基于BlueNRG开发手册

Joshua zhu

2015-Apri

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蓝牙设备连接兼容性

If your product bears this logo…	It's compatible with products bearing any of these logos…
Bluetooth® SMART READY	Bluetooth® SMART READY; Bluetooth®; Bluetooth® SMART
Bluetooth®	Bluetooth® SMART READY; Bluetooth®
Bluetooth® SMART	Bluetooth® SMART READY; Bluetooth® SMART

Bluetooth® Smart ready 典型应用

Bluetooth®
SMART READY

Health Care IT News

New iPad Gets Bluetooth Tune-Up for Health Care

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By: Brian T. Horowitz
2012-03-09

There are 1 user comments on this Health Care IT story.

The third-generation Apple iPad features Bluetooth 4.0 Smart Ready technology to allow patients to connect to interoperable medical monitoring devices.

Along with the announcement of Apple's third-generation iPad on March 7, the tablet is getting a wireless upgrade with Bluetooth 4.0 Smart Ready connectivity. The Bluetooth Special Interest Group (SIG) announced the availability of Smart Ready technology for the new version of the Apple tablet, bringing new possibilities for remote-monitoring medical applications.

Made up of 14,000 member companies, Bluetooth SIG is a nonprofit trade association that publishes the Bluetooth specifications and manages the qualification program for the technology.

Apple's iPhone 4S and Motorola's Droid Razr are among the smartphones that feature Bluetooth Smart Ready connectivity, which the SIG introduced in the fall of 2011.

The new iPad is the first tablet to support Bluetooth Smart Ready technology. The current iPad 2 connects to Bluetooth 2.1 medical devices but will be unable to connect with new Bluetooth Smart Ready devices, Michael Foley executive director of Bluetooth SIG, told *eWEEK*.

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Bluetooth® Smart 典型应用

Bluetooth®
SMART

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传统蓝牙与低功耗蓝牙的区别

Technical Specification	Classic *Bluetooth* technology	*Bluetooth* low energy technology
Radio frequency	2.4 GHz	2.4 GHz
Distance/Range	10 meters	10 meters
Over the air data rate	1-3Mbps	1Mbps
Application throughput	0.7-2.1 Mbps	0.2 Mbps
Nodes/Active slaves	7- 16,777,184	Unlimited
Security	64b/128b and application layer user defined	128b AES and application layer user defined
Robustness	Adaptive fast frequency hopping, FEC, fast ACK	Adaptive fast frequency hopping
Latency (from a non connected state)		
Total time to send data (det.battery life)	100ms	<6ms
Government regulation	Worldwide	Worldwide
Certification body	Bluetooth SIG	Bluetooth SIG
Voice capable	Yes	No
Network topology	Scatternet	Star-bus
Power consumption	1 as the reference	0.01 to 0.5(depending on use case)
Peak current consumption	<30 mA	<15 mA (max 15 mA to run on coin cell battery)
Service discovery	Yes	Yes
Profile concept	Yes	Yes
Primary use cases	Mobile phones, gaming, headsets, stereo audio streaming, automotive, PCs, etc.	Mobile phones, gaming, PCs, watches, sports & fitness, healthcare, automotive, home electronics, automation, Industrial, etc.

BlueNRG 产品

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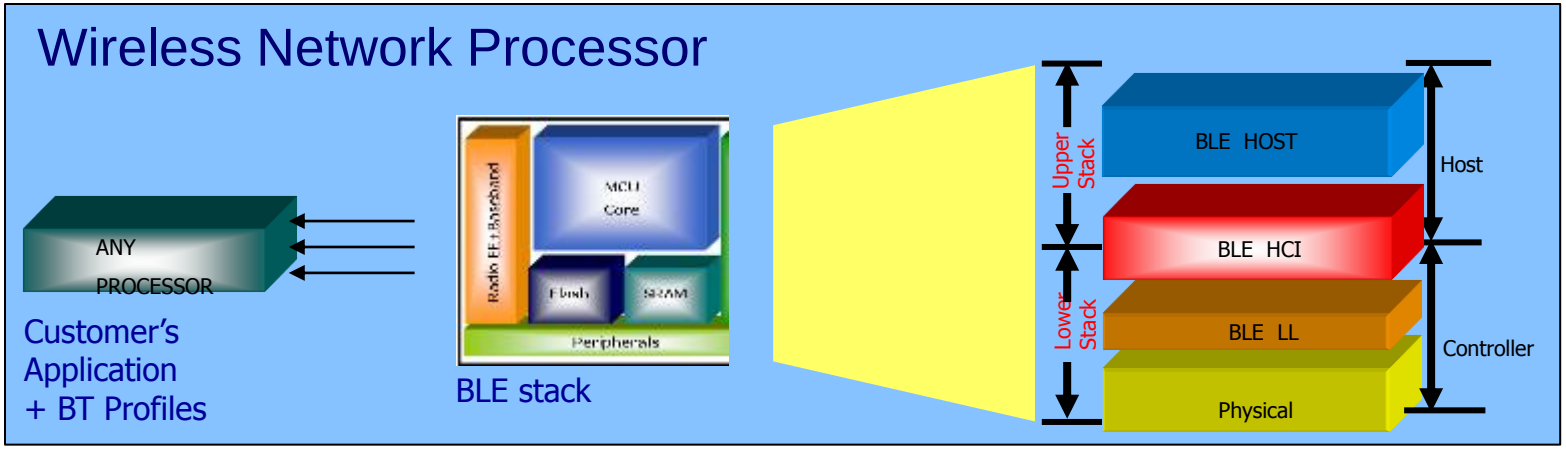
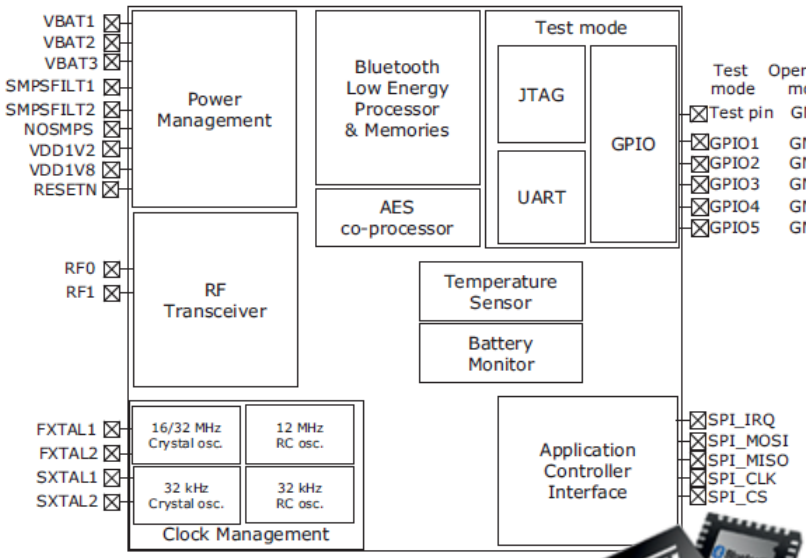
什么是BlueNRG

- BlueNRG 是单模网络处理器.
- 集成2.4GHz收发器和Cortex-M0 微处理器
- 集成片上Flash.



