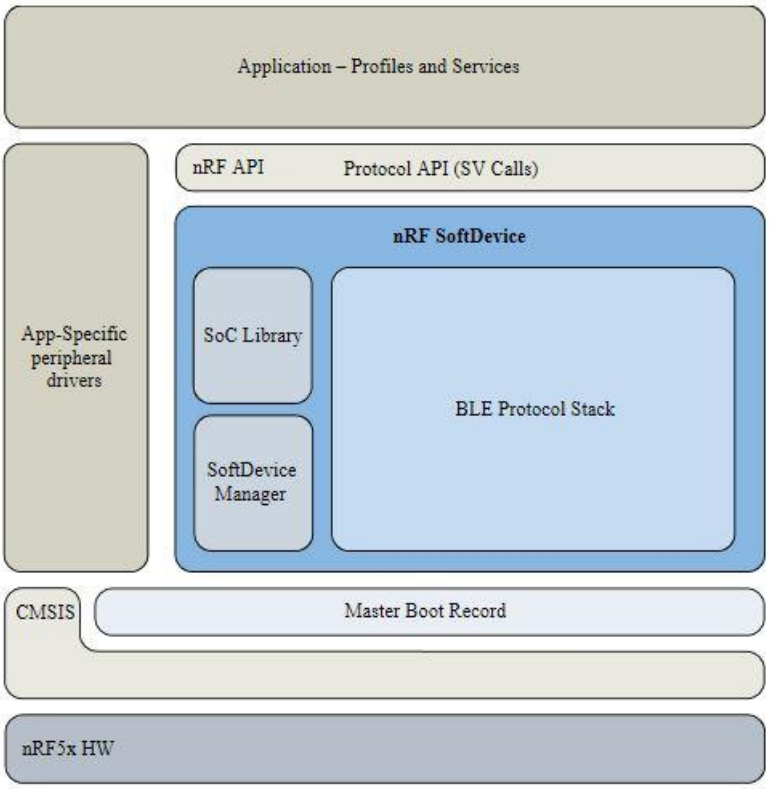
- The application can turn on the GPS radio and attempt to get a fix for 60s.
- The application can run a scan for access points for 10s with WIFI.

Measurement frequency

- When power-up
- Every 10 minutes(editable)
- Whenever the accelerometer triggers an interrupt
- Whenever touching magnetic sensor with magnetic tag

