Bluetooth 5.2 Advertisement Demonstration

Summary

https://www.novelbits.io/bluetooth-low-energy-advertisements-part-1/
The objective is to maximize the advantages of Bluetooth 5.2 compared to Bluetooth 4. And I chose Bluetooth LE Extended Advertisement to show the high rate/range/data size of Bluetooth 5.2.I developed Windows API by programming C#. It was a challenging task because Bluetooth LE Extended Advertisement is a brand new protocol, it cannot be customized by using Windows UWP Namespaces. After using Windows UWP Namespaces to successfully send/receive data, I self-studied the Bluetooth 5.2 Core Specification and tried to program HCI commands as sender but it failed. Firstly, I analyzed the problem by using BTVS to check whether I successfully sent packages into the air. And then, I used Ellisys (air sniffer) to trace and compare both packages sent by Windows UWP Namespaces and HCI commands. Finally, I found out the AD Type was wrong and fixed the problem. Now, not only my app can send/receive Bluetooth LE Extended Advertisement but also the sender is able to cut huge data into slides and broadcast to nearby devices.

1.Single String （Data < 255 Bytes）
1-1.
Sender ： Used Windows API first and successfully sent Bluetooth LE Extended Advertisement.
Receiver ： Used Windows API to catch Bluetooth LE Extended Advertisement and showed sending strings on screen.

1-2.
Sender ： Used hcitool to send Bluetooth LE Extended Advertisement.

1-3.
Sender ： Used hcitool to send Bluetooth LE Extended Advertisement
Receiver ： Used Windows API to catch Bluetooth LE Extended Advertisement and showed sending strings on screen.

1-4.
Sender ： Used hcitool to send Bluetooth LE Extended Advertisement
Receiver ： Used Windows API to catch Bluetooth LE Extended Advertisement and showed sending strings on screen and auto open html file through Chrome.

2.Multiple Strings（Data > 255 Bytes）
2-1.
Sender ： Used hcitool to send Bluetooth LE Extended Advertisement and used "fragment_preference"
Receiver ： Used Windows API to catch Bluetooth LE Extended Advertisement and collected all fragments. In the end, showed sending strings on screen and auto opened html file through Chrome.

->Unexpected

2-2.
Sender ： Used hcitool, cut all data into substrings and sent Bluetooth LE Extended Advertisement.

Receiver ： Used Windows API to catch Bluetooth LE Extended Advertisement, collected all substrings, rearranged them into correct order, and merge them into a big html file. In the end, showed sending strings on screen and auto opened html file through Chrome.

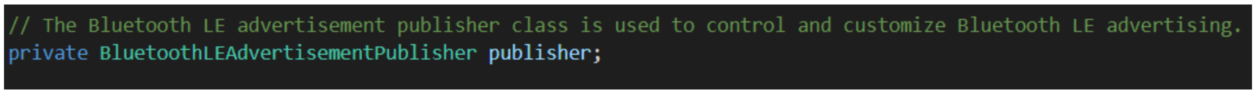
1-1.
Sender ： Used Windows API first and successfully sent Bluetooth LE Extended Advertisement.
Receiver ： Used Windows API to catch Bluetooth LE Extended Advertisement and showed sending strings on screen.

I saw the exist Bluetooth Advertisement API as below.
https://github.com/microsoft/Windows-universal-samples/tree/master/Samples/BluetoothAdvertisement
It could send/receive Bluetooth Advertisement well but not in Extended Mode.

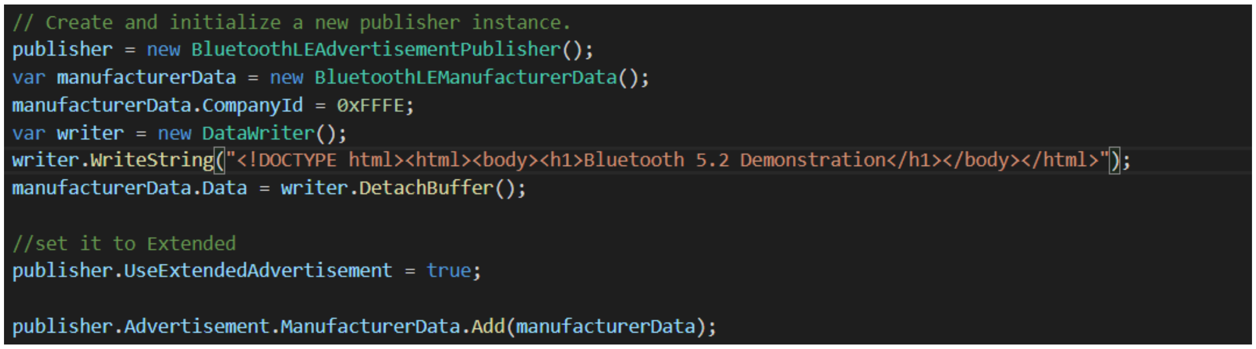
Then, I used this property to send LE Extended Adveritsement
https://docs.microsoft.com/en-us/uwp/api/windows.devices.bluetooth.advertisement.bluetoothleadvertisementwatcher.allowextendedadvertisements?view=winrt-19041

Below is part of my code:

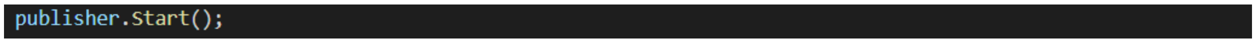
Sender:



```
// The Bluetooth LE advertisement publisher class is used to control and customize Bluetooth LE advertising.
private BluetoothLEAdvertisementPublisher publisher;
```



```
// Create and initialize a new publisher instance.
publisher = new BluetoothLEAdvertisementPublisher();
var manufacturerData = new BluetoothLEManufacturerData();
manufacturerData.CompanyId = 0xFFFE;
var writer = new DataWriter();
writer.WriteString("<!DOCTYPE html><html><body><h1>Bluetooth 5.2 Demonstration</h1></body></html>");
manufacturerData.Data = writer.DetachBuffer();

//set it to Extended
publisher.UseExtendedAdvertisement = true;

publisher.Advertisement.ManufacturerData.Add(manufacturerData);
```



```
publisher.Start();
```

Receiver:

```
private BluetoothLEAdvertisementWatcher watcher;
```

```
watcher = new BluetoothLEAdvertisementWatcher();

watcher.AllowExtendedAdvertisements = true;
var manufacturerData = new BluetoothLEManufacturerData();
manufacturerData.CompanyId = 0xFFFE;
watcher.AdvertisementFilter.Advertisement.ManufacturerData.Add(manufacturerData);
```

```
watcher.Start();
```

To let Receiver recognize advertising data sent from Sender, I set the company ID for the manufacturer data(0xFFFE). That is to say, as receiver starts listening to the advertisement, once it recognizes company ID as 0xFFEE, it will know that this advertising data is coming from my sender.

1-2.
Sender : Used hcitool to send Bluetooth LE Extended Advertisement

I used four HCI commands:
HCI_LE_Set_Extended_Advertising_Parameters
HCI_LE_Set_Extended_Advertising_Data
HCI_LE_Set_Extended_Advertising_Enable
HCI_LE_Set_Extended_Advertising_Disable

Bluetooth Core Specification:
https://www.bluetooth.com/specifications/bluetooth-core-specification/

Bluetooth HCI Interface Guide
https://software-dl.ti.com/simplelink/esd/simplelink_cc13x2_sdk/1.60.00.29_new/exports/docs/ble5stack/vendor_specific_guide/BLE_Vendor_Specific_HCI_Guide/hci_interface.html

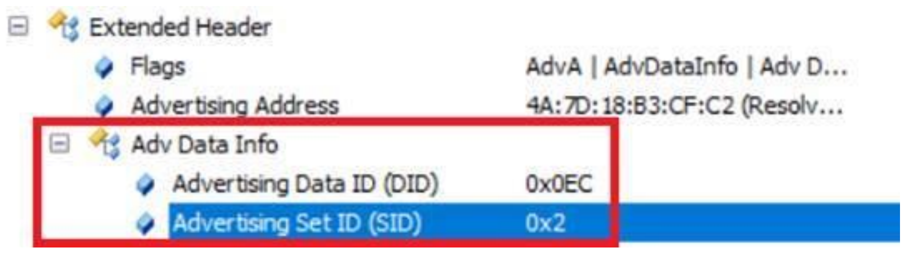
Thanks to Brandon's explanation.

1-2-1. HCI_LE_Set_Extended_Advertising_Parameters

.¥hcitool.exe -c 3BFC1C362019030100A00000F0000007010000000000000000007F0100010200
.¥hcitool.exe -c 3BFC1C36201903010020000020000001010000000000000000007F0100010200 -- shorten the interval and ch 37
.¥hcitool.exe -c 3BFC1C36201903010020000020000001000000000000000000007F0100010200 -- Use Public Device Address
.¥hcitool.exe -c 3BFC1C36201903010020000020000001010000000000000000007F0100020200 -- Secondary_Advertising_PHY: 2M
OGF: 0x08
OCF: 0x0036
[0GF 10~15][0CF 0~9] = 0x2036
Advertising_Handle: 0x03

Advertising_Event_Properties: (page1412) 0x0001 --- Connectable advertising
Primary_Advertising_Interval_Min: 0x0000A0 to 0x000020 (0xA0 * 0.625 = 100ms)
Primary_Advertising_Interval_Max: 0x0000F0 to 0x000020 (0xF0 * 0.625 = 150ms)
Primary_Advertising_Channel_Map: 0x07 --- use channel 37,38 and 39
Own_Address_Type: 0x01 --- Random Device Address
Peer_Address_Type: 0x00 ---- Public Device Address or Public Identity Address
Peer_Address: 0x000000000000
Advertising_Filter_Policy: 0x00 ------- No filter
Advertising_Tx_Power: 0x7F -------- no preference
Primary_Advertising_PHY: 0x01 ---- LE 1M
Secondary_Advertising_Max_Skip: 0x00 ----- AUX_ADV_IND shall be sent prior to the next advertising event.
Secondary_Advertising_PHY: 0x01 ---- LE 1M,
0x02 ------- LE 2M
Advertising_SID: 0x02 ----- value of the advertising SID subfield in the ADI field of the PDU
Scan_Request_Notification_Enable: 0x00 ----- Disabled

PS:
ADI: Adv Data Info
SID: Advertising Set ID : set by advertiser to distinguish between different advertising sets transmitted by this device.
DID: Advertising Data ID: set by advertiser to indicate to the scanner whether it can assume that the data contents in the AdvData are a cuplicated of the prevous AdvData sent in an earlier packet.