BlueNRG 特性

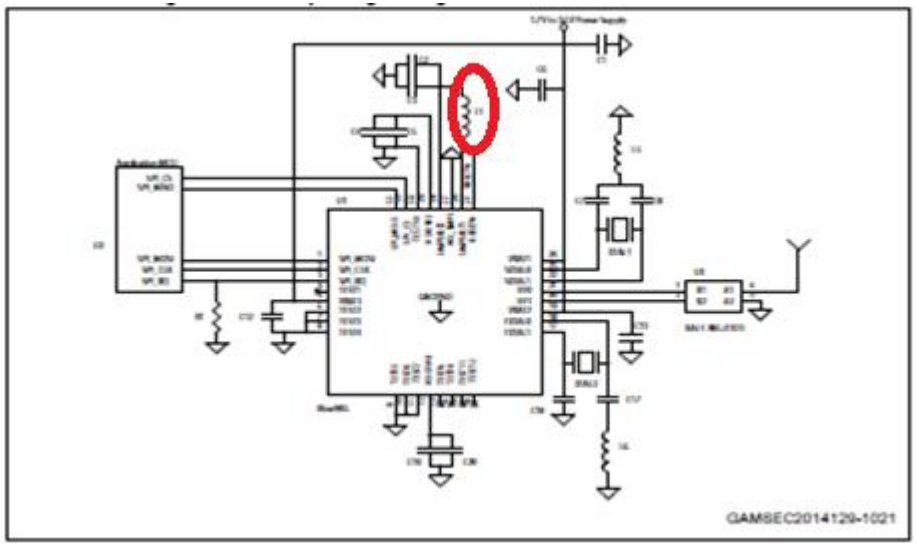
- 射频特性
- 完整的物理层，链路层和主机GATT接口层
- 空中数据速率高达1 Mbps
- 工作电压为2.0V至3.6V的，集成开关电源
- 灵活的时钟.
- 低功率（32）：集成环形振荡器或外部晶体振荡器。
- 主要（16MHz或32MHz）：外部晶体振荡器。
- 输入电压监测和温度传感器。
- 支持还是掌握操作从模式（高达8的奴隶）
- 其他功能
- 蓝牙4.0/4.1（单模低能量）
- AES 128位加密协处理器
- 灵活的主机接口：SPI，GPIO
- ACI–应用控制接口

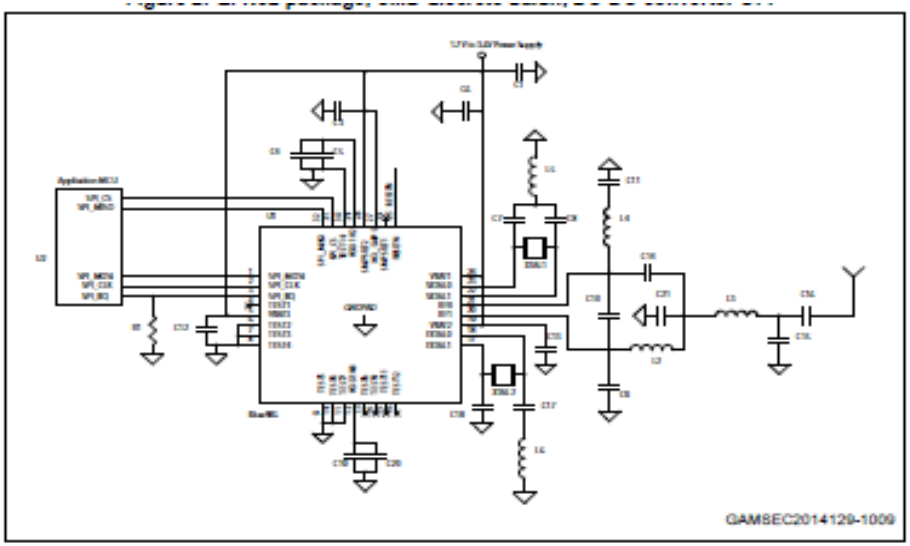


QFN32 5x5x0.9

What you need to remember !	
Bluetooth Smart 4.0 qualified sub-system Lowest power consumption in the field	
Sensitivity	-88dBm
RX Power (peak)	7.7mA with DCDC
Tx Power	8.3mA @ 2dBm with DCDC
Shutdown	5nA

应用原理图& DCDC 用途





使用DC/DC, 需要外加一颗10µH 或者4.7uH 电感

不用DC/DC

关键特性

功耗[Vin=3.0V]

Parameter	Typ. Value No DCDC	Typ. Value With DCDC	Unit
Reset	5	5	nA
Stand-by	1.4 - 2	1.3 - 2	µA
Sleep mode Internal Ring Oscillator External 32khz oscillator	2.8 - 3.5 1.7 - 2.4		µA
Active (CPU, flash and RAM)	3.5	3.3	mA
TX @ +2dBm	17.2	9	mA
RX	14.5	7.7	mA

TX性能 (at antenna connector)

Config.	Parameter	Typ. Value	Unit
High Power	Output power for the lowest power setting	-14	dBm
	Output power for the highest power setting	+8	dBm
Standard Power	Output power for the lowest power setting	-18	dBm
	Output power for the highest power setting	+5	dBm

RX 性能

Parameter	Typ. value	Unit
Sensitivity level for 0.1 % BER	-88	dBm
In band blocking C/I for an wanted signal level of -67 dBm:		
• Co-channel interference	9	dB
• Interference at frequency offset | foffs | = 1 MHz	2	dB
• Interference at frequency offset | foffs | = 2 MHz	-34	dB
• Interference at frequency offset | foffs | ≥ 3 MHz	-40	dB
• Interference at frequency offset | foffs | ≥ 6 MHz	-45	dB