Architecture

Introduction

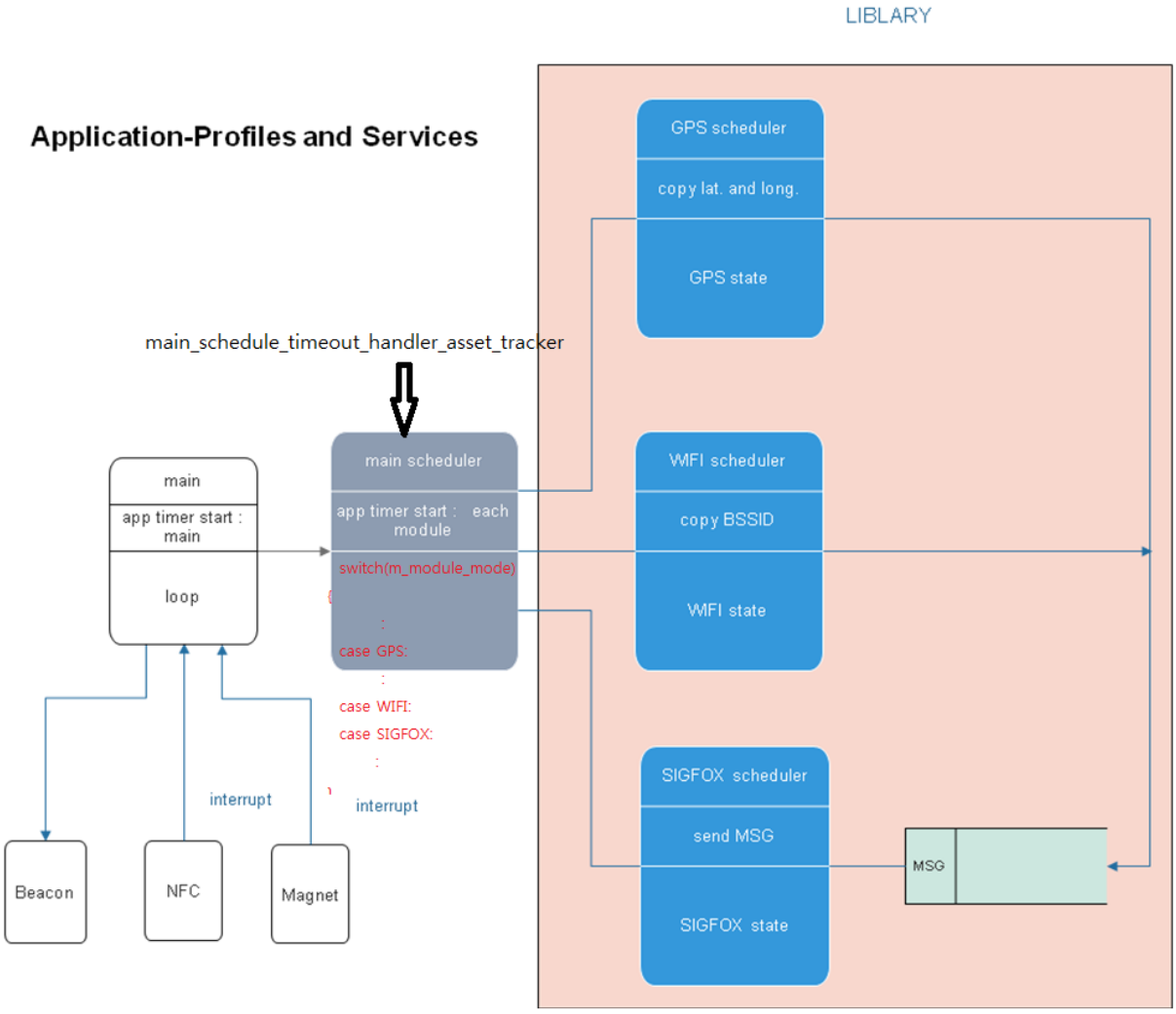


The application is based on nRF52832 platform. The application manages schedule using app timer.

The application has two kinds of scheduler, one is main scheduler and the other is module scheduler.

Application – Profiles and Services

- The tracking-application runs on "application-Profiles and Services" layer.
- The developer can only use the API of Modules like create, start, stop.
- When "start" of API is called, each module automatically will runs and get the results.
- Each module is provided in the form of a library.



Create Scheduler

- The timer library in nRF52832 platform enables the application to create multiple timer instances based on the RTC1 peripheral.
- Checking for time-outs and invoking the user time-out handlers is performed in the RTC1 interrupt handler.
- The main scheduler operates at a 20 ms cycle.
- Ex)
  err_code = app_timer_create(&main_timer_id, mode, timeout_handler)

  mode : either single shot or repeated
  timeout_handler : manage and execute each module

State machine

- Scheduler uses state machine for managing each module.
- Ex)

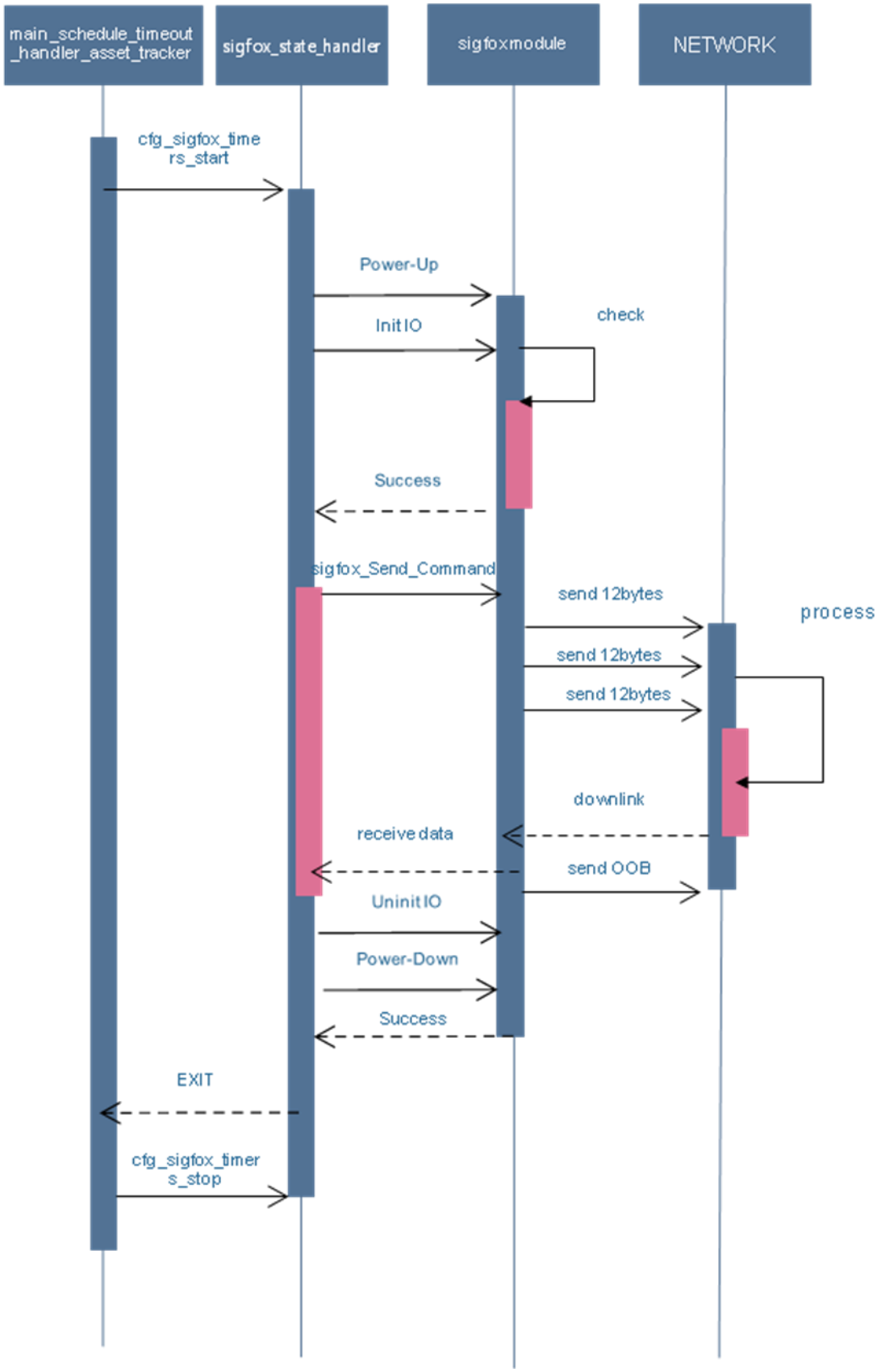
```
typedef enum
{
    NONE,
    ACC,
    MAIN_SCENARIO_LOOP,
    TMP,
    BLE,
    GPS,
    WIFI,
    SIGFOX,
    IDLE,
    BATTERY_CHECK
}module_mode_t
```