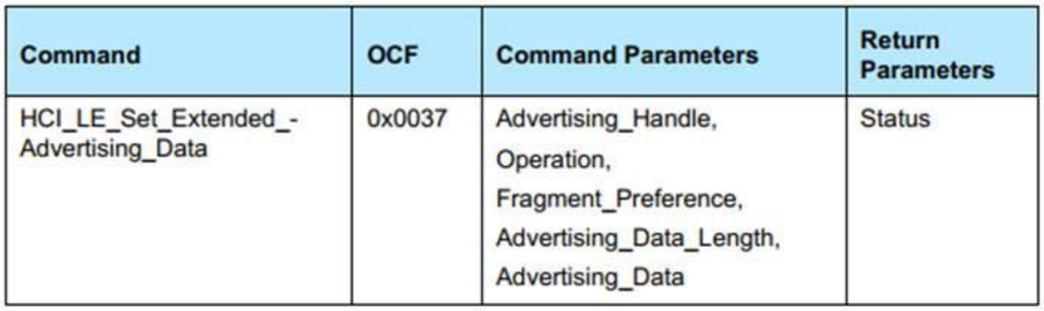

```
⊟ Extended Header
    Flags                          AdvA | AdvDataInfo | Adv D...
    Advertising Address            4A:7D:18:B3:CF:C2 (Resolv...
  ⊟ Adv Data Info
      Advertising Data ID (DID)    0x0EC
      Advertising Set ID (SID)     0x2
```

Command	OCF	Command Parameters	Return Parameters
HCI_LE_Set_-Extended_-Advertising_Parameters	0x0036	Advertising_Handle, Advertising_Event_Properties, Primary_Advertising_Interval_Min, Primary_Advertising_Interval_Max, Primary_Advertising_Channel_Map, Own_Address_Type, Peer_Address_Type, Peer_Address, Advertising_Filter_Policy, Advertising_Tx_Power, Primary_Advertising_PHY, Secondary_Advertising_Max_Skip, Secondary_Advertising_PHY, Advertising_SID, Scan_Request_Notification_Enable	Status, Selected_Tx-_Power

1-2-2. HCI_LE_Set_Extended_Advertising_Data

```
a..\hcitool.exe -c
3BFCFA3720F7030301F302011805030A18EDFE02011805030A18EDFE02011805030A18EDFE02011805030A18EDF
E02011805030A18EDFE02011805030A18EDFE02011805030A18EDFE02011805030A18EDFE02011805030A18EDFE
02011805030A18EDFE02011805030A18EDFE02011805030A18EDFE02011805030A18EDFE02011805030A18EDFE0
2011805030A18EDFE02011805030A18EDFE02011805030A18EDFE02011805030A18EDFE02011805030A18EDFE02
011805030A18EDFE02011805030A18EDFE02011805030A18EDFE02011805030A18EDFE02011805030A18EDFE020
11805030A18EDFE02011805030A18EDFE02011805030A18EDFE       ----- send 243(0xF3) bytes (9 x 27)
b..\hcitool.exe -c
3BFCFC3720F9030301F5F4A9626C7565746F6F74682E626C7565746F6F74682E626C7565746F6F74682E626C7565
746F6F74682E626C7565746F6F74682E626C7565746F6F74682E626C7565746F6F74682E626C7565746F6F74682E6
26C7565746F6F74682E626C7565746F6F74682E79A9626C7565746F6F74682E626C7565746F6F74682E626C75657
46F6F74682E626C7565746F6F74682E626C7565746F6F74682E626C7565746F6F74682E626C7565746F6F74682E62
6C7565746F6F74682E626C7565746F6F74682E626C7565746F6F74682E626C7565746F6F74682E626C7565746F6F7
4682EEE       ---- Send 245 bytes in one AD
```

OGF: 0x08
OCF: 0x0037
[0GF 10˜15][0CF 0˜9] = 0x2037
Advertising_Handle: 0x03
Operation: 0x03 Complete extended advertising data
Fragment_Preference: 0x01 not fragment or should minimize fragmentation
Advertising_Data_Length: 245 = 0xF5 --- The max data we can send without header but includes length and AD Type
Unknown AD Type 0xA9
10 bytes data pattern "626C7565746F6F74682E"



Command	OCF	Command Parameters	Return Parameters
HCI_LE_Set_Extended_-Advertising_Data	0x0037	Advertising_Handle, Operation, Fragment_Preference, Advertising_Data_Length, Advertising_Data	Status

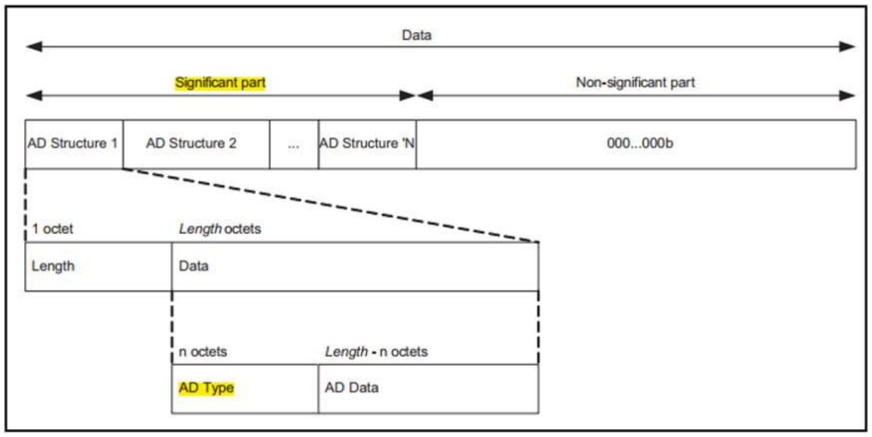


Figure 11.1: Advertising and Scan Response data format

AD type list : https://www.bluetooth.com/specifications/assigned-numbers/generic-access-profile/
0x01: <<flags>> ---- Tile uses this
0x16: <<Service Data>>
0xFF: <<Manufacturer Specific Data>>