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Bluetooth® SMART认证

QDL Bluetooth® Qualified Design Listing

The Bluetooth SIG Hereby Recognizes

STMicroelectronics
Member Company

BlueNRG
Qualified Design Name

Qualified Design ID(s): B021688

Specification Name: 4.0

Product Type: Component (Tested)

Model Number: BlueNRG

BQE Name: Elisabeth Ruiz

Listing Date: 11 October 2013

Assessment Date: 11 October 2013

Hardware Version Number: 2

Software Version Number: 2

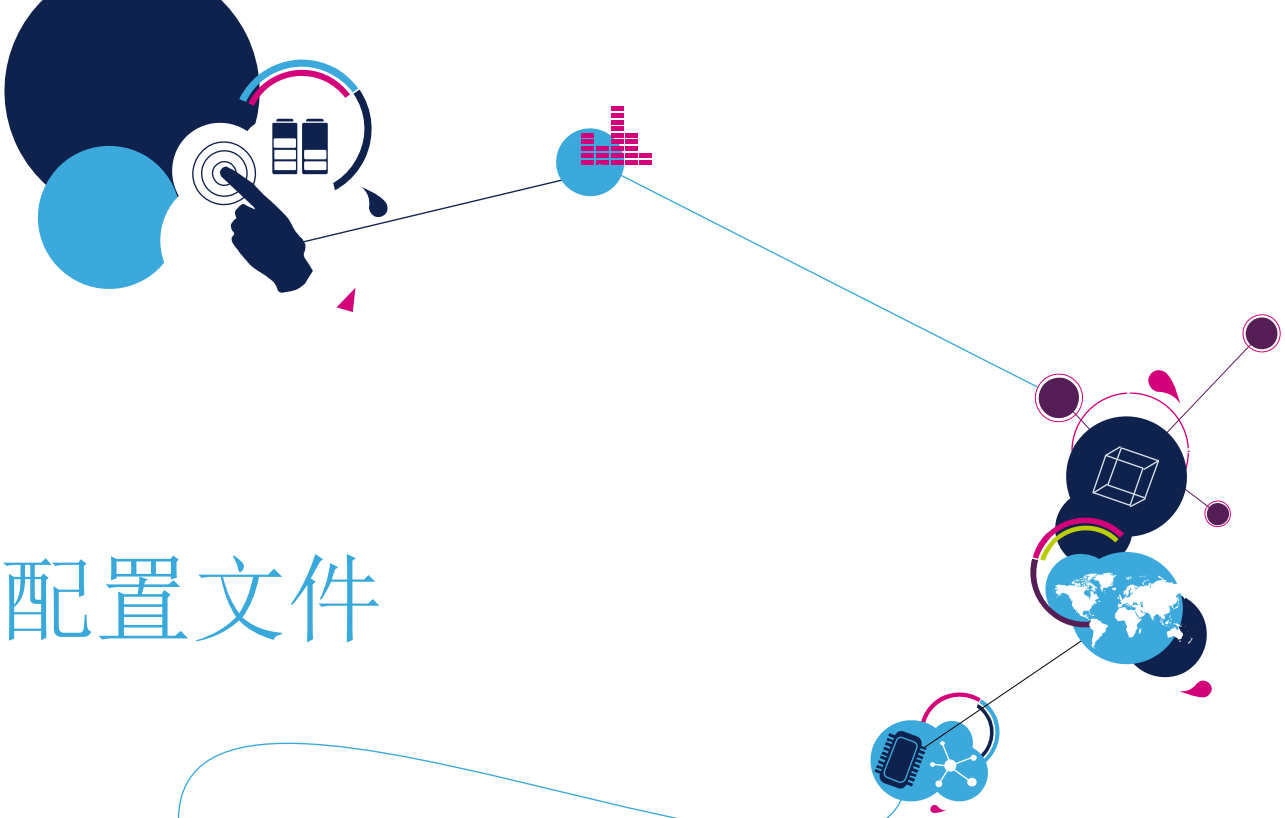
This certificate acknowledges the *Bluetooth*® Specifications declared by the member were achieved in accordance with the *Bluetooth* Qualification Process as specified within the *Bluetooth* Specifications and as required within the current PRD

Bluetooth® SPECIAL INTEREST GROUP

October 11, 2013

RF, LL, HCI
Host stack
Master & Slave

QUALIFIED !



BlueNRG 配置文件

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BlueNRG 开发组件:
硬件和 软件组件

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BlueNRG 开发组件

STEVAL-IDB002V1 平台

- bluenrg开发工具包
- 支持蓝牙4.0低功耗标准，同时支持主从角色。
- 包含多个不同的演示工程
- 订购编码：steval-idb002v1

STEVAL-IDB003V1 平台

- bluenrg开发工具包
- 支持蓝牙4.0低功耗标准，同时支持主从角色。
- 包含多个不同的演示工程
- 订购编码：**STEVAL-IDB003V1**

BlueNRG Development Kit User Manual: **UM1686**

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X-NUCLEO-IDB04A1

- Bluenrg套件是一个单模网络处理器，符合蓝牙 specification v4.0. 它可以作为主或从，整个蓝牙低功耗协议栈运行在嵌入式Cortex M0内核。通过SPI与外部微控制器通讯。

