CPE403 – Advanced Embedded Systems

Design Assignment 6

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Github Repository link (root): https://github.com/AngeloNol/Design_Assignments

Youtube Playlist link (root): Assignment 6

1. Code for Tasks

Collector

```
/******************************************************************************
*
Includes
******************************************************************************/
#include <string.h>
#include <stdint.h>

#include "mac_util.h"
#include "api_mac.h"
#include "cllc.h"
#include "csf.h"
#include "smsgs.h"
#include "collector.h"
#ifndef CUI_DISABLE
#include "cui.h"
#endif /* CUI_DISABLE */
#include <advanced_config.h>
#ifdef FEATURE_SECURE_COMMISSIONING
#include "sm_ti154.h"
#endif /* FEATURE_SECURE_COMMISSIONING */

#ifdef USE_DMM
#include "remote_display.h"
#include "ti_dmm_application_policy.h"
#include <ti/sysbios/knl/Clock.h>
#include <ti/sysbios/knl/Semaphore.h>
#include "util_timer.h"
#ifdef FEATURE_SECURE_COMMISSIONING
#include "sm_commissioning_gatt_profile.h"
```

```
#endif  /* FEATURE_SECURE_COMMISSIONING */
#endif /* USE_DMM */
/*****************************************************************************
*
Constants and definitions
*****************************************************************************/

#if !defined(STATIC)
/* make local */
#define STATIC static
#endif

#if !defined(CONFIG_AUTO_START)
#if defined(AUTO_START)
#define CONFIG_AUTO_START 1
#else
#define CONFIG_AUTO_START 0
#endif
#endif

#if defined(IEEE_COEX_METRICS) && !defined(IEEE_COEX_ENABLED)
#error "IEEE_COEX_ENABLED must be defined to view coex metrics"
#endif

/* Default MSDU Handle rollover */
#define MSDU_HANDLE_MAX 0x1F

/* App marker in MSDU handle */
#define APP_MARKER_MSDU_HANDLE 0x80

/* App Config request marker for the MSDU handle */
```

```
#define APP_CONFIG_MSDU_HANDLE 0x40

/* Ramp data request marker for the MSDU handle */
#define RAMP_DATA_MSDU_HANDLE 0x20
/* App Broadcast Cmd Msg marker for the MSDU Handle */
#define APP_BROADCAST_MSDU_HANDLE 0x20

/* Delay for config request retry in busy network */
#define CONFIG_DELAY 2000
#define CONFIG_RESPONSE_DELAY 3*CONFIG_DELAY
/* Tracking timeouts */
#define TRACKING_CNF_DELAY_TIME 2000 /* in milliseconds */

#if (CONFIG_PHY_ID == APIMAC_50KBPS_915MHZ_PHY_1) || \
   (CONFIG_PHY_ID == APIMAC_50KBPS_868MHZ_PHY_3) || \
   (CONFIG_PHY_ID == APIMAC_50KBPS_433MHZ_PHY_128)
   #define SYMBOL_DURATION       (SYMBOL_DURATION_50_kbps)  //us

#elif (CONFIG_PHY_ID == APIMAC_200KBPS_915MHZ_PHY_132) || \
     (CONFIG_PHY_ID == APIMAC_200KBPS_868MHZ_PHY_133)
   #define SYMBOL_DURATION       (SYMBOL_DURATION_200_kbps) //us

#elif (CONFIG_PHY_ID == APIMAC_5KBPS_915MHZ_PHY_129) || \
     (CONFIG_PHY_ID == APIMAC_5KBPS_433MHZ_PHY_130) || \
     (CONFIG_PHY_ID == APIMAC_5KBPS_868MHZ_PHY_131)
   #define SYMBOL_DURATION       (SYMBOL_DURATION_LRM)     //us

#elif (CONFIG_PHY_ID == APIMAC_250KBPS_IEEE_PHY_0)  // 2.4g
   #define SYMBOL_DURATION       (SYMBOL_DURATION_250_kbps)  //us
#else
   #define SYMBOL_DURATION       (SYMBOL_DURATION_50_kbps)  //us