- When user time-out, scheduler determines whether to work in current state or move to another state.

Inter-Communication

- Main scheduler calls create Function to execute any module.
- After each module work, the result is copied into sending buffer in SIGFOX.
- After main scheduler checking module's work, it move to another module.

- ex) between main scheduler and SIGFOX module


main_schedule_timeout_handler_asset_tracker
sigfox_state_handler
sigfoxmodule
NETWORK
cfg_sigfox_timers_start
Power-Up
InitIO
check
Success
sigfox_Send_Command
send 12bytes
process
send 12bytes
send 12bytes
downlink
receive data
send OOB
UninitIO
Power-Down
Success
EXIT
cfg_sigfox_timers_stop

Configuration

```
:
: /**
:  * @brief setting items
:  */
: typedef struct
: {
:     uint32_t    magic_top;
:     uint32_t    idle_time;                                  //module_parameter_item_idle_time
:     uint32_t    beacon_interval;                            //module_parameter_item_beacon_interval
:     uint32_t    wifi_scan_retry_time_sec;                   //module_parameter_item_wifi_scan_retry_time_sec
:     uint32_t    start_wait_time_for_board_control_attach_sec;  //module_parameter_item_start_wait_time_for_board_control_attach_sec //use to sfm_boot_mode START_WAIT_TIME_FOR_BOARD_CONTROL_ATTACH_SEC
:     uint32_t    start_wait_time_for_ctrl_mode_change_sec;   //module_parameter_item_start_wait_time_for_ctrl_mode_change_sec  //use to sigfox dl enable
:     uint32_t    gps_acquire_tracking_time_sec;              //module_parameter_item_gps_tracking_time_sec
:     bool        boot_nfc_unlock;                            //module_parameter_item_boot_nfc_unlock
:     bool        fota_enable;                                //module_parameter_item_fota_enable
:     uint16_t /*MODULE_DEFAULT_SCENARIO_TYPE*/ scenario_mode;  //module_parameter_item_scenario_mode  //MODULE_DEFAULT_SCENARIO_TYPE
:     bool        magnetic_gpio_enable;                       //module_parameter_item_magnetic_gpio_enable
:     char        wkup_gpio_enable;                           //module_parameter_item_wkup_gpio_enable  //MAIN_WKUP_GPIO_ENABLE_DEFAULT
:     bool        wifi_testmode_enable;                       //module_parameter_item_wifi_testmode_enable
:     bool        sigfox_snek_testmode_enable;                //module_parameter_item_snek_testmode_enable
:     bool        cgps_cn0_current_savetime_enable;           //module_parameter_item_gps_cn0_current_savetime_enable
:
:     //setting value here
:     uint32_t    magic_bottom;
:     uint32_t    guard_area_align4;
:
:     //id cache value here
:     uint8_t     wifi_MAC_STA[6];
:     uint8_t     sigfox_device_ID[4];
:     uint8_t     sigfox_pac_code[8];
:     uint8_t     board_ID;
:     int32_t     guard_area_align4_2;
: } ? end {anonmodule_parameter_t} ? module_parameter_t;
:
```

cfg_board.h

- users can add the parameters they want
- static void module_parameter_init(void) : read the values of the parameters
- static void module_parameter_default_init(void) : set the default values of the parameters