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BlueNRG DK 软件包

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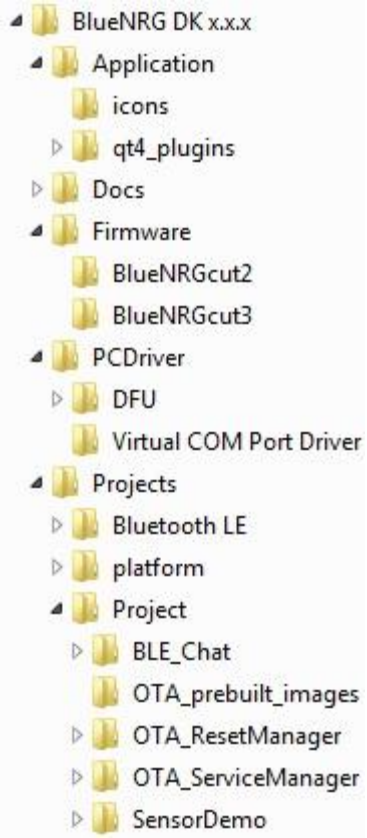
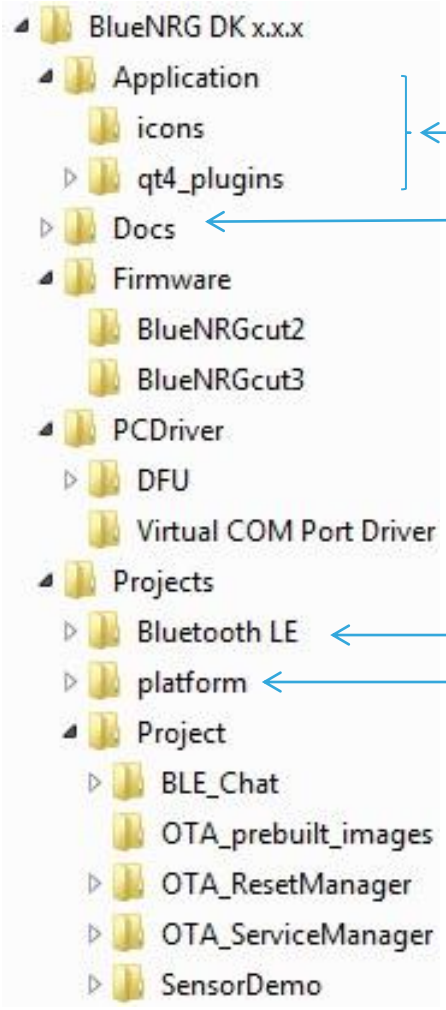
BlueNRG DK 软件包(1/2)

- It contains all the SW components allowing to evaluate, test and demo the BlueNRG product functionalities
- Easy to install & use
  - Extract the content of BlueNRG_DK_-x.x.x-Setup.zip file into a temporary directory.
  - Launch BlueNRG-DK-x.x.x-Setup.exe and follow all the instructions.
- Default installation package is
  - C:\Program Files (x86)\STMicroelectronics



BlueNRG-DK-x.x.x SW package structure

BlueNRG DK 软件包(2/2)



BlueNRG GUI folder

BlueNRG documentation folder

BlueNRG stack & STM32L
prebuilt binary images

PC drivers for DFU and Virtual COM

Code for sending ACI cmds &
definition of BlueNRG events
Platform-dependent files.

BlueNRG demonstration applications
EWARM prj, source & header files(1)

- BlueNRG VCOM & other utilities applications are also provided from DK 1.7.0

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BlueNRG DK 软件包:
BlueNRG GUI

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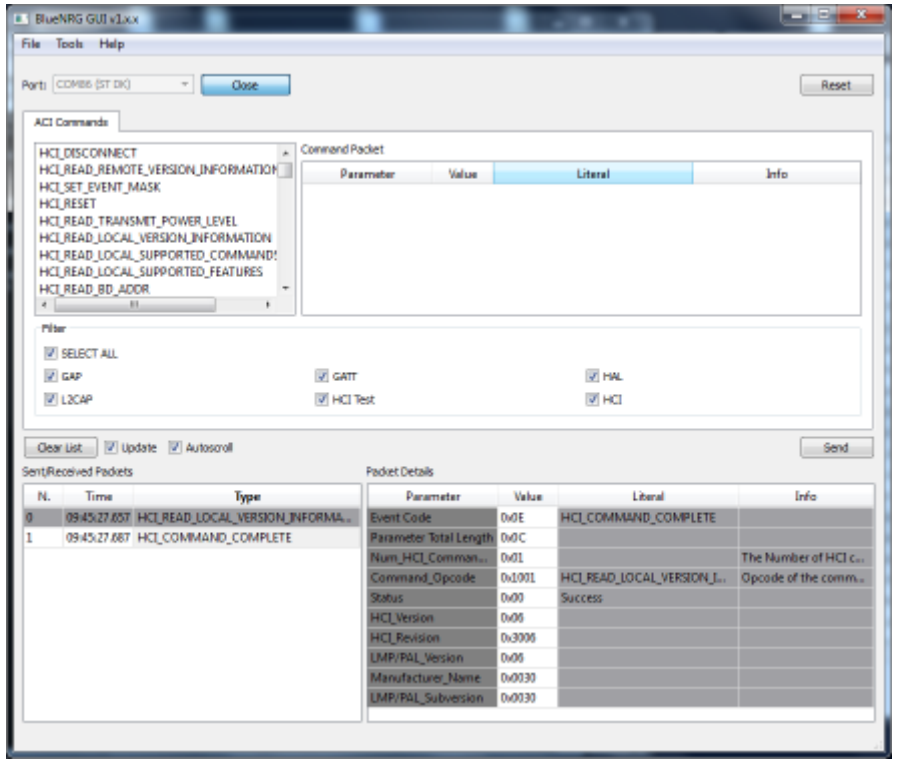
BlueNRG GUI

- BlueNRG GUI is a Graphical User Interface that can be used to interact and evaluate the capabilities of the BlueNRG network processor
- BlueNRG GUI enables
  - RF performance testing
  - HCI Commands testing
  - Bluetooth connection testing
- This utility can send standard and vendor-specific HCI commands to the controller and receive events from it