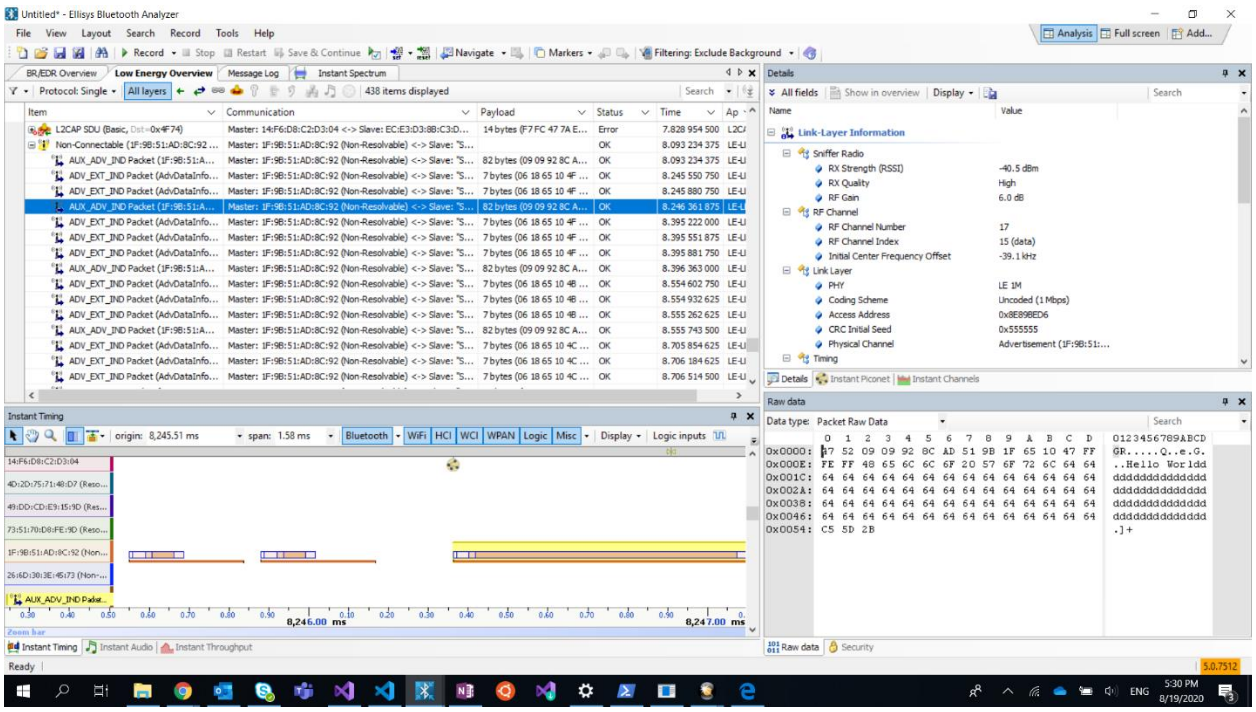
1-2-3. HCI_LE_Set_Extended_Advertising_Enable/Disable

a..\hcitool.exe -c 3BFC093920060101030000000

OGF : 0x08
OCF : 0x0039
[OGF 10~15][OCF 0~9]
0010 00 00 0011 1001 = 0x2039
Enable: 0x01
Number_of_Set: 0x01
Advertising_Handle[i]: 0x03
Duration[i]: 0x0000 ----- No advertising duration. Advertising to continue until the host disables it.
Max_Extended_Advertising_Events[i]: 0x00 ---- No Max number of advertising events.

1-3.

Sender ： Used hcitool to send Bluetooth LE Extended Advertisement
Receiver ： Used Windows API to catch Bluetooth LE Extended Advertisement and showed sending strings on screen.

