



讯联电子

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讯联电子nRF51822蓝牙4.0开发实战之

用 **BLE_USB_DONGLE** 替代 **PCA10000**

V:1.0





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1 背景

辅助调试nRF51822的蓝牙程序有2种类型：

- 1) 手机或者平板。最方便的工具当然是手机了，IPHONE 4S以上和安卓4.3以上的手机装上相应的APP就可以在手机上观察到接收到的蓝牙设备信号强度、MAC地址；并可以通过跟蓝牙设备建立连接，discover其所拥有的service和characteristics。更进一步，通过以读写characteristics这种方式上传下发数据。对于IPHONE或者IPAD，我们推荐装LightBlue，这款软件基本上可以认为是行业目前最好用的BLE APP了。对于安卓，我们推荐装NORDIC提供的MCP (Master Control Panel)。这个APP的功能也很强大的，基本上可以认为是安卓中的LightBlue了。
- 2) PC机。这种方式在一些用作无线数据采集中心节点中也比较常见。自带蓝牙BLE的PC机或者普通PC机上面外接一个DONGLE (适配器)和BLE外设进行通讯，上传下发数据。对于nRF51822的PC机端的DONGLE大家应该知道，叫PCA10000。PCA10000的功能是很强大，扫描、建立连接、discover service和characteristics都不是问题。甚至还有一个OTA (无线固件升级)功能。但是PCA10000售价不便宜，跟PCA10001一套官方价格是1KRMB，不单卖。我等DIYer用不起这个高大上的DONGLE。这就引出了这次教程的主题---<用讯联电子BLE_USB_DONGLE替代PCA10000调试nRF51822>的程序。

2 内容

- 上位机软件BLE Device Monitor的安装
- BLE_USB_DONGLE的安装
- 对BLE外设的scan
- 跟BLE外设create connection
- discover service and characteristics

3 准备工作

软件准备：

- BLE Device Monitor
- Windows XP 或者Windows 7
- BLE协议栈CC254x-1.4.0.exe
- 了解蓝牙基本原理

硬件准备：

- nRF51822EK_TM蓝牙开发板1 PCS
- 1条赠送的MICRO USB数据线
- 讯联电子BLE_USB_DONGLE 1 PCS

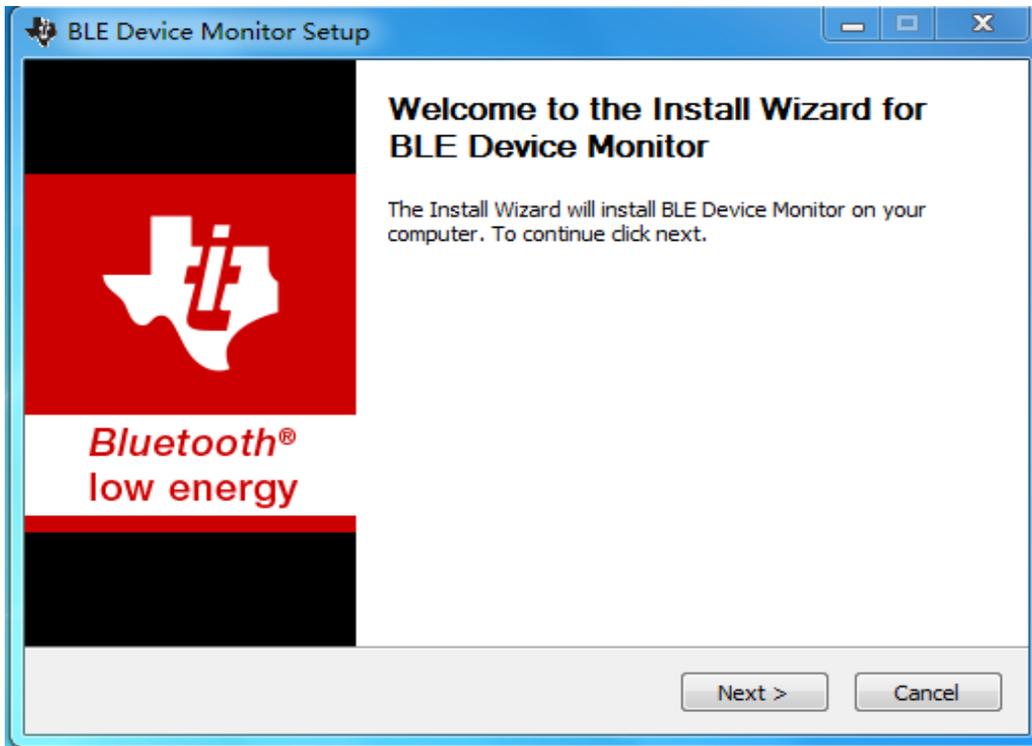


Figure BLE_USB_DONGLE

购买链接: <http://item.taobao.com/item.htm?spm=a1z10.1.w4004-4888311669.11.rdp1e3&id=35506024480>

4 实战

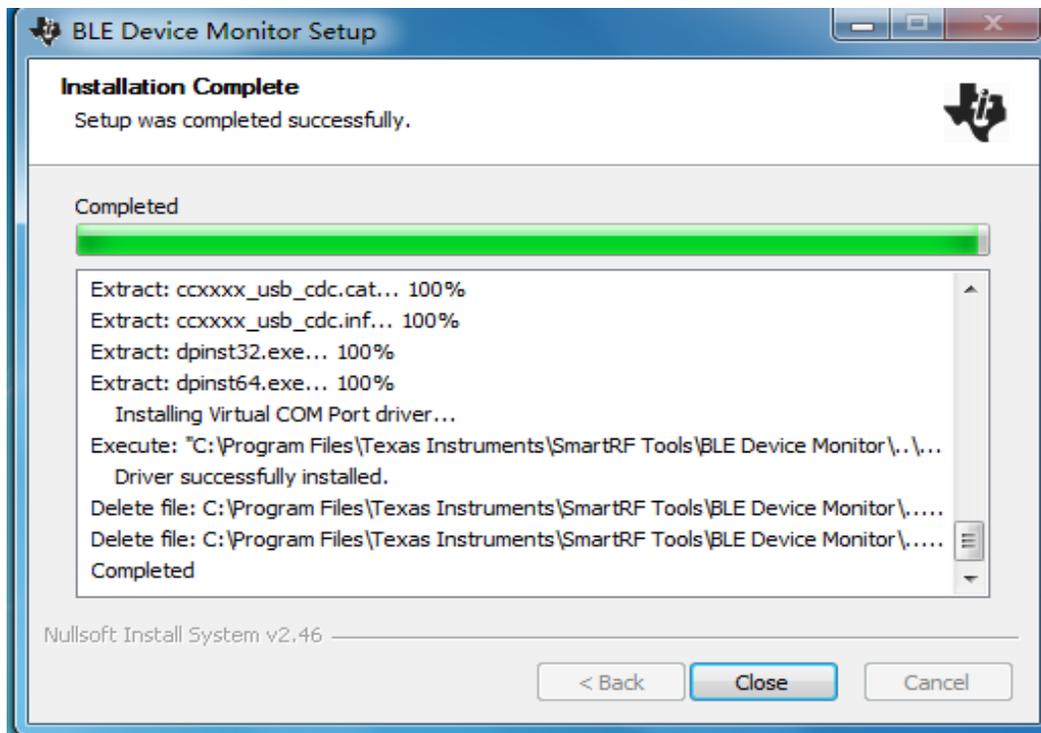
4.1 安装上位机软件BLE Device Monitor(安装文件在用户下载的资料里面)