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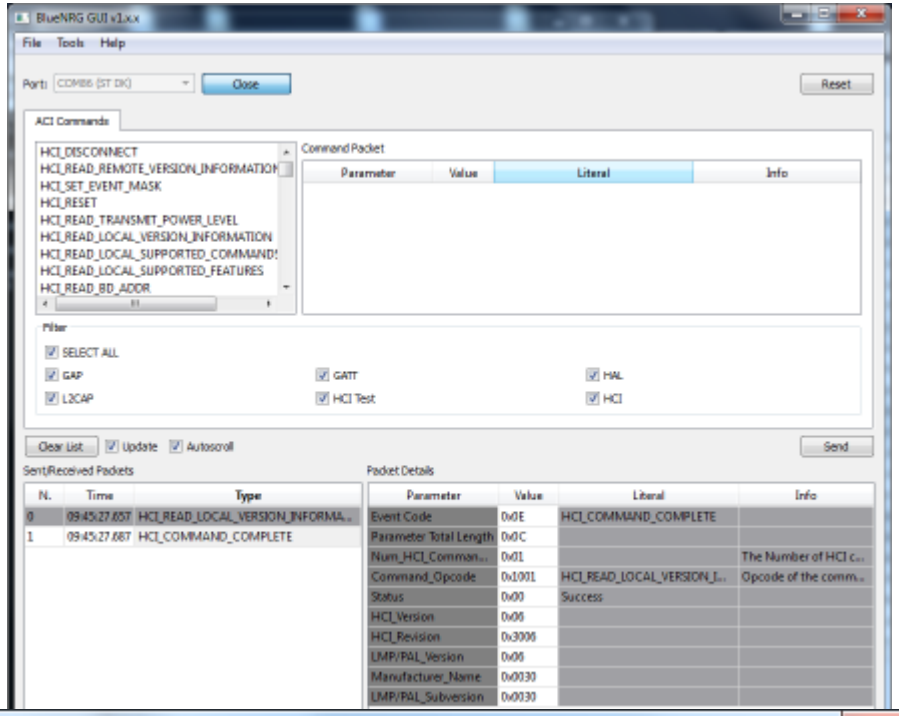
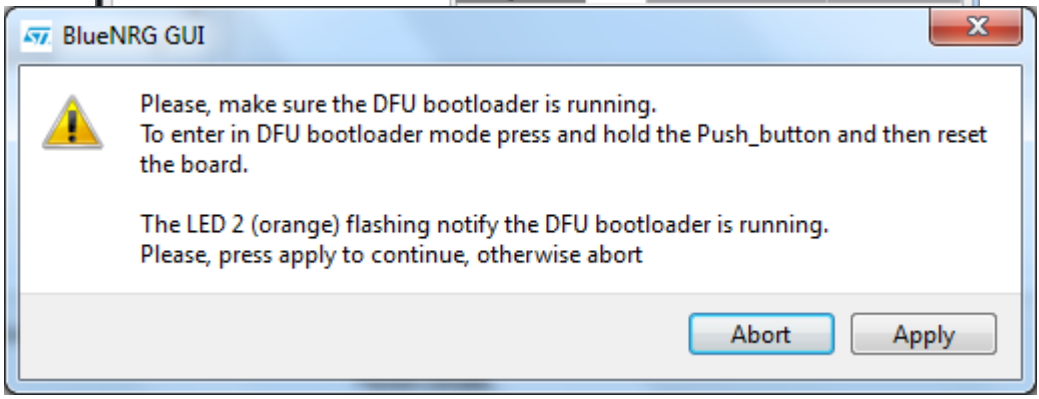
BlueNRG GUI: BlueNRG VCOM application

- In order to use BlueNRG GUI, the BlueNRG Development Kits platform has to be programmed with the **BlueNRG_VCOM_1_x.hex** available on the BlueNRG-DK SW package, using the Flash Motherboard FW utility
  - Tools – Flash Motherboard FW…
- Then Select the COM port on the Port Tab and open it.
- **BlueNRG_VCOM_1_x.hex** supports both platforms STEVAL-IDB002V1, STEVAL-IDB003V1





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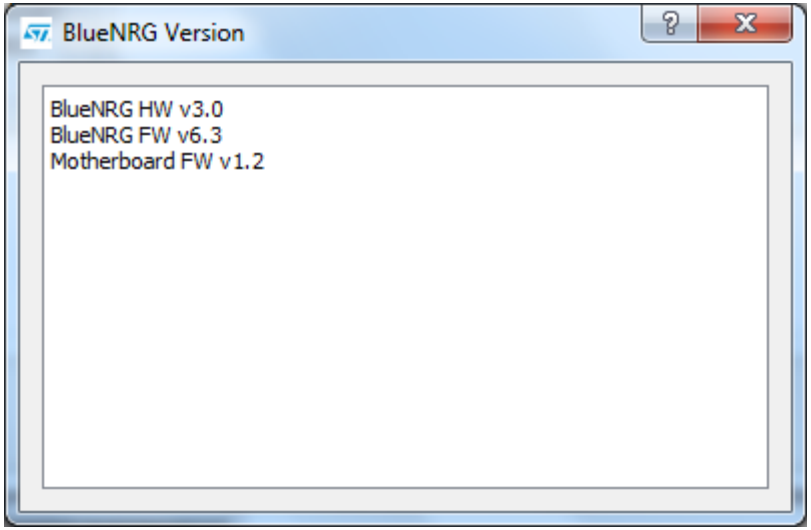
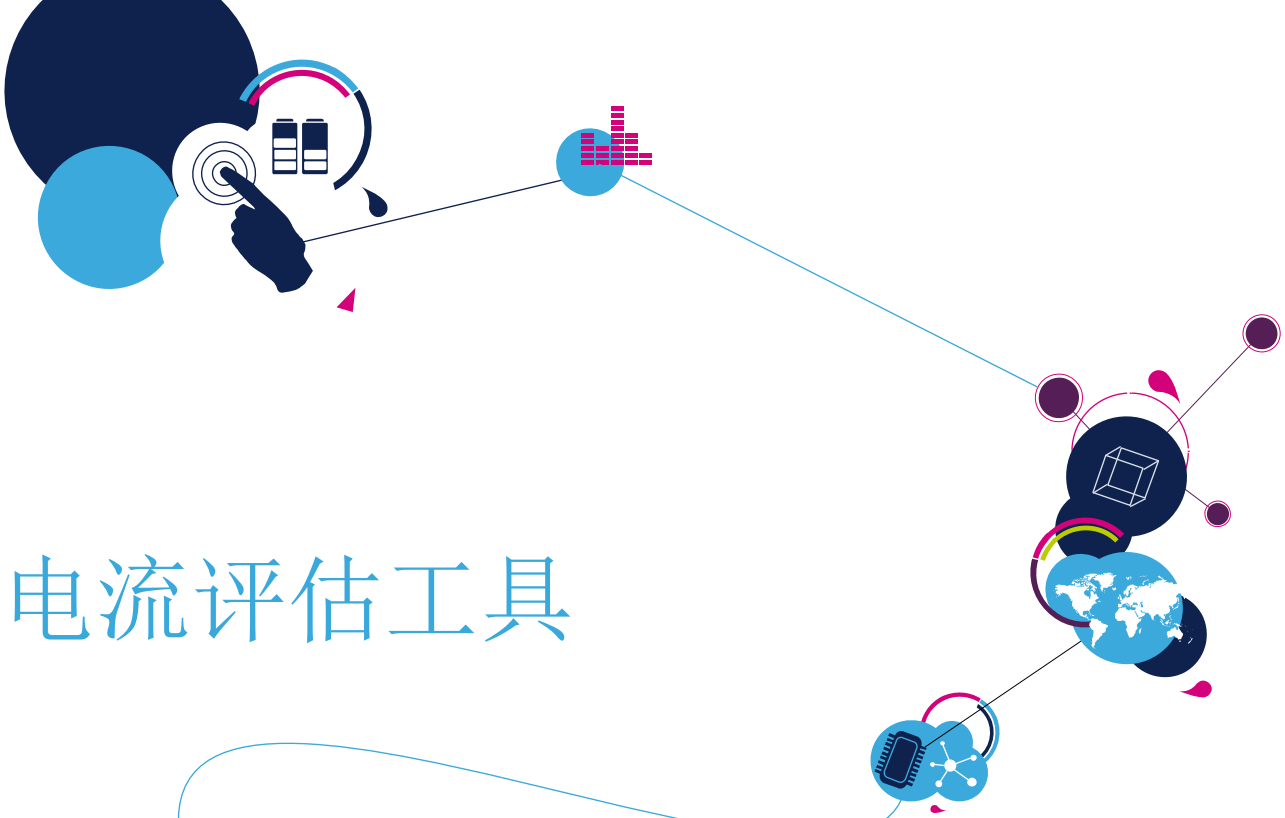
BlueNRG GUI: Utilities