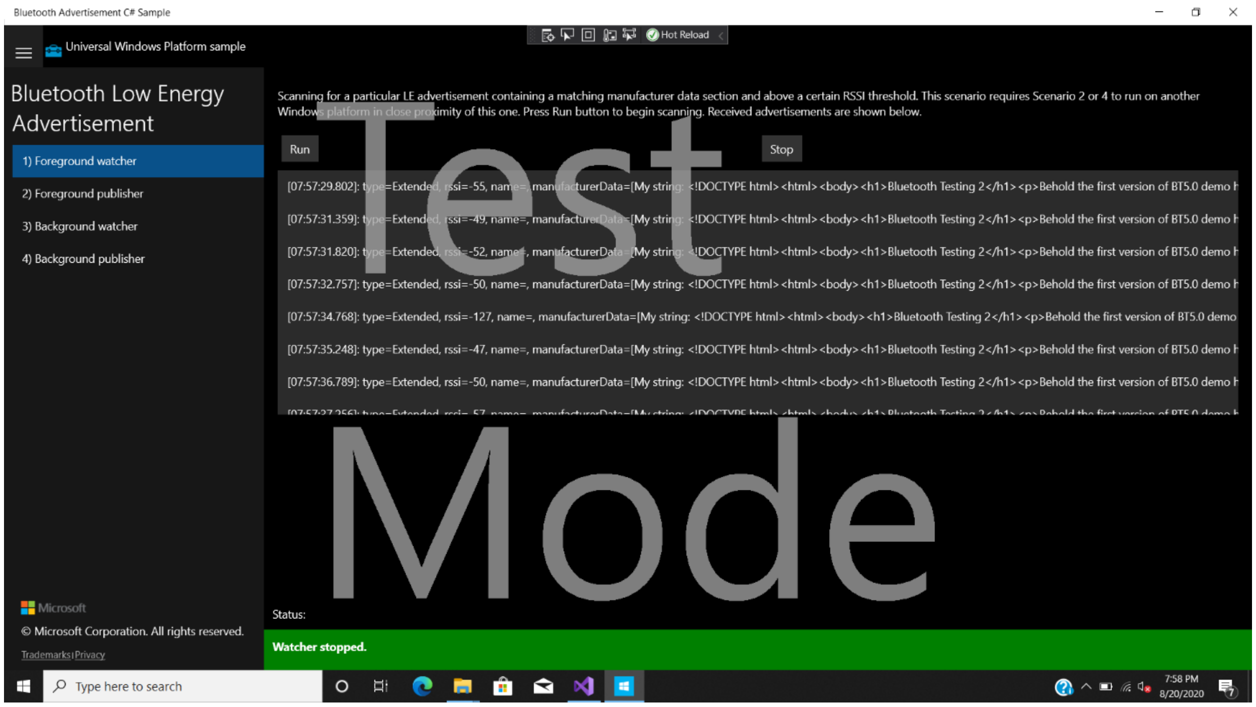

Untitled* - Ellisys Bluetooth Analyzer
File View Layout Search Record Tools Help
Record Stop Restart Save & Continue Navigate Markers Filtering: Exclude Background
Analysis Full screen Add...
BR/EDR Overview Low Energy Overview Message Log Instant Spectrum
Protocol: Single All layers 438 items displayed Search
Details All fields Show in overview Display Search
Instant Timing origin: 8,245.51 ms span: 1.58 ms Bluetooth WiFi HCI WCI WPAN Logic Misc Display Logic inputs
Instant Timing Instant Audio Instant Throughput
Raw data Security
Ready

Item	Communication	Payload	Status	Time	Ap
L2CAP SDU (Basic, Dst=0x4F74)	Master: 14:F6:D8:C2:D3:04 <-> Slave: EC:E3:D3:8B:C3:D...	14 bytes (F7 FC 47 7A E...	Error	7.828 954 500	L2C/
Non-Connectable (1F:9B:51:AD:8C:92 ...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...		OK	8.093 234 375	LE-LI
AUX_ADV_IND Packet (1F:9B:51:A...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...	82 bytes (09 09 92 8C A...	OK	8.093 234 375	LE-LI
ADV_EXT_IND Packet (AdvDataInfo...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...	7 bytes (06 18 65 10 4F ...	OK	8.245 550 750	LE-LI
ADV_EXT_IND Packet (AdvDataInfo...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...	7 bytes (06 18 65 10 4F ...	OK	8.245 880 750	LE-LI
AUX_ADV_IND Packet (1F:9B:51:A...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...	82 bytes (09 09 92 8C A...	OK	8.246 361 875	LE-LI
ADV_EXT_IND Packet (AdvDataInfo...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...	7 bytes (06 18 65 10 4F ...	OK	8.395 222 000	LE-LI
ADV_EXT_IND Packet (AdvDataInfo...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...	7 bytes (06 18 65 10 4F ...	OK	8.395 551 875	LE-LI
ADV_EXT_IND Packet (AdvDataInfo...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...	7 bytes (06 18 65 10 4F ...	OK	8.395 881 750	LE-LI
AUX_ADV_IND Packet (1F:9B:51:A...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...	82 bytes (09 09 92 8C A...	OK	8.396 363 000	LE-LI
ADV_EXT_IND Packet (AdvDataInfo...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...	7 bytes (06 18 65 10 4B ...	OK	8.554 602 750	LE-LI
ADV_EXT_IND Packet (AdvDataInfo...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...	7 bytes (06 18 65 10 4B ...	OK	8.554 932 625	LE-LI
ADV_EXT_IND Packet (AdvDataInfo...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...	7 bytes (06 18 65 10 4B ...	OK	8.555 262 625	LE-LI
AUX_ADV_IND Packet (1F:9B:51:A...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...	82 bytes (09 09 92 8C A...	OK	8.555 743 500	LE-LI
ADV_EXT_IND Packet (AdvDataInfo...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...	7 bytes (06 18 65 10 4C ...	OK	8.705 854 625	LE-LI
ADV_EXT_IND Packet (AdvDataInfo...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...	7 bytes (06 18 65 10 4C ...	OK	8.706 184 625	LE-LI
ADV_EXT_IND Packet (AdvDataInfo...	Master: 1F:9B:51:AD:8C:92 (Non-Resolvable) <-> Slave: "S...	7 bytes (06 18 65 10 4C ...	OK	8.706 514 500	LE-LI

Name	Value
Link-Layer Information	
Sniffer Radio	
RX Strength (RSSI)	-40.5 dBm
RX Quality	High
RF Gain	6.0 dB
RF Channel	
RF Channel Number	17
RF Channel Index	15 (data)
Initial Center Frequency Offset	-39.1 kHz
Link Layer	
PHY	LE 1M
Coding Scheme	Uncoded (1 Mbps)
Access Address	0x8E89BED6
CRC Initial Seed	0x555555
Physical Channel	Advertisement (1F:9B:51:...
Timing	