点下一步安装BLE Device Monitor



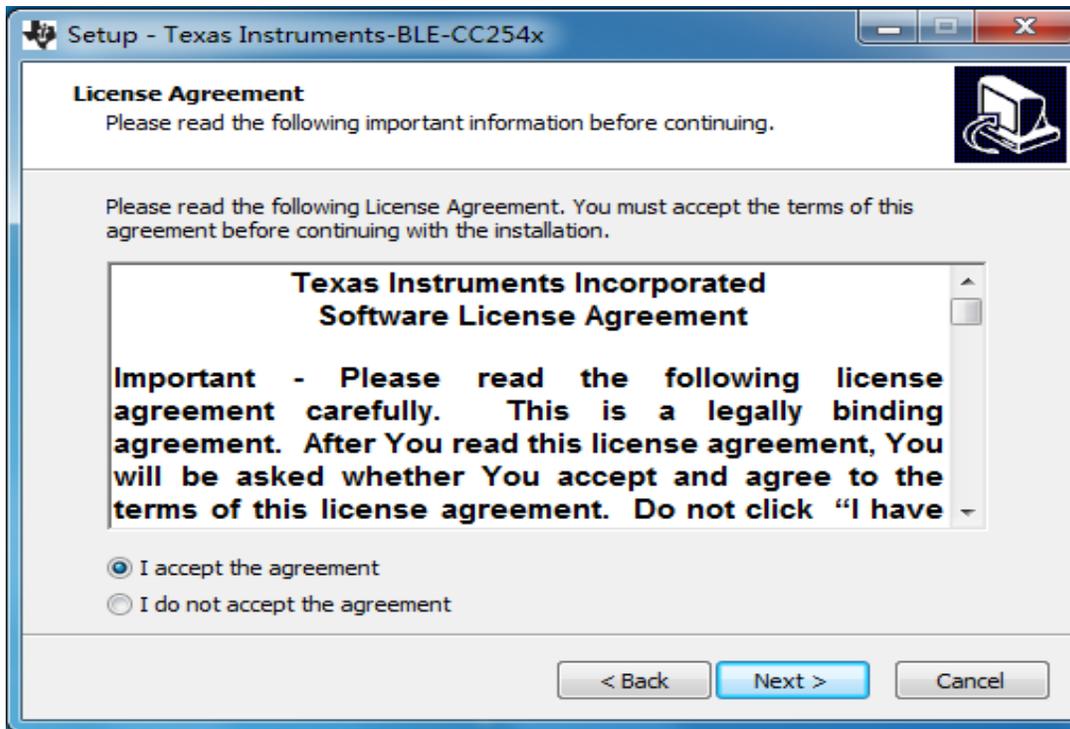
全部勾选



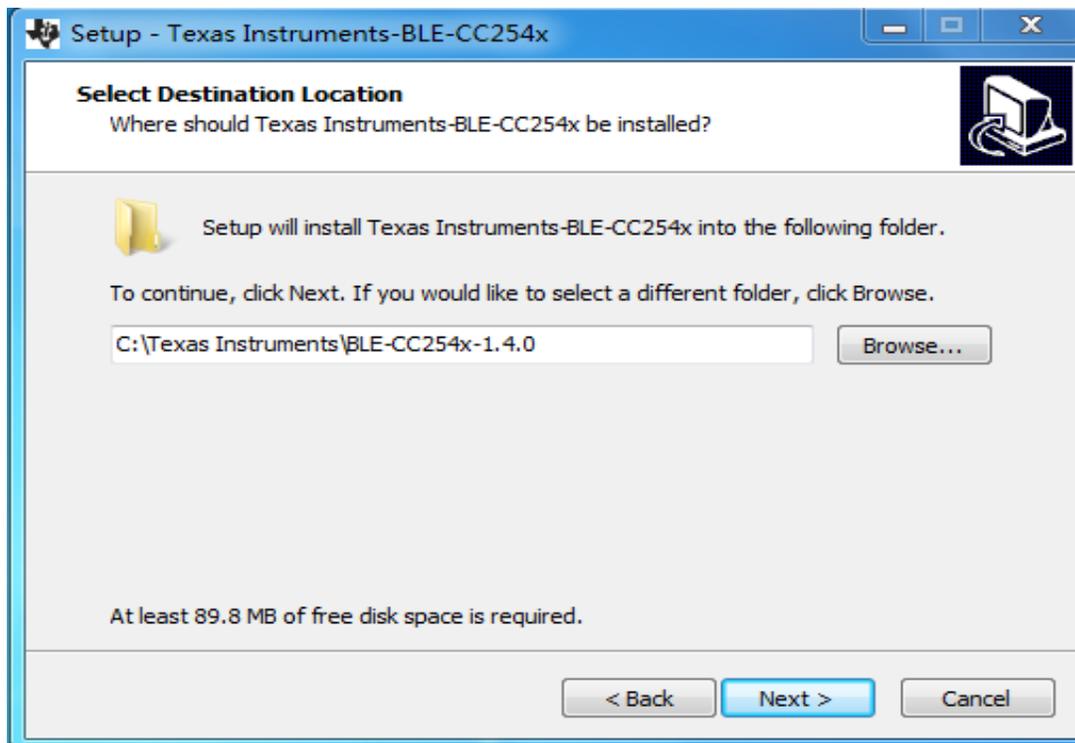