- From Tools menu
  - BlueNRG Updater
  - BlueNRG IFR…
  - Flash Motherboard FW…
  - OTA bootloader
  - Get Version (1) (2)
  - Get Production data (3)



BlueNRG Version utility

(1) It allows to retrieve the version of the BlueNRG GUI firmware (VCOM) on the STM23L, and hardware and firmware version from the BlueNRG.
(2) First topic to be checked when potential issues are detected on the BlueNRG platform
(3) It allows to retrieve production information from the BlueNRG daughterboard. This data is stored inside the EEPROM on the daughterboard.



BlueNRG 电流评估工具

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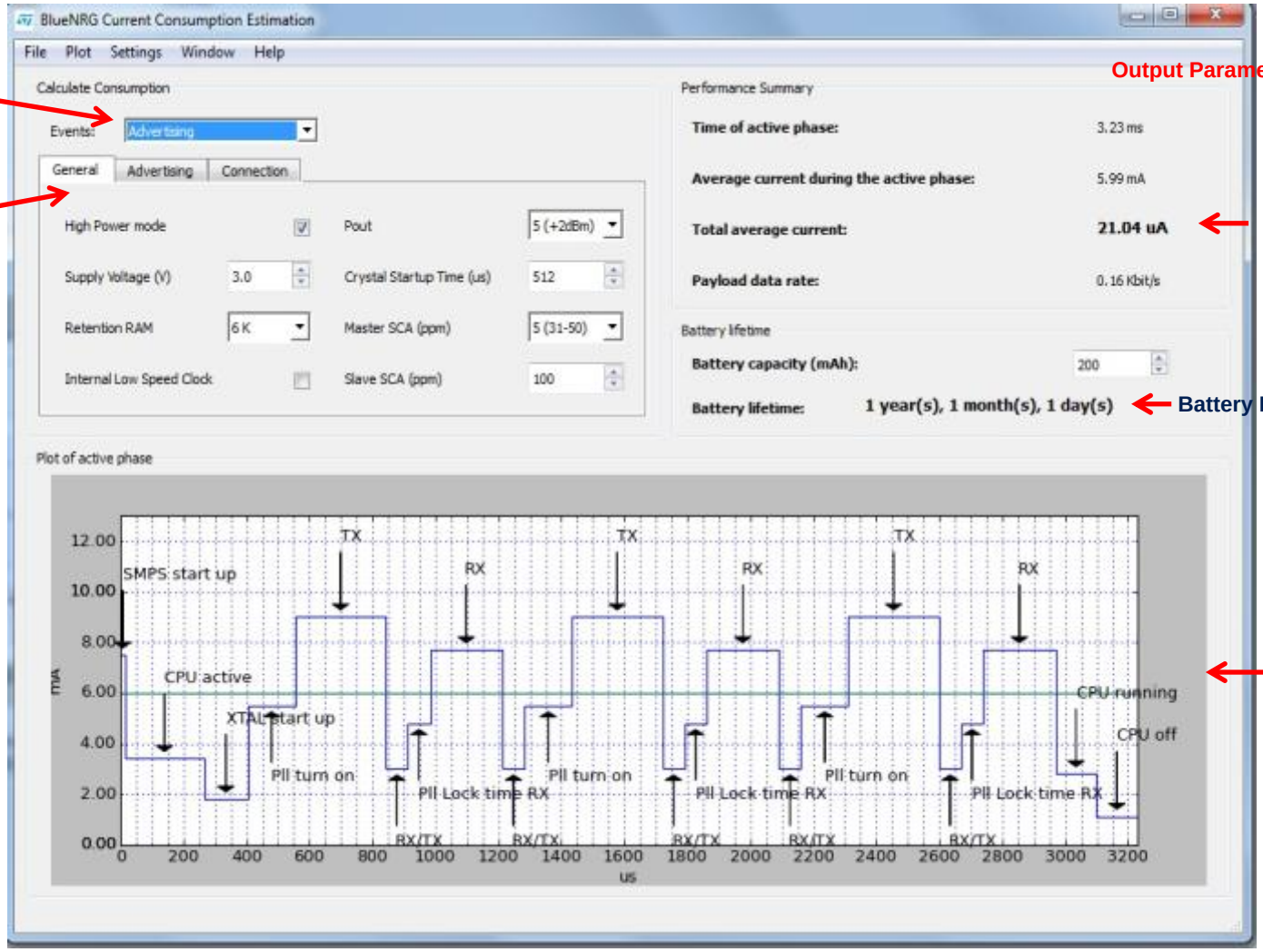
BlueNRG 电流评估工具

Mode:
- Advertising
- Connection – Salve
- Connection – Master

Input Parameters:
- **General**
- **Advertising:**
  - ADV Data length
  - ADV interval,
  - ADV Channels
- **Connection:**
  - Payload
  - # packets
  - Conn interval



Output Parameters

AVG current

Battery Life Estimation

Plot

Addition features:
- PDF Report creation
- Settings Management (Load, Save and Restore default)
- Save Plot