```

```
#endif

#if (CONFIG_MAC_BEACON_ORDER != NON_BEACON_ORDER)
/* This is 3 times the polling interval used in beacon mode. */
#define TRACKING_TIMEOUT_TIME ((1<<CONFIG_MAC_BEACON_ORDER) * 960 *
SYMBOL_DURATION * 3 / 1000) /*in milliseconds*/
#else
#define TRACKING_TIMEOUT_TIME (CONFIG_POLLING_INTERVAL * 3) /*in milliseconds*/
#endif

#ifdef IEEE_COEX_METRICS
/* Timeout in milliseconds for coex metrics reads */
#define COEX_IEEE_METRICS_TIMEOUT_TIME  120000
#endif
#ifdef MAC_STATS
/* Timeout in milliseconds for coex metrics reads */
#define MAC_STATS_TIMEOUT_TIME  10000
#endif

/* Initial delay before broadcast transmissions are started in FH mode */
#define BROADCAST_CMD_START_TIME 60000

/* Assoc Table (CLLC) status settings */
#define ASSOC_CONFIG_SENT      0x0100    /* Config Req sent */
#define ASSOC_CONFIG_RSP       0x0200    /* Config Rsp received */
#define ASSOC_CONFIG_MASK      0x0300    /* Config mask */
#define ASSOC_TRACKING_SENT    0x1000    /* Tracking Req sent */
#define ASSOC_TRACKING_RSP     0x2000    /* Tracking Rsp received */
#define ASSOC_TRACKING_RETRY   0x4000    /* Tracking Req retried */
#define ASSOC_TRACKING_ERROR   0x8000    /* Tracking Req error */
#define ASSOC_TRACKING_MASK    0xF000    /* Tracking mask  */
```

```
#define MAX_DATA_REQ_MSDU_MAP_TABLE_SIZE 3
#ifdef USE_DMM
#define NTWK_DISCOVER_TIMER        100
#endif /* USE_DMM */
/*********************************************************************
*
Global variables
*********************************************************************/

/* Task pending events */
uint16_t Collector_events = 0;

/*! Collector statistics */
Collector_statistics_t Collector_statistics;

/* Permit join setting */
extern bool permitJoining;

/*********************************************************************
*
Local variables
*********************************************************************/

static void *sem;

/*! true if the device was restarted */
static bool restarted = false;

/*! CLLC State */
STATIC Cllc_states_t cllcState = Cllc_states_initWaiting;

/*! Device's PAN ID */
```

```
STATIC uint16_t devicePanId = 0xFFFF;

/*! Device's Outgoing MSDU Handle values */
STATIC uint8_t deviceTxMsduHandle = 0;

STATIC bool fhEnabled = false;

STATIC ApiMac_msduAddrMap_t
dataRequestMsduMappingTable[MAX_DATA_REQ_MSDU_MAP_TABLE_SIZE];

#ifdef USE_DMM
/* Device List Discovery Flag */
static bool listDiscovery = false;
/* current Sensor Address */
static uint16_t currentSensor;

STATIC Clock_Struct ntwkDiscoverClkStruct;
STATIC Clock_Handle ntwkDiscoverClkHandle;
#endif /* USE_DMM */
Sensor
/*********************************************************************
*
Includes
*********************************************************************/
#include <string.h>
#include <stdint.h>
#include "mac_util.h"
#include "api_mac.h"
#include "jdllc.h"
#include "ssf.h"
#include "smsgs.h"
#include "sensor.h"
```

```
#include <advanced_config.h>
#include "ti_154stack_config.h"

#ifdef FEATURE_NATIVE_OAD
#include "oad_client.h"
#endif /* FEATURE_NATIVE_OAD */