完成安装



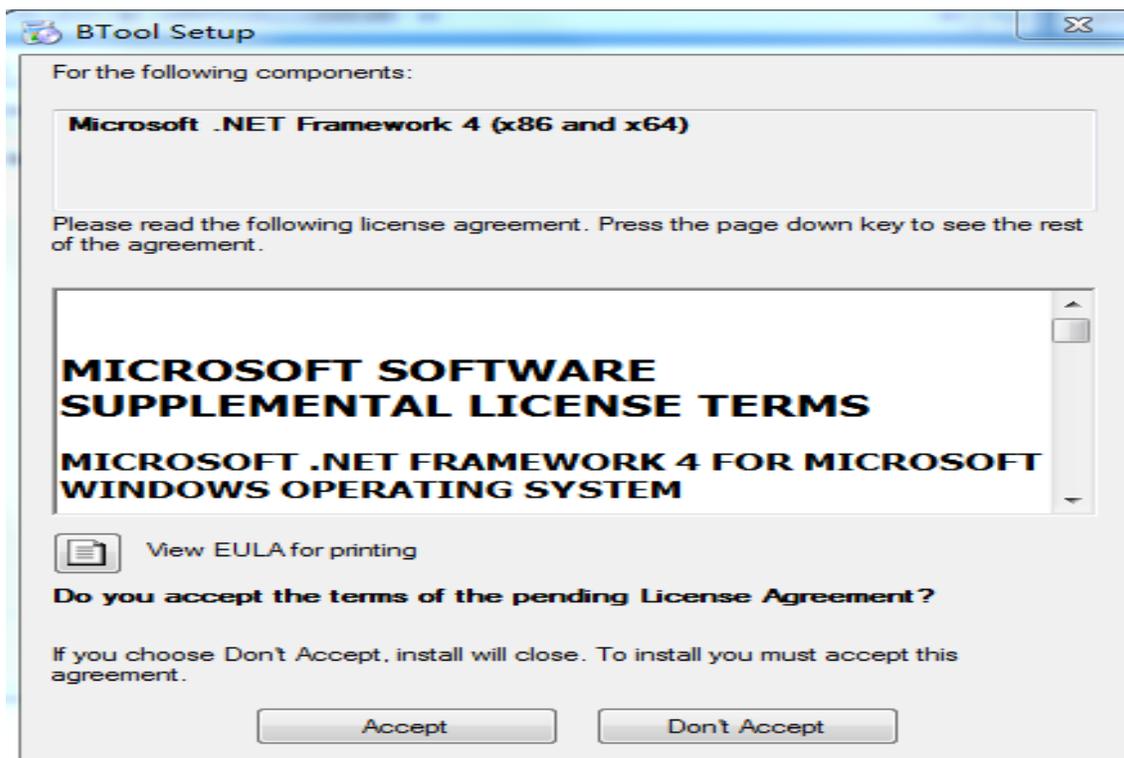
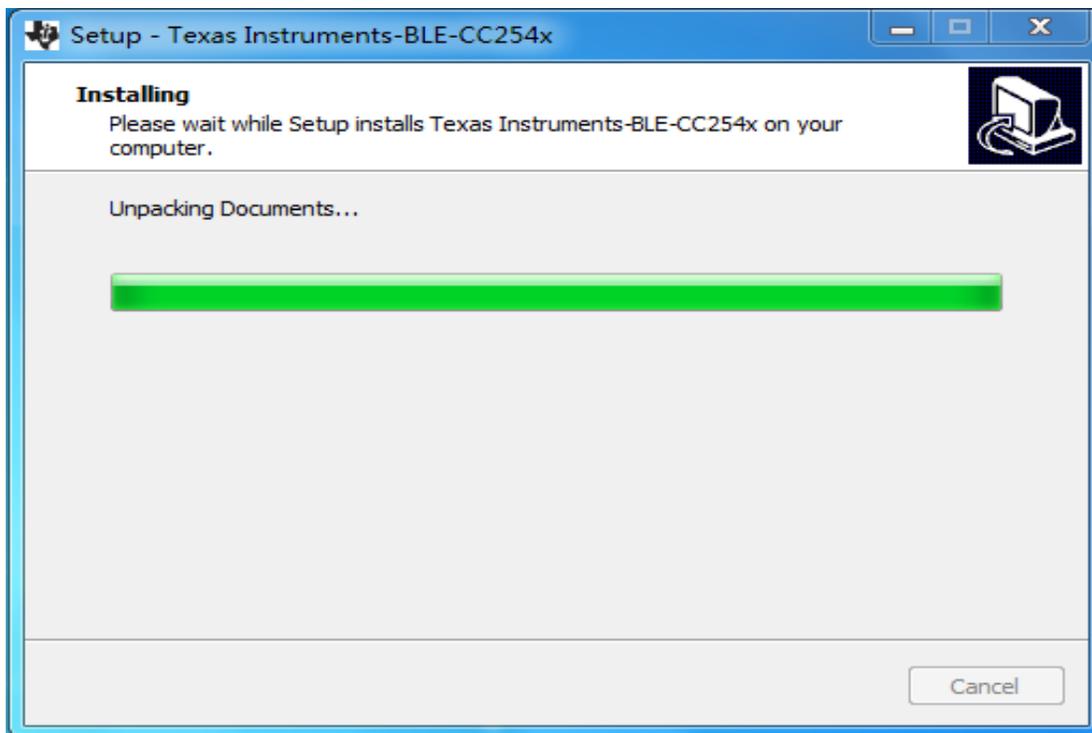
安装1.40版本的蓝牙协议栈