BlueNRG 文档，网页/支持资源

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BlueNRG 文档

ID	Title
UM1686	BlueNRG Development Kits User Manual
UM1755	BlueNRG Bluetooth LE Stack Application Command Interface (ACI) User Manual
AA4491	BlueNRG Updater Application Note
AN4486	BlueNRG Over the Air Bootloader Application Note
AN4494	Bringing Up BlueNRG Application Note

支持资源：Mantis database

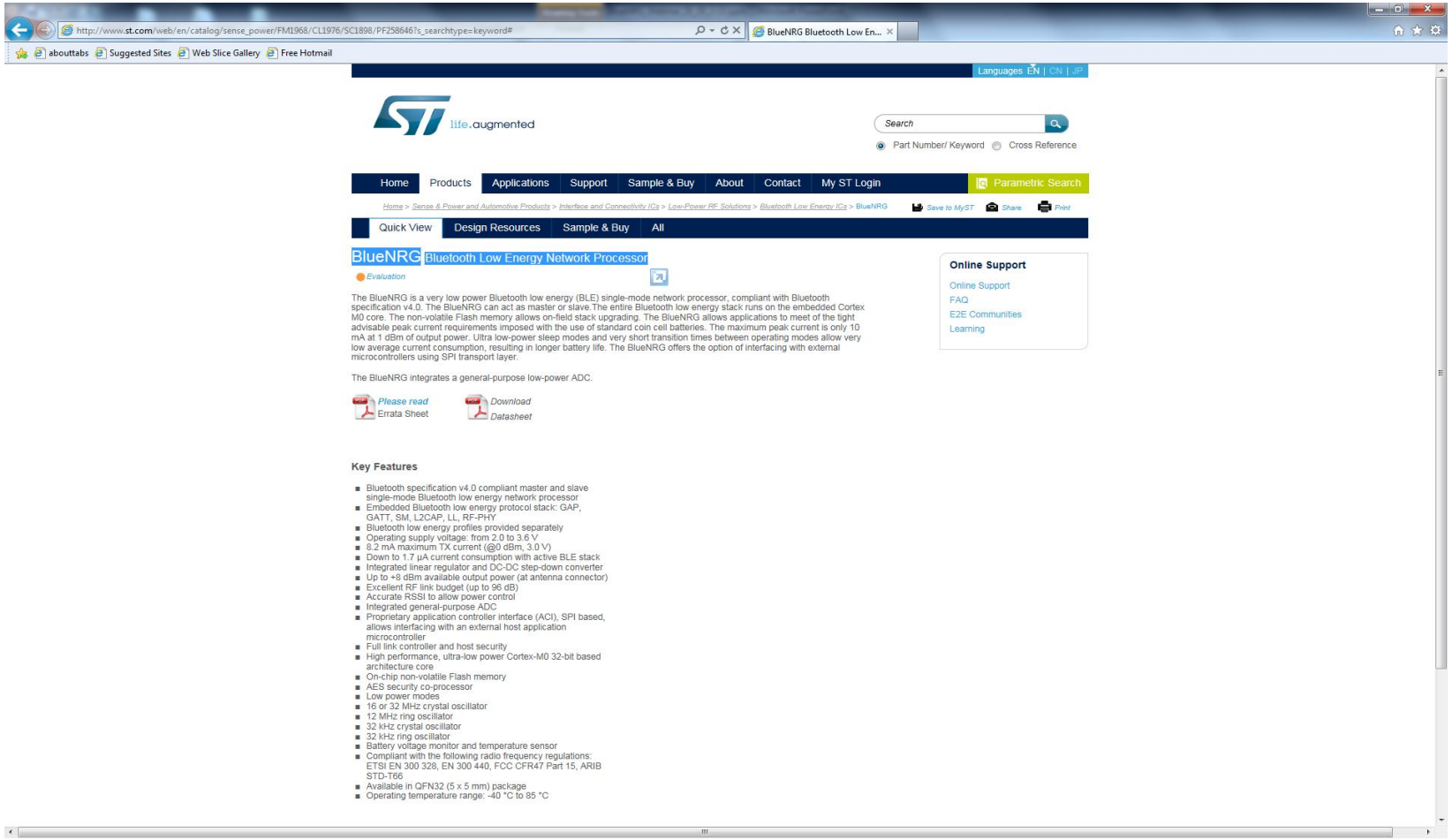
- To submit issues go to the link
  - http://synccad.ctn.st.com/mantis/hea_rf_support/login_page.php
- Access managed through LDAP (Outlook login and password)

- For support on Mantis tool (and **not** on BlueNRG or other product) contact **CTN-DDM-Group@list.st.com**

- **It is strongly recommended to use Mantis for reporting issues**
  - Higher Priority of Your requests over e-mail/phone request
  - Build a knowledge database that can limit the support request
  - Track Your request support and it does not get lost in somebody e-mail Inbox.
  - Build statistics about support effort
  - It allows an internal filter in order to assign request to the proper expert people.

BlueNRG 网页

http://www.st.com/web/catalog/sense_power/FM2185/CL1976/SC1898/PF258646?s_searchtype=partnumber



Guidelines for Nucleo_L053R8 _X_Nucleo_IDB04A1 _ X_Nulceo_IKS01A1

The hardware description

The demo board is composed of

Nucleo-L053R8 + X-Nucleo-IDB04A1 + X-Nulceo-IKS01A1

description of each part of the man function

Source: Bluetooth SIG

TOP architecture for Main()

- Initialize the STM32 Nucleo platform on the L053R8
- Initialize the sensors on the IKS01A1
- Initialize the BlueNRG on the IDB04A1
- Infinite loop calling two functions
  - HCI_Process()
  - User_Process(&axes_data)

TOP Arch : Initialize the STM32 Nucleo platform on L053R8


```
/* STM32Cube HAL library initialization:
 *  - Configure the Flash prefetch, Flash preread and Buffer caches
 *  - Systick timer is configured by default as source of time base, but user
 *    can eventually implement his proper time base source (a general purpose
 *    timer for example or other time source), keeping in mind that Time base
 *    duration should be kept 1ms since PPP_TIMEOUT_VALUEs are defined and
 *    handled in milliseconds basis.
 *  - Low Level Initialization
 */
HAL_Init();

/* Configure LED2 */
//BSP_LED_Init(LED2); //used for debugging

/* Configure the User Button in GPIO Mode */
BSP_PB_Init(BUTTON_KEY, BUTTON_MODE_GPIO);

/* Configure the system clock */
SystemClock_Config();
```