#ifdef OSAL_PORT2TIRTOS
#include <ti/sysbios/knl/Clock.h>
#else
#include "icall.h"
#endif

#ifdef USE_DMM
#ifdef DMM_CENTRAL
#include "central_display.h"
#else
#include "remote_display.h"
#endif /* DMM_CENTRAL */
#include "ti_dmm_application_policy.h"
#ifdef FEATURE_SECURE_COMMISSIONING
#include "sm_commissioning_gatt_profile.h"
#endif /* FEATURE_SECURE_COMMISSIONING */
#endif /* USE_DMM */

#ifdef LPSTK
#include "lpstk/lpstk.h"
#endif /* LPSTK */

#ifndef CUI_DISABLE
#include "cui.h"
```

```
#endif /* CUI_DISABLE */

#ifdef DEVICE_TYPE_MSG
#include <ti/devices/DeviceFamily.h>
#include "device_type.h"
#endif /* DEVICE_TYPE_MSG */

#ifdef FEATURE_SECURE_COMMISSIONING
#include "sm_ti154.h"
#endif /* FEATURE_SECURE_COMMISSIONING */

/******************************************************************************
*
Constants and definitions
******************************************************************************/

#if !defined(CONFIG_AUTO_START)
#if defined(AUTO_START)
#define CONFIG_AUTO_START 1
#else
#define CONFIG_AUTO_START 0
#endif
#endif

/* default MSDU Handle rollover */
#define MSDU_HANDLE_MAX 0x1F

/* App marker in MSDU handle */
#define APP_MARKER_MSDU_HANDLE 0x80

/* App Message Tracking Mask */
```

```
#define APP_MASK_MSDU_HANDLE 0x60

/* App Sensor Data marker for the MSDU handle */
#define APP_SENSOR_MSDU_HANDLE 0x40

/* App tracking response marker for the MSDU handle */
#define APP_TRACKRSP_MSDU_HANDLE 0x20

/* App config response marker for the MSDU handle */
#define APP_CONFIGRSP_MSDU_HANDLE 0x60

/* Reporting Interval Min and Max (in milliseconds) */
#define MIN_REPORTING_INTERVAL 1000
#define MAX_REPORTING_INTERVAL 360000

/* Polling Interval Min and Max (in milliseconds) */
#define MIN_POLLING_INTERVAL 1000
#define MAX_POLLING_INTERVAL 10000

/* Blink Time for Identify LED Request (in seconds) */
#define IDENTIFY_LED_TIME 1

/* Inter packet interval in certification test mode */
#if CERTIFICATION_TEST_MODE
#if (((CONFIG_PHY_ID >= APIMAC_MRFSK_STD_PHY_ID_BEGIN) && (CONFIG_PHY_ID <=
APIMAC_MRFSK_GENERIC_PHY_ID_BEGIN)) || \
   ((CONFIG_PHY_ID >= APIMAC_200KBPS_915MHZ_PHY_132) && (CONFIG_PHY_ID <=
APIMAC_200KBPS_868MHZ_PHY_133)))
/*! Regular Mode */
#define CERT_MODE_INTER_PKT_INTERVAL 50
#elif ((CONFIG_PHY_ID >= APIMAC_MRFSK_GENERIC_PHY_ID_BEGIN + 1) && (CONFIG_PHY_ID
<= APIMAC_5KBPS_868MHZ_PHY_131))
```

```
/*! LRM Mode */
#define CERT_MODE_INTER_PKT_INTERVAL 300
#else
#error "PHY ID is wrong."
#endif
#endif

/******************************************************************************
*
Global variables
******************************************************************************/
extern uint16_t generic_sensor_val;

static Smsgs_genericSensorField_t genericSensor =
{
0
};
/* MAC's IEEE address. This is only for Sensor */
extern ApiMac_sAddrExt_t ApiMac_extAddr;

/* Task pending events */
uint16_t Sensor_events = 0;

/* accumulated total E2E delay */
uint32_t totalE2EDelaySum = 0;

/* saved end to end delay */
uint32_t endToEndDelay = 0;

/*! Sensor statistics */
Smsgs_msgStatsField_t Sensor_msgStats =
```