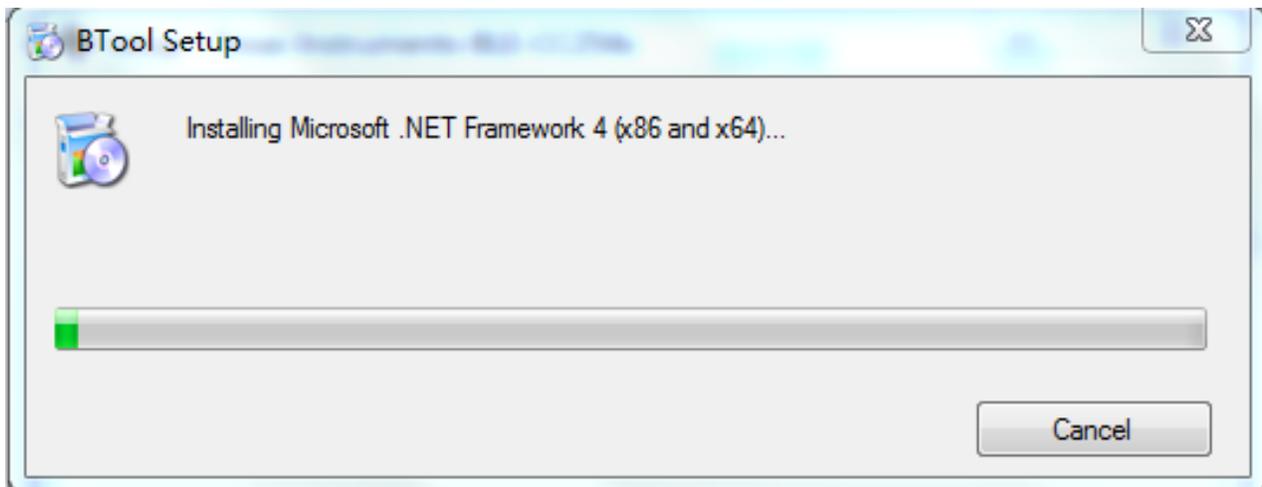
接受协定



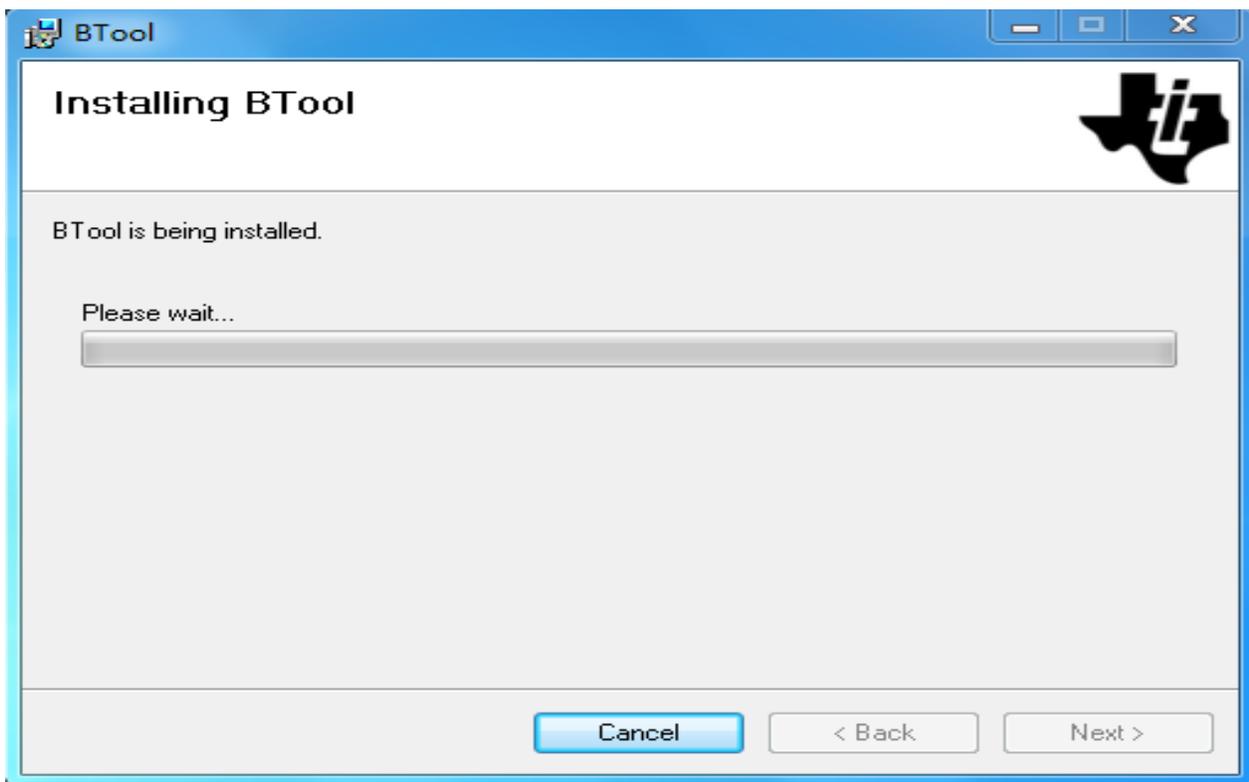
选择安装协议栈的路径



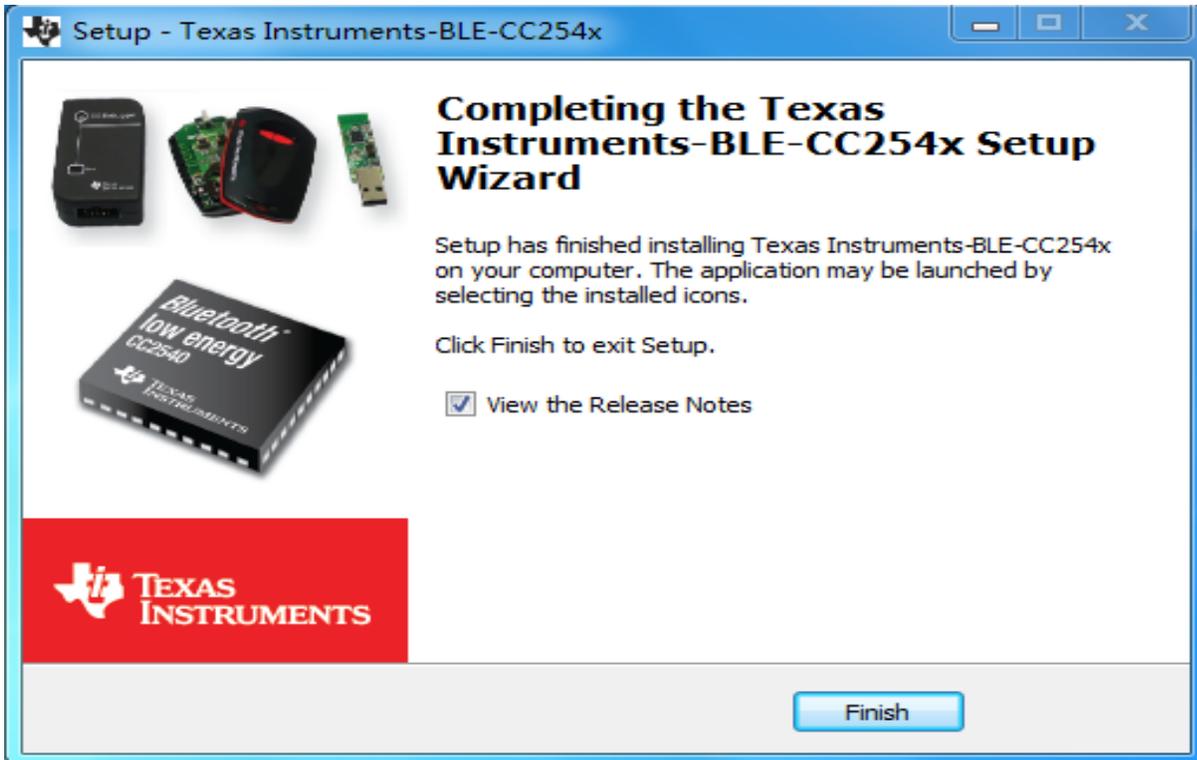
安装协议栈的时候BTOOL会自动被安装上



跟系统有关系，也许会出现安装.NET Framwork的界面



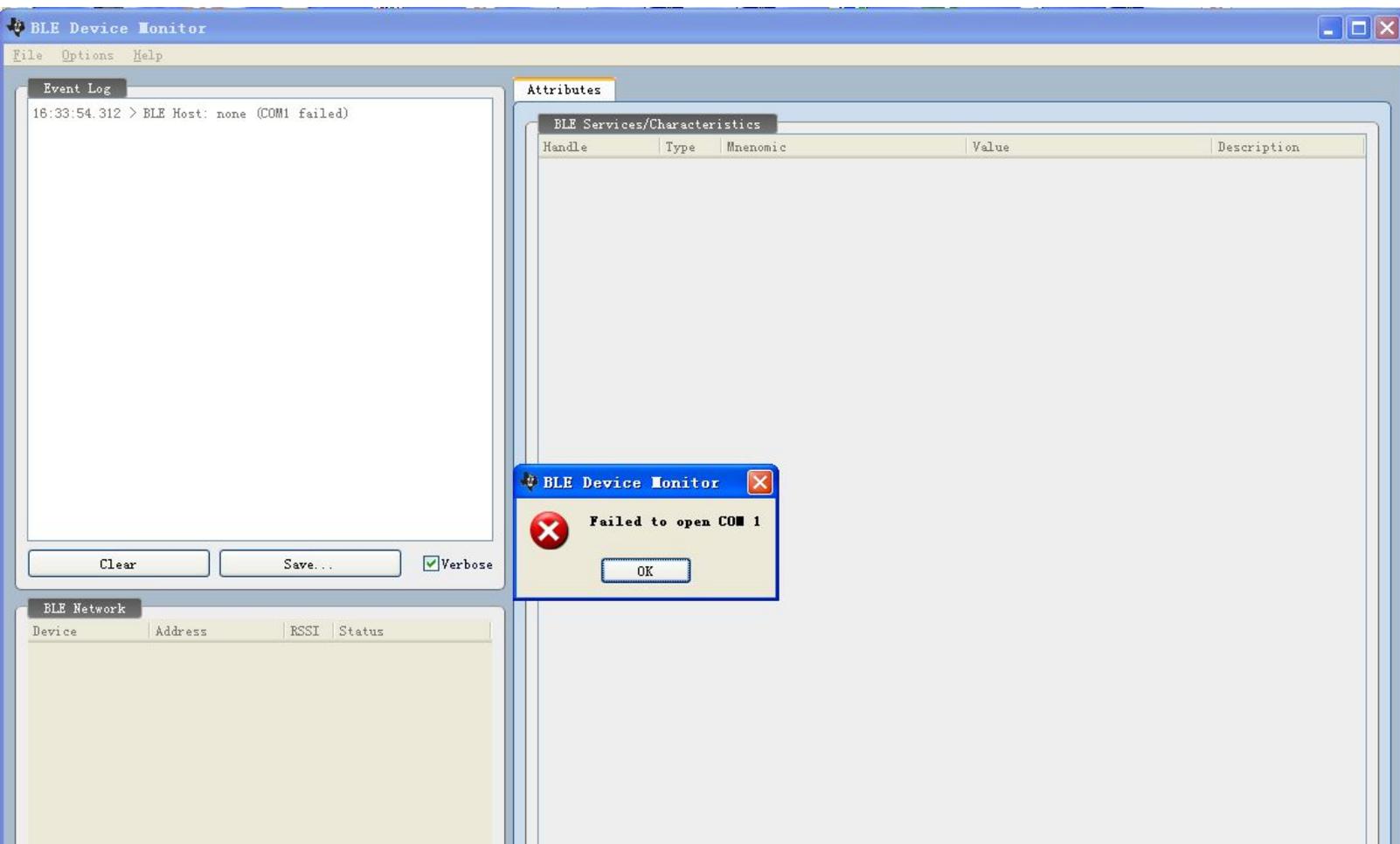
BTOOL安装中。题外话,BT00L是个功能很强大，很好用的蓝牙开发工具。



协议栈安装完成。



4.2 利用BLE USB DONGLE连接nRF51822EK_TM进行程序调试



把BLE USB DONGLE插在PC机的USB口上。正常的话PC机会提示安装驱动程序，一般选自动安装就行了，PC机会自动帮我们安装上DONGLE的驱动。上位机软件和协议栈安装完成后在开始菜单或者桌面找到Device Monitor的图标，双击运行程序。第一次打开的时候可能会出现Fail to open COM1. 这个时候我们要把串口设定为BLE USB DONGLE在使用的串口。见下图。



BLE Device Monitor

File Options Help

Event Log

```
16:45:19.703 > BLE Host: none (COM1 failed)
16:45:20.871 > Failed to open COM 1
```

Clear Save... Verbose

BLE Network

Device	Address	RSSI	Status
--------	---------	------	--------

Attributes

BLE Services/Characteristics

Handle	Type	Mnemonic	Value	Description
--------	------	----------	-------	-------------