NFC

- Initialize

```
void nfc_init()
{
    uint32_t err_code;

    if(!mnfc_init_flag)
    {
        /* Set up NFC */
        err_code = nfc_t2t_setup(nfc_callback, NULL);
        APP_ERROR_CHECK(err_code);

        /** @snippet [NFC URI usage_1] */
        /* Provide information about available buffer size to encoding function */
        uint32_t len = sizeof(m_ndef_msg_buf);

        welcome_msg_encode(m_ndef_msg_buf, &len);

        /** @snippet [NFC URI usage_1] */

        /* Set created message as the NFC payload */
        err_code = nfc_t2t_payload_set(m_ndef_msg_buf, len);
        APP_ERROR_CHECK(err_code);

        /* Start sensing NFC field */
        err_code = nfc_t2t_emulation_start();
        mnfc_init_flag = true;
    } ? end if !mnfc_init_flag ?
} ? end nfc_init ?
```

callback function for handling NFC events

- Set data

```
/**
 * @brief Function for encoding the welcome message.
 */

NFC_NDEF_MSG_DEF(welcome_msg, MAX_REC_COUNT);
static void welcome_msg_encode(uint8_t * p_buffer, uint32_t * p_len)
{
    sigfox_id_record_add(&NFC_NDEF_MSG(welcome_msg));
    sigfox_pac_record_add(&NFC_NDEF_MSG(welcome_msg));
    ble_mac_record_add(&NFC_NDEF_MSG(welcome_msg));

    /** @snippet [NFC text usage_2] */
    uint32_t err_code = nfc_ndef_msg_encode(&NFC_NDEF_MSG(welcome_msg),
                                            p_buffer,
                                            p_len);

    APP_ERROR_CHECK(err_code);
    /** @snippet [NFC text usage_2] */
}
```

set SIGFOX ID, PAC, and MAC to NFC MSG

BLE

- m_module_parameter.beacon_interval : advertising interval
- err_code = sd_ble_gap_device_name_set(&sec_mode,
  (const uint8_t *)DEVICE_NAME,
  strlen(DEVICE_NAME));
  you can change advertising payload using the function.
- static void services_init(void) : add ble uart service and FOTA service
- refer to http://infocenter.nordicsemi.com/index.jsp for more details

MAIN

- create main scheduler
  static void main_timer_create()
- start main scheduler
  void main_timer_schedule_start(void)
  // call static void main_schedule_timeout_handler_asset_tracker(void * p_context) periodic 200ms
- go to sleep
  void main_timer_idle_start(void)
  m_module_parameter.idle_time : report over sigfox every idle_time sec
- stop main scheduler
  void main_timer_schedule_stop(void)
- callback function for handling main state from main schedule timer
  static void main_schedule_timeout_handler_asset_tracker(void * p_context)
- move to state
  ex) main_set_module_state(MAIN_SCENARIO_LOOP); //go to MAIN_SCENARIO_LOOP

Accelerometer

- create accelerometer module
  void cfg_bma250_timer_create()
- start accelerometer module
  void cfg_bma250_timers_start(void)
- set interrupt
  void cfg_bma250_interrupt_init(void)
- callback function for handling accelerometer state from acc module timer
  static void bma250_state_handler(void * p_context)
  case SET_S: call the function of configuration in accelerometer
  ex) error_code = bma250_slope_set();