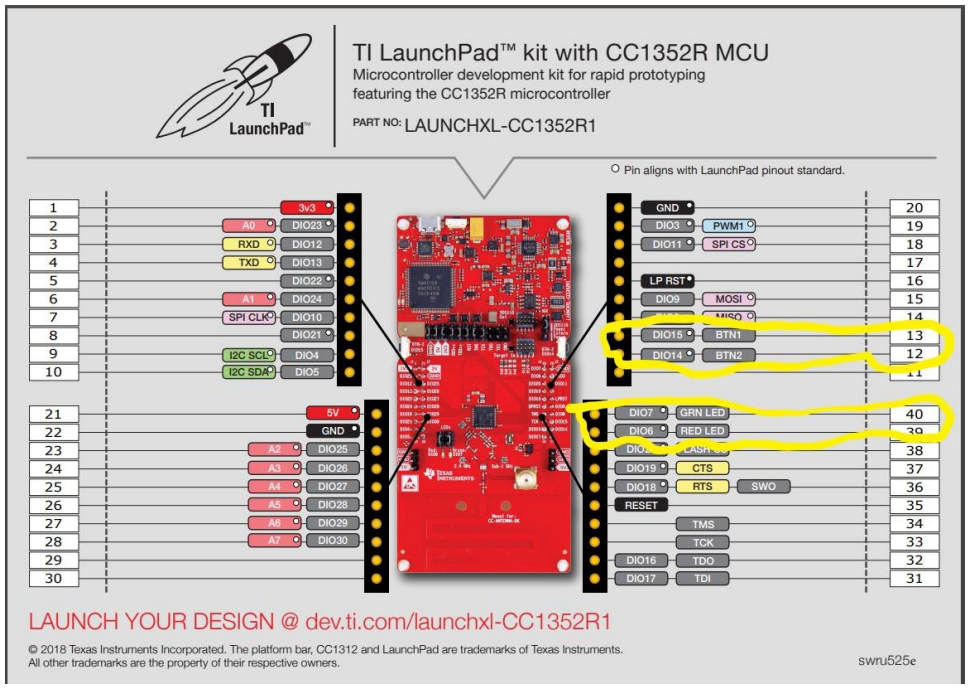
```
   { 0 };
extern bool initBroadcastMsg;
extern bool parentFound;

#ifdef POWER_MEAS
/*! Power Meas Stats fields */
Smsgs_powerMeastatsField_t Sensor_pwrMeasStats =
   { 0 };
#endif
/**************************************************************************
*
Local variables
**************************************************************************/

static void *sem;

/*! Rejoined flag */
static bool rejoining = false;

/*! Collector's address */
static ApiMac_sAddr_t collectorAddr = {0};

/* Join Time Ticks (used for average join time calculations) */
static uint_fast32_t joinTimeTicks = 0;

/* End to end delay statistics timestamp */
static uint32_t startSensorMsgTimeStamp = 0;

/*! Device's Outgoing MSDU Handle values */
STATIC uint8_t deviceTxMsduHandle = 0;
```

```
STATIC Smsgs_configReqMsg_t configSettings;

#if !defined(OAD_IMG_A) && !defined(POWER_MEAS)
/*!
Temp Sensor field - valid only if Smsgs_dataFields_tempSensor
is set in frameControl.
*/
STATIC Smsgs_tempSensorField_t tempSensor =
  { 0 };

/*!
Light Sensor field - valid only if Smsgs_dataFields_lightSensor
is set in frameControl.
*/
STATIC Smsgs_lightSensorField_t lightSensor =
  { 0 };

/*!
Humidity Sensor field - valid only if Smsgs_dataFields_humiditySensor
is set in frameControl.
*/
STATIC Smsgs_humiditySensorField_t humiditySensor =
  { 0 };

#ifdef LPSTK
/*!
Hall Effect Sensor field - valid only if Smsgs_dataFields_hallEffectSensor
is set in frameControl.
*/
STATIC Smsgs_hallEffectSensorField_t hallEffectSensor =
  { 0 };
```