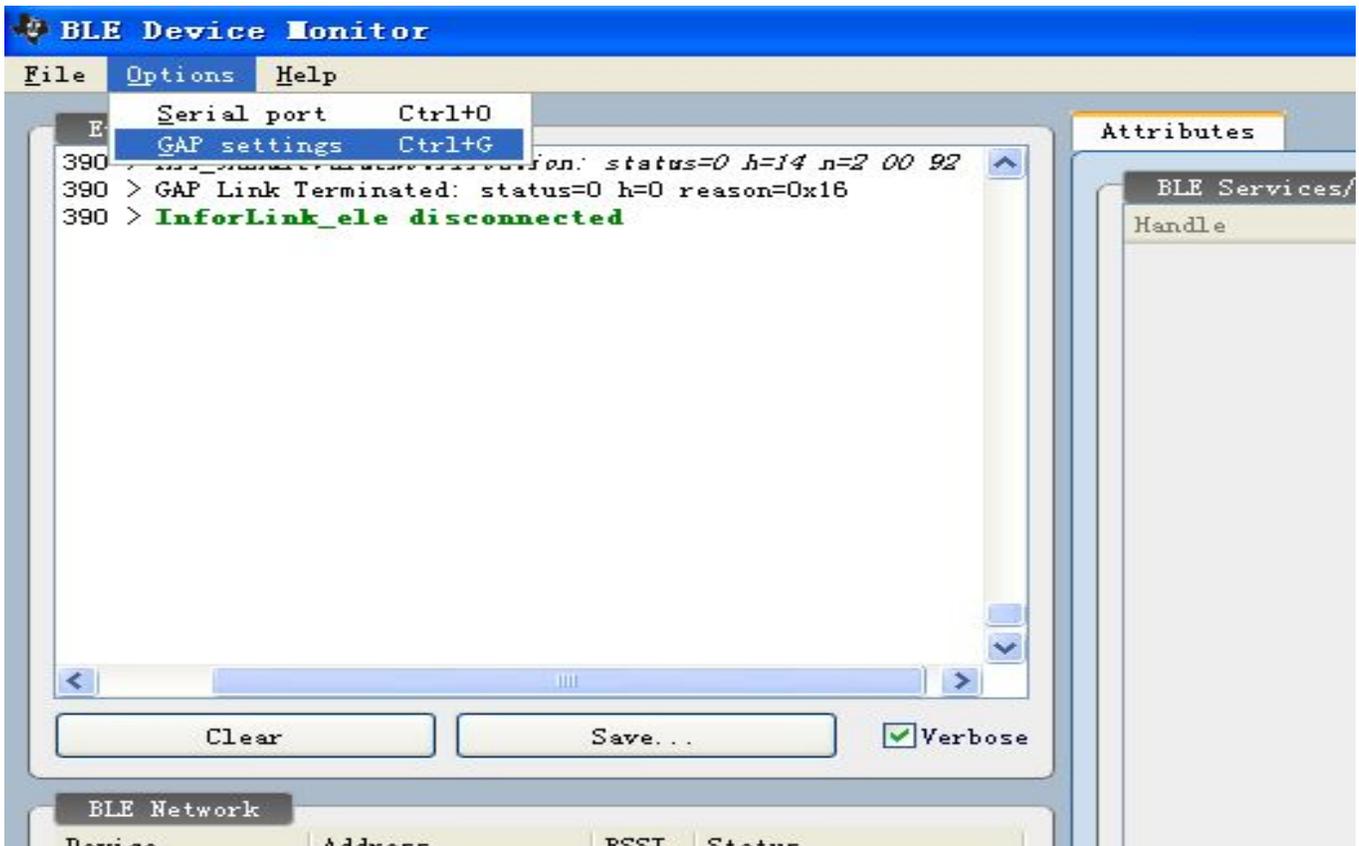
Serial Port Settings

Port: COM25

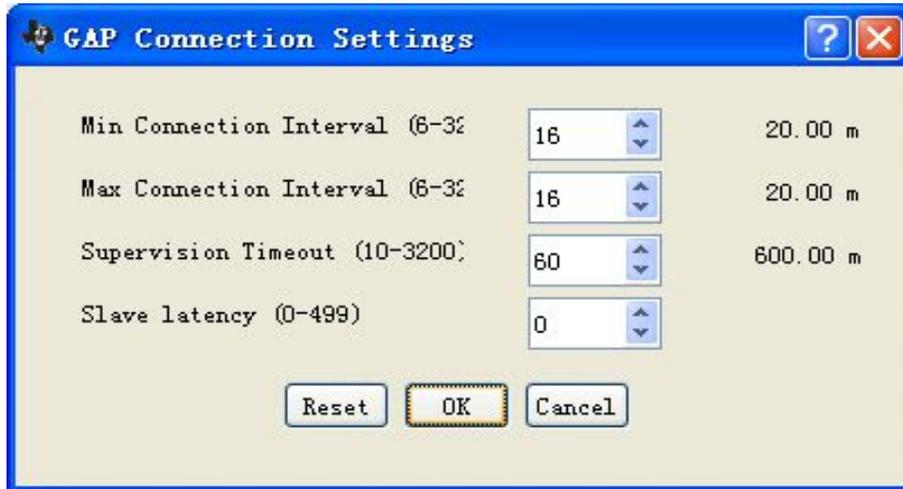
Baud: 115200

Flow: Hardware

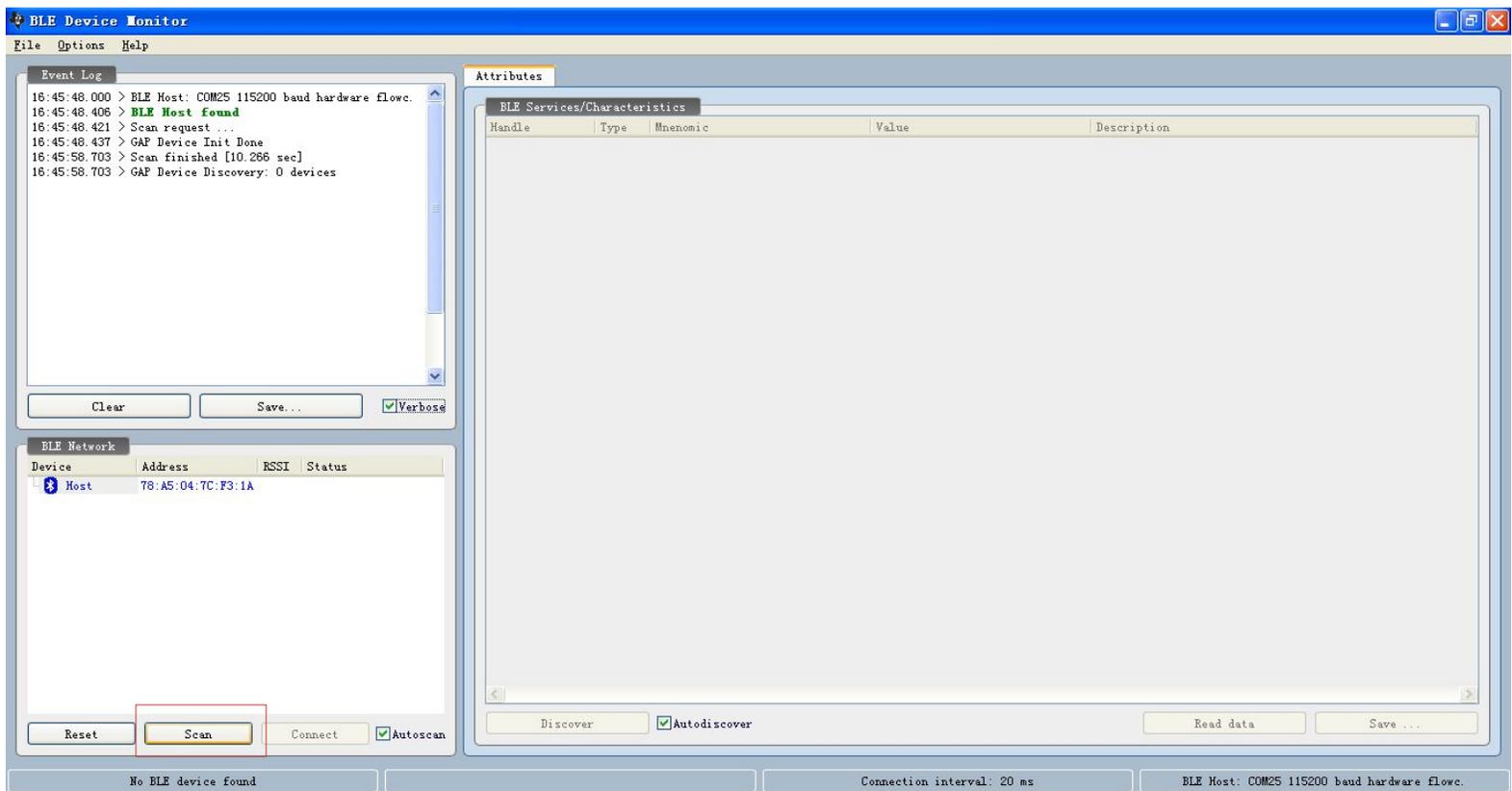
OK Cancel



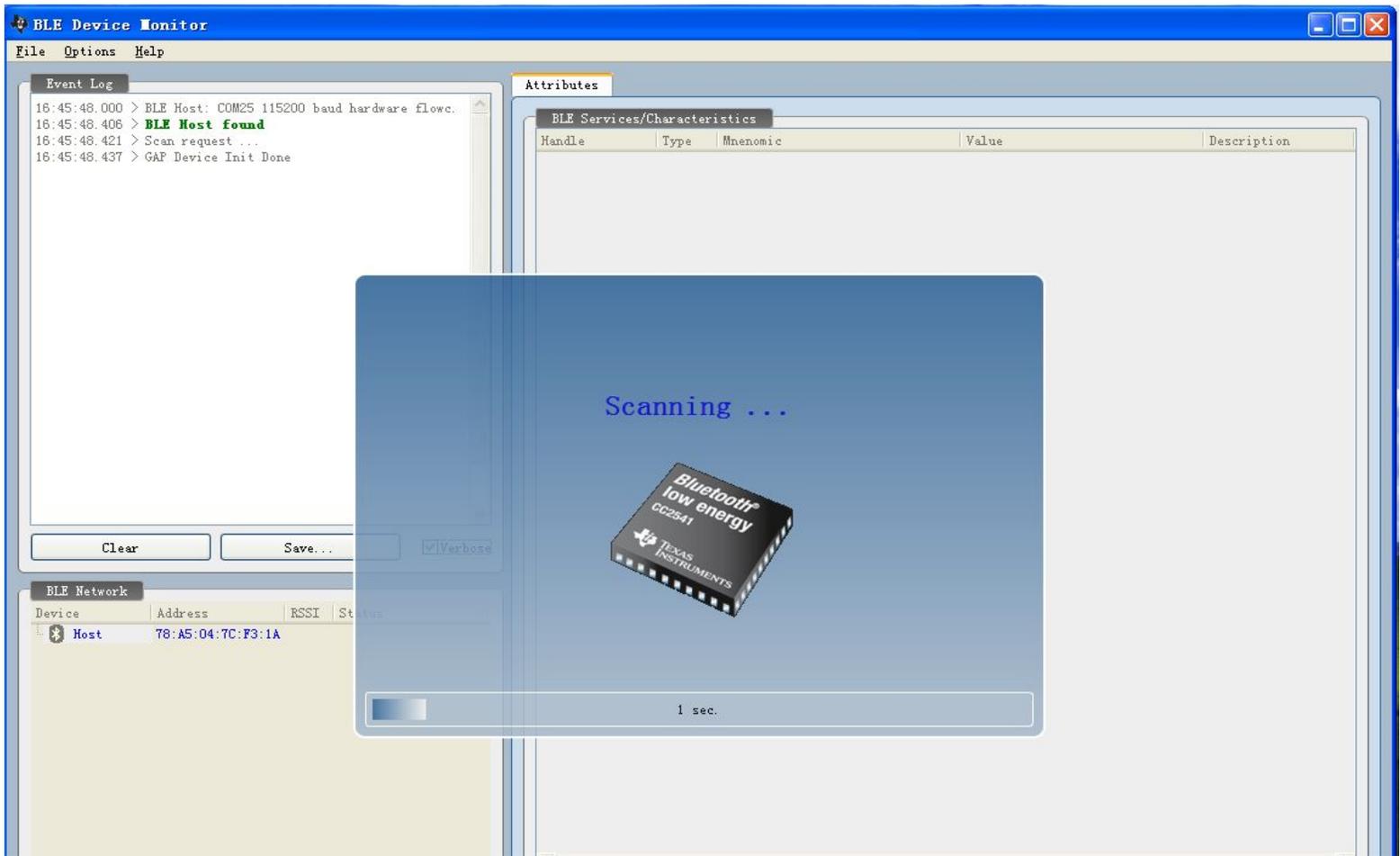
如果扫描参数不对的话，DONGLE是扫描不到BLE外设的。所以为了能扫描到BLE外设，我们需要配置一下合适的扫描参数。首先我们从菜单中选取GAP settings, 见上图。合适的参数值见下图。



上面这些值跟蓝牙外设的固件设置的广播参数有关系。



参数设定好以后，我们把已经烧录好蓝牙固件的nRF51822EK_TM蓝牙开发板上电，正常的话此时LED0应该会闪烁，表示nRF51822EK_TM开发板正在发广播信号。然后在软件里面点击Scan, 启动蓝牙外设的扫描。这里以HRS (心率传感器)的范例程序为例子讲解。关于HRS所带有的功能，读者可以先了解一下。



DONGLE正在扫描，假如在设定的时间内没有扫到任何BLE外设，DONGLE会退出扫描模式。



The screenshot displays the BLE Device Monitor application. The Event Log on the left shows the following sequence of events:

```
16:45:48.000 > BLE Host: COM25 115200 baud hardware flow.
16:45:48.406 > BLE Host found
16:45:48.421 > Scan request ...
16:45:48.437 > GAP Device Init Done
16:45:58.703 > Scan finished [10.266 sec]
16:45:58.703 > GAP Device Discovery: 0 devices
17:04:25.531 > Scan request ...
17:04:28.875 > GAP Device Information: status=0 type=0x00 [
17:04:28.875 > MAC address: E5:42:5B:E1:EC:C7
17:04:28.875 > Device found: InforLink_ele
17:04:28.875 > Scan resp: ad=0x19 len=3
17:04:28.875 > Scan resp: ad=0x01 len=2
17:04:28.875 > Scan resp: ad=0x03 len=7
17:04:29.531 > Scan cancel request ...
17:04:29.546 > Scan finished [4.15 sec]
17:04:29.578 > GAP Device Discovery: 0 devices
```

The BLE Network table shows the following device:

Device	Address	RSSI	Status
Host	78:A5:04:7C:F3:1A		
InforLink...	E5:42:5B:E1:EC:C7	-58	