SIGFOX

- create SIGFOX module and get SIGFOX ID and PAC
  void cfg_sigfox_prepare_start(void)
- create SIGFOX module
  void cfg_sigfox_timer_create()
  : if call void cfg_sigfox_prepare_start(void), don't call void cfg_sigfox_timer_create()
- start SIGFOX module
  void cfg_sigfox_timers_start(void)
- sending buffer
  : uint8_t frame_data[(SIGFOX_SEND_PAYLOAD_SIZE*2)+1]; //for hexadecimal
- downlink buffer
  : uint8_t downlink_data[30];
- check whether SIGFOX finishes sending.
  bool sigfox_check_exit_excute(void)
- select SNEK or SIGFOX network
  m_module_parameter.sigfox_snek_testmode_enable =
  MAIN_SIGFOX_SNEK_TESTMODE_ENABLE_DEFAULT; true : snek
- enble/disable DOWNLINK
  cfg_sigfox_downlink_on_off(true); : call it before start SIGFOX module

```
case SIGFOX:
    if(sigfox_get_state() == SETUP_S)
    {
        if(m_init_excute)
        {
            cTBC_write_state_noti("Sigfox");
            cPrintLog(CDBG_FCTRL_INFO, "%s %d SIGFOX MODULE started\n", __func__, __LINE__);
            cfg_sigfox_timers_start();

            m_init_excute = false;
        }
    }
    else if(sigfox_check_exit_excute())
    {
        main_set_module_state(BLE);
        cfg_sigfox_timers_stop();
        sigfox_set_state(SETUP_S);
        nus_send_data('T');
        nus_send_data('B');
    }
    break;
```

after copy data to frame_data[], start SIGFOX module

check SIGFOX 'work done

WIFI

- WIFI initialization

```
void cfg_board_init(void)
{
....

#ifdef CDEV_WIFI_MODULE
    cWifi_resource_init();
    cWifi_prepare_start();
#endif
....
}
```

- Run WIFI Scan

```
        case WIFI:
            {
                bool send_data_req = false;
                uint8_t send_data[SIGFOX_SEND_PAYLOAD_SIZE] = {0,};
#ifdef CDEV_WIFI_MODULE
                int get_bssid_result;
                uint8_t *bssidBuf;
                int wifi_result;

                ++m_module_ready_wait_timeout_tick;
                if(m_init_excute)
                {
....
                    wifi_result = cWifi_ap_scan_req();
                    if(wifi_result == CWIFI_Result_OK)
                    {
....
                        m_init_excute = false;
                    }
                    else
                    {
                        cPrintLog(CDBG_FCTRL_INFO, "%s %d Not Availalble Wifi Module! send NUll data!\n", __func__, __LINE__);
                        send_data_req = true;
                    }
                }
                else
                {
                    if(!cWifi_is_scan_state() && !cWifi_bus_busy_check())  //wait scan
                    {
....
                        get_bssid_result = cWifi_get_BSSIDs_bufPtr(&bssidBuf);
                        cPrintLog(CDBG_FCTRL_INFO, "%s %d WIFI MODULE end! result:%d BSSID:", __func__, __LINE__, get_bssid_result);
                        cDataDumpPrintOut(CDBG_FCTRL_INFO, bssidBuf, (CWIFI_BSSID_CNT*CWIFI_BSSID_SIZE));
                        if(get_bssid_result == CWIFI_Result_OK)
                        {
....
                            memcpy(send_data, bssidBuf, sizeof(send_data));
....
                        }
                        else if(get_bssid_result == CWIFI_Result_NoData)
                        {
                            cPrintLog(CDBG_FCTRL_INFO, "%s %d WIFI MODULE NoData! send NUll data!\n", __func__, __LINE__);
                        }
                        else
                        {
                            cPrintLog(CDBG_FCTRL_INFO, "%s %d Not Availalble Wifi Module! send NUll data!\n", __func__, __LINE__);
                        }
                        send_data_req = true;
                    } ? end if !cWifi_is_scan_state(... ?
                } ? end else ?
#else
....
#endif
                if(send_data_req)
                {
                    memcpy(m_module_peripheral_data.sigfixdata_wifi, send_data, sizeof(m_module_peripheral_data.sigfixdata_wifi));
                    cfg_bin_2_hexadecimal(send_data, SIGFOX_SEND_PAYLOAD_SIZE, (char *)frame_data);  //set sigfox payload
                    cPrintLog(CDBG_FCTRL_INFO, "%s %d send request sigfox! data:%s\n", __func__, __LINE__, frame_data);
                    main_set_module_state(SIGFOX);
                }
            }
            break;
```