Data type: Packet Raw Data

```
         0  1  2  3  4  5  6  7  8  9  A  B  C  D   0123456789ABCD
0x0000: 47 52 09 09 92 8C AD 51 9B 1F 65 10 47 FF   GR.....Q..e.G.
0x000E: FE FF 48 65 6C 6C 6F 20 57 6F 72 6C 64 64   ..Hello Worldd
0x001C: 64 64 64 64 64 64 64 64 64 64 64 64 64 64   dddddddddddddd
0x002A: 64 64 64 64 64 64 64 64 64 64 64 64 64 64   dddddddddddddd
0x0038: 64 64 64 64 64 64 64 64 64 64 64 64 64 64   dddddddddddddd
0x0046: 64 64 64 64 64 64 64 64 64 64 64 64 64 64   dddddddddddddd
0x0054: C5 5D 2B                                    .]+
```

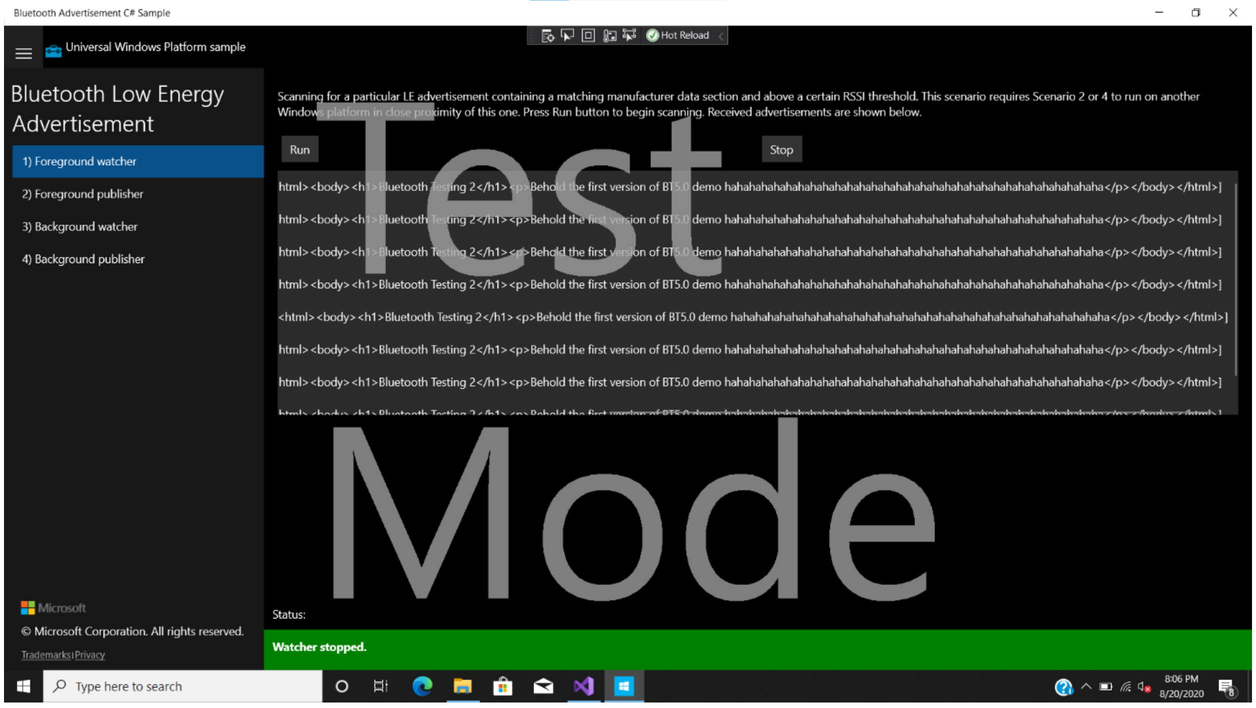


Scanning for a particular LE advertisement containing a matching manufacturer data section and above a certain RSSI threshold. This scenario requires Scenario 2 or 4 to run on another Windows platform in close proximity of this one. Press Run button to begin scanning. Received advertisements are shown below.

```
[07:57:29.802]: type=Extended, rssi=-55, name=, manufacturerData=[My string: <!DOCTYPE html> <html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo h
[07:57:31.359]: type=Extended, rssi=-49, name=, manufacturerData=[My string: <!DOCTYPE html> <html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo h
[07:57:31.820]: type=Extended, rssi=-52, name=, manufacturerData=[My string: <!DOCTYPE html> <html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo h
[07:57:32.757]: type=Extended, rssi=-50, name=, manufacturerData=[My string: <!DOCTYPE html> <html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo h
[07:57:34.768]: type=Extended, rssi=-127, name=, manufacturerData=[My string: <!DOCTYPE html> <html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo
[07:57:35.248]: type=Extended, rssi=-47, name=, manufacturerData=[My string: <!DOCTYPE html> <html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo h
[07:57:36.789]: type=Extended, rssi=-50, name=, manufacturerData=[My string: <!DOCTYPE html> <html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo h
[07:57:37.256]: type=Extended, rssi=-57, name=, manufacturerData=[My string: <!DOCTYPE html> <html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo h
```

Status:

Watcher stopped.



Scanning for a particular LE advertisement containing a matching manufacturer data section and above a certain RSSI threshold. This scenario requires Scenario 2 or 4 to run on another Windows platform in close proximity of this one. Press Run button to begin scanning. Received advertisements are shown below.