The Attributes panel is currently empty. The status bar at the bottom indicates: 1 BLE device(s) found, Connection interval: 20 ms, BLE Host: COM25 115200 baud hardware flow.

DONGLE已经扫描到名字为<InforLink>的蓝牙外设。同时BLE Monitor Device也把MAC地址和接收到的信号强度显示出来了。



The screenshot shows the BLE Device Monitor application. The Event Log on the left contains the following text:

```
16:45:48.000 > BLE Host: COM25 115200 baud hardware flowc.
16:45:48.406 > BLE Host found
16:45:48.421 > Scan request ...
16:45:48.437 > GAP Device Init Done
16:45:58.703 > Scan finished [10.286 sec]
16:45:58.703 > GAP Device Discovery: 0 devices
17:04:25.531 > Scan request ...
17:04:28.875 > GAP Device Information: status=0 type=0x00 [
17:04:28.875 > MAC address: E5:42:5B:E1:EC:C7
17:04:28.875 > Device found: InforLink_ele
17:04:28.875 > Scan resp: ad=0x19 len=3
17:04:28.875 > Scan resp: ad=0x01 len=2
17:04:28.875 > Scan resp: ad=0x03 len=7
17:04:29.531 > Scan cancel request ...
17:04:29.546 > Scan finished [4.15 sec]
17:04:29.578 > GAP Device Discovery: 0 devices
```

The BLE Network table shows the following data:

Device	Address	RSSI	Status
Host	78:A5:04:7C:F3:1A		
InforLink...	E5:42:5B:E1:EC:C7	-58	

The Connect button in the BLE Network section is highlighted with a red box. The status bar at the bottom indicates '1 BLE device(s) found', 'Connection interval: 20 ms', and 'BLE Host: COM25 115200 baud hardware flowc.'

假如有多个外设同时在广播，BLE Device Monitor会以列表的方式显示出来。用户想跟哪个外设连接，先选中那个外设，点击Connect即可。这里我们选<InforLink>,点击Connect.