request for WIFI Scan

check WIFI'work done

get Scaned MAC

send data to sigfox

BATTERY_CHECK

- cfg_bas_timer_create();
- Run BATTERY CHECK

```
        case BATTERY_CHECK:
#ifdef PIN_DEF_BATTERY_ADC_INPUT
            ++m_module_ready_wait_timeout_tick;
            if(m_init_excute)
            {
                adc_configure();
                cfg_bas_timer_start();
                m_init_excute = false;
            }
            else
            {
                if(m_module_ready_wait_timeout_tick >= (APP_MAIN_SCHEDULE_HZ * 2))  //wait 2 sec
                {
....
                    avg_batt_lvl_in_milli_volts = get_avg_batt_lvl_in_milli_volts();
                    if(3000 <= avg_batt_lvl_in_milli_volts && 5200 >= avg_batt_lvl_in_milli_volts)
                    {
                        if(m_module_parameter.wifi_testmode_enable /*disable_battery_power_down*/)cPrintLog(CDBG_MAIN_LOG, "Battery Pwr Off Disabled\n");
                        if(!m_module_parameter.wifi_testmode_enable /*disable_battery_power_down*/ && !cTBC_check_host_connected() && avg_batt_lvl_in_milli_volts < 3500)  //low battery
                        {
....
                            main_powerdown_request = true;
                        }
                        else if(!m_module_parameter.wifi_testmode_enable /*disable_battery_power_down*/ && avg_batt_lvl_in_milli_volts < 3600)  //battery warning
                        {
....
                        }
                        else
                        {
                            main_set_module_state(TMP);   //battery value is enough
                        }
                    }
                    else
                    {
                        if(log_once_flag)cPrintLog(CDBG_MAIN_LOG, "ADC Not Available:%d\n", avg_batt_lvl_in_milli_volts);
                        main_set_module_state(TMP);  //battery value is not available
                    }
                } ? end if m_module_ready_wait_t... ?
            } ? end else ?
#else
            main_set_module_state(TMP);
#endif
            break;
```

request for ADC Read

get battery value average

TMP

#define TMP102_I2C_ADDRESS 72 /* This is the I2C address for our chip – 0x48 */

- TMP102 timer create
- TMP102 timer start
- TMP102 timer stop

```
case TMP:
    if(tmp102_get_state() == NONE_TMP)
    {
        cTBC_write_state_noti("Temperature");
        cPrintLog(CDBG_FCTRL_INFO, "%s %d TMP MODULE started\n",  __func__, __LINE__);
        tmp102_set_state(TMP_SET_S);
        cfg_tmp102_timers_start();
    }
    else if(tmp102_get_state() == EXIT_TMP)
    {
        cfg_tmp102_timers_stop();
        tmp102_set_state(NONE_TMP);
        main_set_module_state(GPS);
    }
    break;
```

tmp102 time create

tmp102 time stop

```
int tmp102_get_result(int *tmp102_int, int *tmp102_dec)
{
    int result = 0;

    *tmp102_int = tmp102a;
    *tmp102_dec = tmp102b;
    if((tmp102a != 0) || (tmp102b != 0))
    {
        result= true;
    }
    else
    {
        result = false;
    }

    return result;
}
```

get temperature

GPS

- Initialize GPS

```
void cfg_board_init(void)
{
    ...
    cGps_resource_init();
    cGps_prepare_start();
    ...
}
```

GPIO & Power control

- GPS start

```
            break;
        case GPS:
#ifdef CDEV_GPS_MODULE
            memset(gps_send_data, 0, sizeof(gps_send_data));

            if(work_mode == GPS_START)
            {
                if(cGps_status_available() == CGPS_Result_OK)
                {
                    cTBC_write_state_noti("GPS");
                    cPrintLog(CDBG_FCTRL_INFO, "%s %d GPS MODULE started  \n", __func__, __LINE__);
                    cGps_nmea_acquire_request();
                    cfg_ble_led_control(false);
                    work_mode = GPS_WORK; //wait scan
                }
                else
                {
                    work_mode = GPS_END;
                }
            }
```

Request start GPS acquire

- GPS position fixed check

```
else if(work_mode == GPS_WORK)
{
    cfg_ble_led_control(true);
    get_nmea_result = cGps_acquire_tracking_check();
    if(get_nmea_result == CGPS_Result_OK)
    {
        cfg_ble_led_control(false);
        work_mode = GPS_END;
    }
    else  if(get_nmea_result ==  CGPS_Result_Busy)
    {
        ;
    }
    else
```

GPS position fixed check

- Send data to sigfox

```
else if(work_mode == GPS_END)
{
    cfg_ble_led_control(true);
    get_nmea_result = cGps_nmea_get_bufPtr(&nmea_Buf);
    if(get_nmea_result == CGPS_Result_OK)
    {
        memcpy(gps_send_data, nmea_Buf, sizeof(gps_send_data));
        send_gps_data_req = true;
    }
    if(send_gps_data_req)
    {
        gps_send_data[9] = SIGFOX_MSG_SEND_REASON(main_wakeup_reason);  /*10th bype Status filed modifyed*/
        cfg_bin_2_hexadecimal(gps_send_data, SIGFOX_SEND_PAYLOAD_SIZE, (char *)frame_data);  //set sigfox payload
        cPrintLog(CDBG_FCTRL_INFO, "[GPS] %d send request sigfox! frame_data:[%s]  \n", __LINE__, frame_data);
        send_gps_data_req = false;
        work_mode = GPS_START;
```