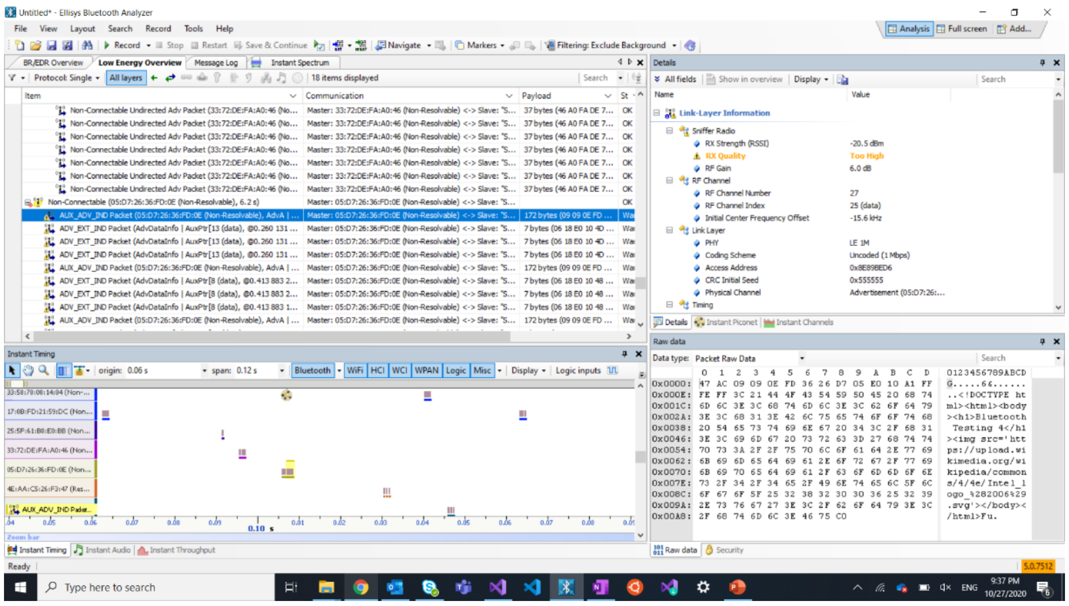
```
html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo hahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahaha</p> </body> </html>]
html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo hahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahaha</p> </body> </html>]
html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo hahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahaha</p> </body> </html>]
html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo hahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahaha</p> </body> </html>]
<html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo hahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahaha</p> </body> </html>]
html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo hahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahaha</p> </body> </html>]
html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo hahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahaha</p> </body> </html>]
html> <body> <h1>Bluetooth Testing 2</h1> <p>Behold the first version of BT5.0 demo hahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahahaha</p> </body> </html>]
```

Status:

Watcher stopped.

1-4.
Sender : Used hcitool to send Bluetooth LE Extended Advertisement
Receiver : Used Windows API to catch Bluetooth LE Extended Advertisement and showed sending strings on screen and auto open html file through Chrome.

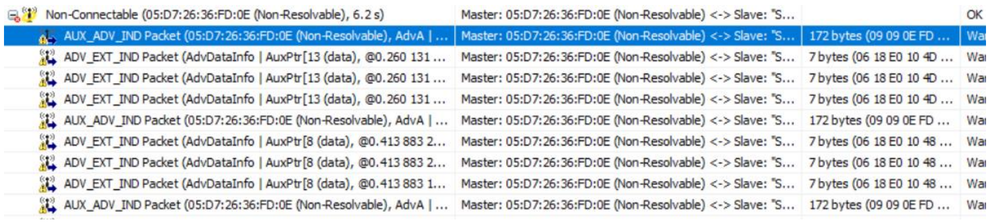
Microsoft API Sender (see through Ellisys)
Device : Small PC