Event Log

```
17:09:53.953 > ATT_FindInfoResp: status=0 n=21
17:09:53.984 > ATT_FindInfoResp: status=0 n=21
17:09:54.031 > ATT_FindInfoResp: status=0 n=21
17:09:54.078 > ATT_FindInfoResp: status=0 n=17
17:09:54.109 > ATT_FindInfoResp: status=26 n=0
17:09:54.109 > Characteristic Description Discovery done [0.
17:09:54.109 > Characteristic discovery started
17:09:54.171 > ATT_ReadByTypeResp: status=0 n=22
17:09:54.187 > ATT_ReadByTypeResp: status=0 n=22
17:09:54.234 > ATT_ReadByTypeResp: status=0 n=15
17:09:54.265 > ATT_ReadByTypeResp: status=26 n=0
17:09:54.265 > Characteristic Discovery done [0.156] sec
```

Attributes

Handle	Type	Mnemonic	Value	Description
Attributes				
1	0x2800	GATT Primary Service Declaration	00:18	Generic Access Service
8	0x2800	GATT Primary Service Declaration	01:18	Generic Attribute Service
12	0x2800	GATT Primary Service Declaration	0D:18	Heart Rate Service
18	0x2800	GATT Primary Service Declaration	0F:18	Battery Service
22	0x2800	GATT Primary Service Declaration	0A:18	Device Information Service

BLE Network

Device	Address	RSSI	Status
Host	78:A5:04:7C:F3:1A		
InforLink...	E5:42:5B:E1:EC:C7	-55	Connected

Status Bar

1 BLE device(s) found InforLink_ele connected Connection interval: 20 ms BLE Host: COM25 115200 baud hardware flow.

DONGLE和nRF51822EK_TM连接成功。上图中左边红色框内表示的是EVENT LOG即对已发生时间的记录信息。右边的方框为DONGLE和开发板建立连接以后对开发板所Discover的service。了解过NORDIC HRS例程的读者应该知道该程序包含Heart Rate Service、Battery Service、Device Information Service、General Access Service、General Attribute Service。其中Heart Rate Service的Characteristics(特征值)Heart Rate Measurement的值会随开发板上的按键BUTTON0和BUTTON1的按下而变化。当BUTTON0被按下的时候, Heart Rate Measurement值会加2; 当BUTTON1被按下的时候Heart Rate Measurement值减2。



BLE Device Monitor

File Options Help

Event Log

```
17:11:16.671 > ATT_HandleValueNotification: status=0 h=14 n:
17:11:17.671 > ATT_HandleValueNotification: status=0 h=14 n:
17:11:18.671 > ATT_HandleValueNotification: status=0 h=14 n:
17:11:19.671 > ATT_HandleValueNotification: status=0 h=14 n:
17:11:20.390 > GAP_Link_Param_Update: 0 0 800 0 400
17:11:21.406 > ATT_HandleValueNotification: status=0 h=14 n:
```

Attributes

Handle	Type	Mnemonic	Value	Description
1	GATT Primary Service Declaration	Generic Access Service	00:18	Generic Access Service
8	GATT Primary Service Declaration	Generic Attribute Service	01:18	Generic Attribute Service
12	GATT Primary Service Declaration	Heart Rate Service	00:18	Heart Rate Service
13	GATT Characteristic Declaration	Heart Rate Measurement	10:0E:00:37:2A	Heart Rate Measurement
14	Heart Rate Measurement		00:B4	
15	Client Characteristic Configuration		01:00	Write "01:00" to enable notifications, "00:00..."
16	GATT Characteristic Declaration	Body Sensor Location	02:11:00:38:2A	Body Sensor Location
18	GATT Primary Service Declaration	Battery Service	0F:18	Battery Service
22	GATT Primary Service Declaration	Device Information Service	0A:18	Device Information Service

BLE Network

Device	Address	RSSI	Status
Host	78:A5:04:7C:F3:1A		
InforLink...	E5:42:5B:E1:EC:C7	-55	Connected

Reset Scan Disconnect Autoscan

Discover Autoscan Read data Save ...

1 BLE device(s) found InforLink_ele connected Connection interval: 1000 ms BLE Host: COM25 115200 baud hardware flow.

要想在Heart Rate Measurement值有变化的时候我们得到通知，需要在Client Characteristics Configuration那一栏输入01:00，回车。



BLE Device Monitor

File Options Help

Event Log

```
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 AF
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 AC
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 AB
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 A6
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 A2
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 A0
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 BE
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 9C
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 9A
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 96
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 94
```

Clear Save... Verbose

BLE Network

Device	Address	RSSI	Status
Host	78:A5:04:7C:F3:1A		
InforLink...	E5:42:5B:E1:EC:C7	-55	Connected

Reset Scan Disconnect Autoscan

Attributes

Handle	Type	Mnemonic	Value	Description
1	GATT Primary Service Declaration		00:18	Generic Access Service
8	GATT Primary Service Declaration		01:18	Generic Attribute Service
12	GATT Primary Service Declaration		00:18	Heart Rate Service
13	GATT Characteristic Declaration		10:0E:00:37:2A	Heart Rate Measurement
14	GATT Characteristic Declaration		00:94	Heart Rate Measurement
15	Client Characteristic Configuration		01:00	Write "01:00" to enable notifications, "00:00..."
16	GATT Characteristic Declaration		02:11:00:38:2A	Body Sensor Location
18	GATT Primary Service Declaration		0F:18	Battery Service
22	GATT Primary Service Declaration		0A:18	Device Information Service

Discover Autodiscover Read data Save ...

1 BLE device(s) found InforLink_ele connected Connection interval: 1000 ms BLE Host: COM25 115200 baud hardware flowc.

回车以后。可以看到每隔一秒DONGLE会收到一次数据。这个数据对应Heart Rate Mesurement这个characteristics (特征值)。按下BUTTON0, 数值加2; 按下BUTTON1, 数值减2。



BLE Device Monitor

File Options Help

Event Log

```
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 B4
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 B6
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 B8
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 BA
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 BC
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 BE
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 C2
406 > ATT_HandleValueNotification: status=0 h=14 n=2 00 C4
```

Attributes

BLE Services/Characteristics

Handle	Type	Mnemonic	Value	Description
1	GATT Primary Service Declaration		00:18	Generic Access Service
8	GATT Primary Service Declaration		01:18	Generic Attribute Service
12	GATT Primary Service Declaration		00:18	Heart Rate Service
13	GATT Characteristic Declaration		10:0E:00:37:2A	Heart Rate Measurement
14	GATT Characteristic Declaration		00:C4	
15	Client Characteristic Configuration		01:00	Write "01:00" to enable notifications, "00:00..."
16	GATT Characteristic Declaration		02:11:00:38:2A	Body Sensor Location
18	GATT Primary Service Declaration		0F:18	Battery Service
22	GATT Primary Service Declaration		0A:18	Device Information Service

BLE Network

Device	Address	RSSI	Status
Host	78:A5:04:7C:F3:1A		
InforLink...	E5:42:5B:E1:EC:C7	-55	Connected

Reset Scan Disconnect Autoscan

Discover Autodiscover Read data Save ...

1 BLE device(s) found InforLink_ele connected Connection interval: 1000 ms BLE Host: COM25 115200 baud hardware flow.

当我们想要断开连接的时候点Disconnect即可。