GPS Latitude & longitude data check

send data to sigfox

API

Bluetooth API

- refer to documents of Nordic SDK

SIGFOX API(

- Module mode
  start SIGFOX module after calling cfg_sigfox_timer_start()
  ex) example of tracker when using statemachine

- API mode
  Users have to wait for result of sending

- refer to ₩development₩sigfox_cfg2₩documentation₩application_note₩
  [WISOL]AppNote_SFM20R_example_of_Sigfox_V200.pdf for more details

WIFI API

* Can not run with GPS because it shares SPI resources

- Initialize wifi driver

```
int wifi_drv_init(void)
{
    cWifi_resource_init();
    cWifi_prepare_start();
    if(cWifi_is_detected())
    {
        return CWIFI_Result_OK;
    }
    else
    {
        return CWIFI_Result_NoDevice;
    }
}
```

- Scan for local WIFI access points
  1) Sort by RSSI. It can get up to 2

```
int start_AP_scan(void)
{
    return cWifi_ap_scan_req();
}
```

retval CWFI_Result_OK in successc

2) BSSID filtered(prefix). It can get highest RSSI 1.

```
wifi_result = cWifi_ap_get_available_first_BSSID(prefixSSID);
```

retval CWFI_Result_OK in successc

- Set the duration of a scan from 1s to 60s
  void set_scan_interval(int interval);
  param interval 1~60 sec

- Report basestation IDs and associated RSSI readings
  int get_AP_scanResult(uint32_t * get_cnt, uint8_t **ssid, int32_t **rssi, uint8_t **bssid);
  param[out] *get_cnt pointer to scan count
  param[out] **ssid pointer to ssid data
  param[out] **rssi pointer to rssi data
  param[out] **bssid pointer to bssid data

- refer to ₩development₩sigfox_cfg2₩documentation₩application_note₩
  [WISOL]AppNote_SFM20R_example_of_WIFI_V200.pdf for more details

* Use the Bypass API, it can control directly with AT commands.
See the cfg_examples_wifi_bypass() function. (cfg_examples.c)

ACCELEROMETER API

- Initialize I2C
  void cfg_i2c_master_init(void);

- Uninitialize I2C
  void cfg_i2c_master_uninit(void);

- Take an accelerometer reading(x,y,z)
  bool cfg_bma250_read_xyz(struct bma_accel_data *accel);
  param[out] struct bma_accel_data pointer to value of x,y,z
  retval true in success

  struct bma_accel_data {
  int16_t x,/**< accel x data */
  y,/**< accel y data */
  z;/**< accel z data */
  };

- Read the value of register
  bool cfg_bma250_read_reg(uint8_t reg_addr, uint8_t * read);
  param[in] uint8_t reg_addr address of register
  param[out] uint8_t * read value of register
  retval true in success

- Write the value in register
  bool cfg_bma250_write_reg(uint8_t reg_addr, uint8_t reg_data);
  param[in] uint8_t reg_addr address of register
  param[in] uint8_t reg_data value to write to register

- refer to BST-BMA250E-DS004-06.pdf for knowing registers in detail.

GPS API

- Initialize GPS driver

```
void gps_init(void)
{
    cGps_resource_init();   // initializing gpio of GPS
    cGps_prepare_start();   // GPS power control
}
```

- Start tracking
  int start_gps_tracking(void);
  retval 0 in success

- GPS Tracking set/get interval time
  void gps_tracking_set_interval(module_parameter_item_e item, unsigned int val);
  unsigned int gps_tracking_get_interval(module_parameter_item_e item);

- Get GPS NMEA data
  int get_NMEA_Location(char **latitude, char **longitude);
  int get_NMEA_UTCTime(uint8_t *hour, uint8_t *minute, uint8_t *second);
  int get_NMEA_HDOP(char **hdop);
  int get_NMEA_Speed_knot(char **speed);
  int get_NMEA_Direction(char **ns, char **ew);
  int get_NMEA_UTCDate(uint8_t *year, uint8_t *month, uint8_t *day);

- GPS position fixed check
  int cGps_nmea_position_fix_check(void);

- Report the longitude and latitude
  int get_lastLocation(char **ns, char**latitude, char ** ew, char**longitude);
  param[out] char **ns pointer to the data of cardinal point (N or S)
  param[out] char **latitude pointer to the data of latitude
  param[out] char **new pointer to the data of cardinal point (E or W)
  param[out] char **latitude pointer to the data of longitude
  retval 0 in success

TEMPERATURE API

#define TMP102_I2C_ADDRESS 72 /* This is the I2C address for our chip – 0x48 */

#define TMP102_TEMP_REG 0x00
#define TMP102_CONF_REG 0x01
#define TMP102_TLOW_REG 0x02
#define TMP102_THIGH_REG 0x03