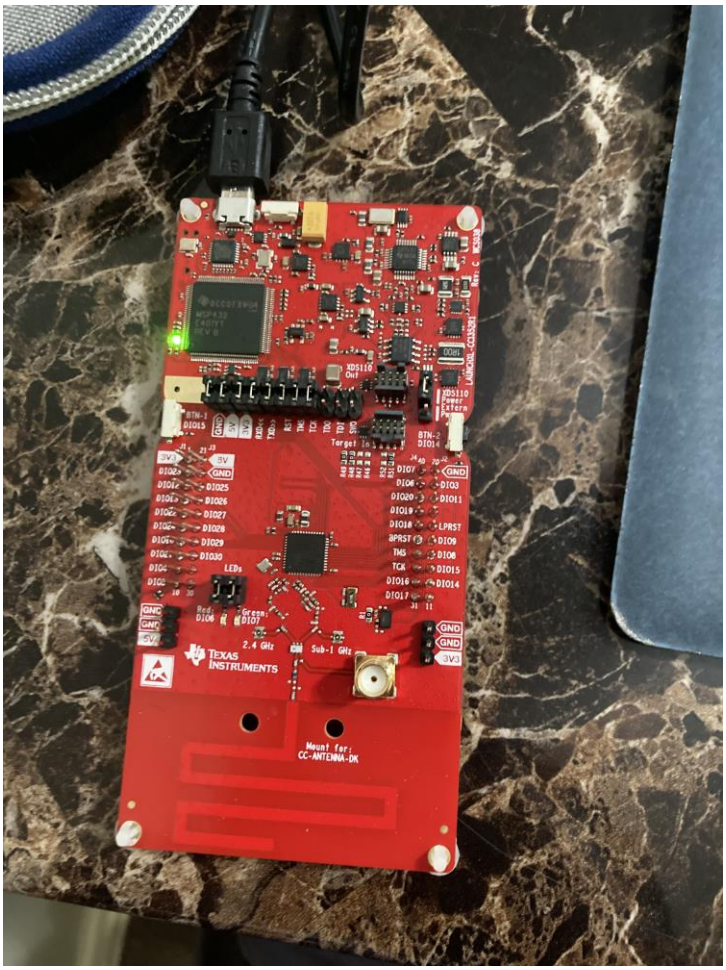
```
/*!
Accelerometer Sensor field - valid only if Smsgs_dataFields_accelSensor
is set in frameControl.
*/
STATIC Smsgs_accelSensorField_t accelerometerSensor =
  { 0 };
#endif /* LPSTK */

#ifdef DMM_CENTRAL
/*!
BLE Sensor field - valid only if Smsgs_dataFields_bleSensor
is set in frameControl.
*/
STATIC Smsgs_bleSensorField_t bleSensor =
  { 0 };
#endif

#endif /* !defined(OAD_IMG_A) && !defined(POWER_MEAS) */

STATIC Llc_netInfo_t parentInfo = {0};

STATIC uint16_t lastRcvdBroadcastMsgId = 0;

#ifdef FEATURE_SECURE_COMMISSIONING
/* variable to store the current setting of auto Request Pib attribute
* before it gets modified by SM module, in beacon mode
*/
static bool currAutoReq = 0;
SMMsgs_authMethod_t smAuthMethod = SM_SENSOR_DEFAULT_AUTH_METHOD;
#endif /* FEATURE_SECURE_COMMISSIONING */
```

```
#ifdef DMM_OAD
ApiMac_deviceDescriptor_t cacheddevInfo = {0};
Llc_netInfo_t cachedparentInfo = {0};
#endif
```