TOP Arch : Initialize the sensors on the IKS01A1


```
int mul = 1;
for(int i = 0; i < dec_precision; i++)
   mul = mul*10;

if(!BSP_HUM_TEMP_isInitialized()) {
   BSP_HUM_TEMP_Init();
  }
/*End Temp Sensor Init*/

/*Initialize the pressure sensors*/
if(!BSP_PRESSURE_isInitialized()) {
   BSP_PRESSURE_Init();
  }

  /*Initialize the Magneto sensors*/
if(!BSP_MAGNETO_isInitialized()) {
   BSP_MAGNETO_Init();
  }

  /*Initialize the Accelerometer and Gyrometer sensors*/
if(!BSP_IMU_6AXES_isInitialized()) {
   BSP_IMU_6AXES_Init();
  }
```

TOP Arch : Initialize the BlueNRG on the IDB04A1

1. Initialize SPI interface (details refer to AN4494, sec.3.5)
   allowing external microcontroller to properly get access to the BlueNRG features
2. Hci initialization (details refer to UM1755, sec.2 ACI command format)
3. Reset the BlueNRG network coprocessor
4. Configure BlueNRG public address (refer to PM0237, 3.1.1)
5. Initialize BlueNRG GATT layer
6. Initialize BlueNRG GAP layer to peripheral
7. Set the authentication
8. Define the GATT service and characteristic for Accelerometer and Environmental sensor

Initialize the BlueNRG on the IDB04A1 1~3


```
/* Initialize the BlueNRG SPI driver */
BNRG_SPI_Init();

/* Initialize the BlueNRG HCI */
HCI_Init();

/* Reset BlueNRG hardware */
BlueNRG_RST();
```

Initialize the BlueNRG on the IDB04A1 4~6


```
/* The Nucleo board must be configured as SERVER */
Osal_MemCpy(bdaddr, SERVER_BDADDR, sizeof(SERVER_BDADDR));

ret = aci_hal_write_config_data(CONFIG_DATA_PUBADDR_OFFSET,
                                CONFIG_DATA_PUBADDR_LEN,
                                bdaddr);
if(ret){
  PRINTF("Setting BD_ADDR failed.\n");
}

ret = aci_gatt_init();
if(ret){
  PRINTF("GATT_Init failed.\n");
}

ret = aci_gap_init(GAP_PERIPHERAL_ROLE, &service_handle,
                   &dev_name_char_handle, &appearance_char_handle);
if(ret != BLE_STATUS_SUCCESS){
  PRINTF("GAP_Init failed.\n");
}
```

Initialize the BlueNRG on the IDB04A1 7


```
ret = aci_gatt_update_char_value(service_handle, dev_name_char_handle, 0,
                                 strlen(name), (uint8_t *)name);

if(ret){
  PRINTF("aci_gatt_update_char_value failed.\n");
  while(1);
}

ret = aci_gap_set_auth_requirement(MITM_PROTECTION_REQUIRED,
                                   OOB_AUTH_DATA_ABSENT,
                                   NULL,
                                   7,
                                   16,
                                   USE_FIXED_PIN_FOR_PAIRING,
                                   123456,
                                   BONDING);
if (ret == BLE_STATUS_SUCCESS) {
  PRINTF("BLE Stack Initialized.\n");
}

PRINTF("SERVER: BLE Stack Initialized\n");
```

Initialize the BlueNRG on the IDB04A1 8


```
ret = Add_Acc_Service();

if(ret == BLE_STATUS_SUCCESS)
  PRINTF("Acc service added successfully.\n");
else
  PRINTF("Error while adding Acc service.\n");

ret = Add_Environmental_Sensor_Service();

if(ret == BLE_STATUS_SUCCESS)
  PRINTF("Environmental Sensor service added successfully.\n");
else
  PRINTF("Error while adding Environmental Sensor service.\n");

/* Set output power level */
ret = aci_hal_set_tx_power_level(1,4);

while(1)
```

TOP Arch: Inifinite loop calling two functions


```
while(1)
{
  HCI_Process();
  User_Process(&axes_data);
}
}
```

Inifinite loop calling two functions

--HCI_PROCESS()

- 1.In the HCI_Process() API, a specific user application function where user actions/events are processed (advertising, connections, services and characteristics discovery, notification and related events).

- 1)When receive EVT_BLUE_GATT_READ_PERMIT_REQ, This event is given to the application when a read request or read blob request is received(details refer to UM1755, sec.4.6.6), Read_Request_CB(pr->attr_handle) will be called;

- 2). In Read_Request_CB(pr->attr_handle), the following function will be called and update the related sensor data.

- Acc_Update((AxesRaw_t*)&ACC_Value)

- Temp_Update(TEMPERATURE_Value * 10)

- Press_Update((int32_t)(PRESSURE_Value * 100))

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Inifinite loop calling two functions

--HCI_PROCESS()

- In Acc_Update((AxesRaw_t*)&ACC_Value), calling aci_gatt_update_char_value(accServHandle, accCharHandle, 0, 6, buff) to update Acc data(details refer to UM1755, sec.4.5.7);
- In Temp_Update(TEMPERATURE_Value * 10), calling aci_gatt_update_char_value(envSensServHandle, tempCharHandle, 0, 2,(uint8_t*)&temp) to update tem data (details refer to UM1755, sec.4.5.7);
- In Press_Update((int32_t)(PRESSURE_Value * 100)), calling aci_gatt_update_char_value(envSensServHandle, pressCharHandle, 0, 3,(uint8_t*)&press) to update press data(details refer to UM1755, sec.4.5.7);

Inifinite loop calling two functions

--USER_PROCESS()

- 1.In the HCI_Process() API, every 100ms, Acc_Update((AxesRaw_t*)&ACC_Value) will be called to update ACC data.

```
if (Time1 > 100)                        // wait 100ms
{
        Time1 = 0;
        if(BSP_IMU_6AXES_isInitialized())
        {
                BSP_IMU_6AXES_X_GetAxesRaw((AxesRaw_TypeDef *)&ACC_Value);
                Acc_Update((AxesRaw_t*)&ACC_Value);
        }
}
```

Nucleo sensor demo

STM32L Nucleo -智能蓝牙 + 传感器演示

Bluetooth SMART

Bluetooth® 4.0 low-energy chip

所有传感器数据都是实时更新的

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