- TMP102 timer create
  void cfg_tmp102_timer_create(void);
- TMP102 timer start
  void cfg_tmp102_timers_start(void);
- TMP102 timer stop
  void cfg_tmp102_timers_stop(void);
- TMP102 shutdown
  uint32_t tmp102_req_shutdown_mode(void);
- Initialize I2C
  void cfg_i2c_master_init(void);
- Uninitialize I2C
  void cfg_i2c_master_uninit(void);
- TMP102 set/get state
  typedef enum
  {
  NONE_TMP,
  TMP_SET_S,
  TMP_SET_R,
  TMP_READ_DATA_S,
  TMP_READ_DATA_R,
  TMP_SLEEP_S, //5
  TMP_SLEEP_R,
  EXIT_TMP

} tmp102_state_s;

void tmp102_set_state(tmp102_state_s m_state);
tmp102_state_s tmp102_get_state(void);

- Read temperature
  int get_temperature(int * tmp_int, int *tmp_dec);
  param[out] int *tmp_int pointer to integer of temperature
  param[out] int *tmp_dec pointer to decimals of temperature
  retval 1 in success

- Set threashold(low, high)
  uint32_t set_alert_threshold(u16 tmp_min, u16 tmp_max);
  param[in] u16 tmp_min the low value of temperature
  param[in] u16 tmp_max the high value of temperature
  retval 0 in success

Battery Check API (use ADC)

ADC Resolution is 10 bit
see define PIN_DEF_BATTERY_ADC_INPUT
(undefined or NRF_SAADC_INPUT_AIN0 or NRF_SAADC_INPUT_AIN1)

```
: #define PIN_DEF_BATTERY_ADC_INPUT NRF_SAADC_INPUT_AIN0
```

Modify ADC_RESULT_IN_MILLI_VOLTS macro for resistance distribution

```
#define ADJUST_BATTERY_VALUE    50
#define ADC_RESULT_IN_MILLI_VOLTS(ADC_VALUE) (((((ADC_VALUE) * ADC_REF_VOLTAGE_IN_MILLIVOLTS) / ADC_RES_10BIT) * ADC_PRE_SCALING_COMPENSATION) * 5/3)
```

- Initialize ADC driver
  cfg_bas_timer_create();

- Read (ADC Resolution is 10 bit)
  adc_configure();
  cfg_bas_timer_start();

- Get value
  get_avg_batt_lvl_in_milli_volts()
  retval eg. 3.7V -> 3700

GPIO Keys API

1) Magnetic

modify #define PIN_DEF_MAGNETIC_SIGNAL

cfg_magnetic_sensor_init(magnetic_attach_callback, magnetic_detach_callback)

2) WKUP key

modify #define PIN_DEF_WKUP

cfg_wkup_gpio_init(wkup_detect_callback)

3) Button

short press interval : GFG_BUTTON_SENSE_PRESS_TICK_SHORT

log press interval : GFG_BUTTON_SENSE_PRESS_TICK_LONG

cfg_button_init(is_active_high, pin, short_press_CB, long_press_CB)

Sleep

The ARM core is in a sleep state until an event or interrupt occurs.

```
static void power_manage(void)
{
    uint32_t err_code;
    if(m_softdevice_init_flag)
    {
        err_code = sd_app_evt_wait();
        if(m_softdevice_init_flag)
        {
            APP_ERROR_CHECK(err_code);
        }
    }
    else
    {
        __WFE();
    }
}
```

* Sleep Test Code (Run the commented test code.)

One timer is executed and Led is turned on/coff.

Consumes less than 5uA current, Wh

"if 0" to "if 1"

```
#if 1  //sleep test code
APP_TIMER_DEF(m_test_led_blink_timer_id);
void main_test_for_sleep_timer_handler(void * p_context)

.......


int main(void)
{
.....
    // Enter main loop.
    main_test_for_sleep();  //sleep test
.....
}
```

call the test function

Deep Sleep

The ARM core and Ram are in a power down state.

It can wake up with GPIO or NFC.

```
cPrintLog(CDBG_MAIN_LOG, "enter deep sleep mode\n");
main_prepare_power_down();
// Enter System OFF mode.
sd_power_system_off();
while(1);
```

Flash binary

The binary download uses J-Link equipment.

1. Build by KEIL
2. Run sigfox_cfg2_make_factory_image.bat
   The firmware is created in "development₩sigfox_cfg2₩binary".
3. Run development₩sigfox_cfg2₩binary₩SFM20R_factory_write.cmd
   Download the firmware using J-Link.