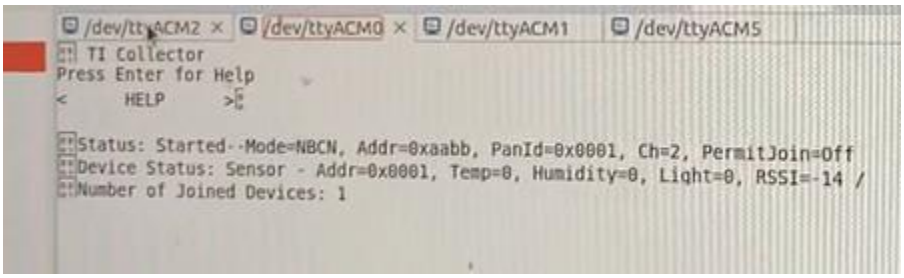
2. Block diagram and/or Schematics showing the components, pins used, and interface.



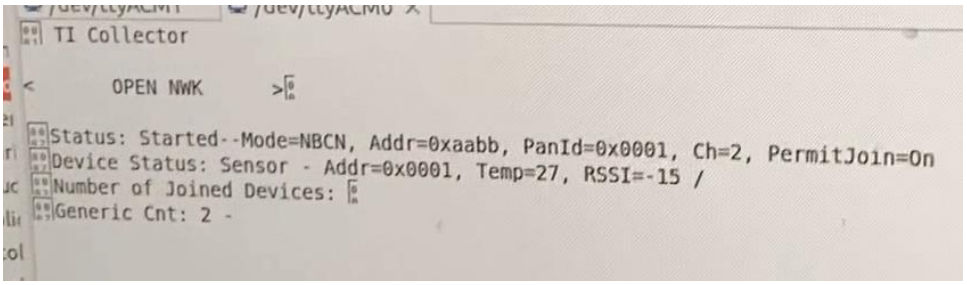
3. Screenshots of the IDE, physical setup, debugging process

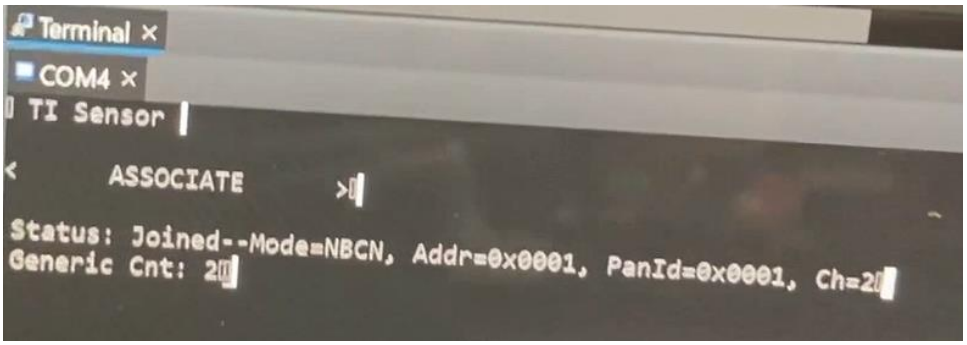


Task 2



Task 4


TI Collector
< OPEN NWK >
Status: Started--Mode=NBCN, Addr=0xaabb, PanId=0x0001, Ch=2, PermitJoin=On
Device Status: Sensor - Addr=0x0001, Temp=27, RSSI=-15 /
Number of Joined Devices:
Generic Cnt: 2 -


Terminal
COM4
TI Sensor
< ASSOCIATE >
Status: Joined--Mode=NBCN, Addr=0x0001, PanId=0x0001, Ch=2
Generic Cnt: 2

4. Declaration

I understand the Student Academic Misconduct Policy - http://studentconduct.unlv.edu/misconduct/policy.html

"This assignment submission is my own, original work".

Angelo Nolasco