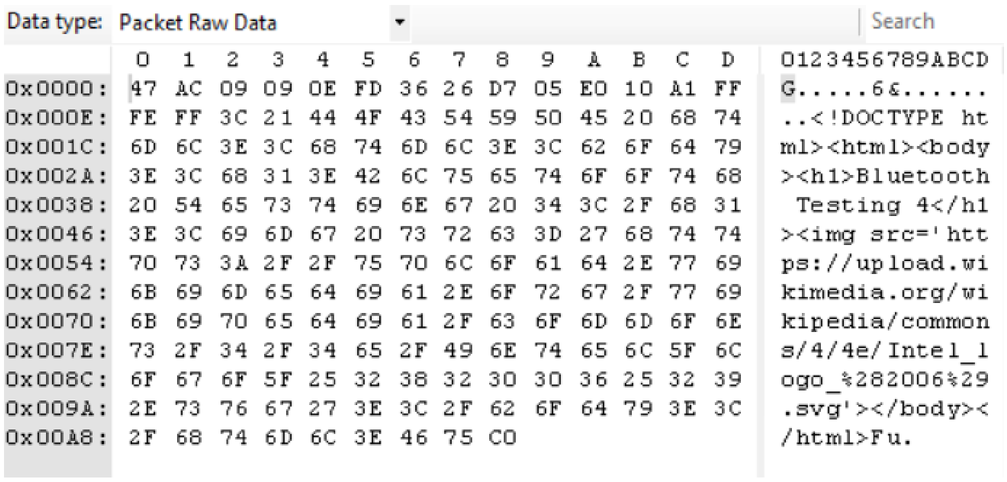
```
Item                                                                        Communication                                                          Payload                      St
Non-Connectable Undirected Adv Packet (33:72:DE:FA:A0:46 (No...             Master: 33:72:DE:FA:A0:46 (Non-Resolvable) <-> Slave: "S...            37 bytes (46 A0 FA DE 7...   OK
Non-Connectable Undirected Adv Packet (33:72:DE:FA:A0:46 (No...             Master: 33:72:DE:FA:A0:46 (Non-Resolvable) <-> Slave: "S...            37 bytes (46 A0 FA DE 7...   OK
Non-Connectable Undirected Adv Packet (33:72:DE:FA:A0:46 (No...             Master: 33:72:DE:FA:A0:46 (Non-Resolvable) <-> Slave: "S...            37 bytes (46 A0 FA DE 7...   OK
Non-Connectable Undirected Adv Packet (33:72:DE:FA:A0:46 (No...             Master: 33:72:DE:FA:A0:46 (Non-Resolvable) <-> Slave: "S...            37 bytes (46 A0 FA DE 7...   OK
Non-Connectable Undirected Adv Packet (33:72:DE:FA:A0:46 (No...             Master: 33:72:DE:FA:A0:46 (Non-Resolvable) <-> Slave: "S...            37 bytes (46 A0 FA DE 7...   OK
Non-Connectable Undirected Adv Packet (33:72:DE:FA:A0:46 (No...             Master: 33:72:DE:FA:A0:46 (Non-Resolvable) <-> Slave: "S...            37 bytes (46 A0 FA DE 7...   OK
Non-Connectable Undirected Adv Packet (33:72:DE:FA:A0:46 (No...             Master: 33:72:DE:FA:A0:46 (Non-Resolvable) <-> Slave: "S...            37 bytes (46 A0 FA DE 7...   OK
Non-Connectable (05:D7:26:36:FD:0E (Non-Resolvable), 6.2 s)                 Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...                                         OK
  AUX_ADV_IND Packet (05:D7:26:36:FD:0E (Non-Resolvable), AdvA | ...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            172 bytes (09 09 0E FD ...   Wa
  ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[13 (data), @0.260 131 ...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            7 bytes (06 18 E0 10 4D ...  Wa
  ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[13 (data), @0.260 131 ...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            7 bytes (06 18 E0 10 4D ...  Wa
  ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[13 (data), @0.260 131 ...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            7 bytes (06 18 E0 10 4D ...  Wa
  AUX_ADV_IND Packet (05:D7:26:36:FD:0E (Non-Resolvable), AdvA | ...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            172 bytes (09 09 0E FD ...   Wa
  ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[8 (data), @0.413 883 2...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            7 bytes (06 18 E0 10 48 ...  Wa
  ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[8 (data), @0.413 883 2...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            7 bytes (06 18 E0 10 48 ...  Wa
  ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[8 (data), @0.413 883 1...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            7 bytes (06 18 E0 10 48 ...  Wa
  AUX_ADV_IND Packet (05:D7:26:36:FD:0E (Non-Resolvable), AdvA | ...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            172 bytes (09 09 0E FD ...   Wa
```

```
Name                                      Value
Link-Layer Information
  Sniffer Radio
    RX Strength (RSSI)                    -20.5 dBm
    RX Quality                            Too High
    RF Gain                               6.0 dB
  RF Channel
    RF Channel Number                     27
    RF Channel Index                      25 (data)
    Initial Center Frequency Offset       -15.6 kHz
  Link Layer
    PHY                                   LE 1M
    Coding Scheme                         Uncoded (1 Mbps)
    Access Address                        0x8E89BED6
    CRC Initial Seed                      0x555555
    Physical Channel                      Advertisement (05:D7:26:...
  Timing
```

```
Data type: Packet Raw Data

         0  1  2  3  4  5  6  7  8  9  A  B  C  D    0123456789ABCD
0x0000: 47 AC 09 09 0E FD 36 26 D7 05 E0 10 A1 FF    G.....6&......
0x000E: FE FF 3C 21 44 4F 43 54 59 50 45 20 68 74    ..<!DOCTYPE ht
0x001C: 6D 6C 3E 3C 68 74 6D 6C 3E 3C 62 6F 64 79    ml><html><body
0x002A: 3E 3C 68 31 3E 42 6C 75 65 74 6F 6F 74 68    ><h1>Bluetooth
0x0038: 20 54 65 73 74 69 6E 67 20 34 3C 2F 68 31     Testing 4</h1
0x0046: 3E 3C 69 6D 67 20 73 72 63 3D 27 68 74 74    ><img src='htt
0x0054: 70 73 3A 2F 2F 75 70 6C 6F 61 64 2E 77 69    ps://upload.wi
0x0062: 6B 69 6D 65 64 69 61 2E 6F 72 67 2F 77 69    kimedia.org/wi
0x0070: 6B 69 70 65 64 69 61 2F 63 6F 6D 6D 6F 6E    kipedia/common
0x007E: 73 2F 34 2F 34 65 2F 49 6E 74 65 6C 5F 6C    s/4/4e/Intel_l
0x008C: 6F 67 6F 5F 25 32 38 32 30 30 36 25 32 39    ogo_%282006%29
0x009A: 2E 73 76 67 27 3E 3C 2F 62 6F 64 79 3E 3C    .svg'></body><
0x00A8: 2F 68 74 6D 6C 3E 46 75 C0                   /html>Fu.
```

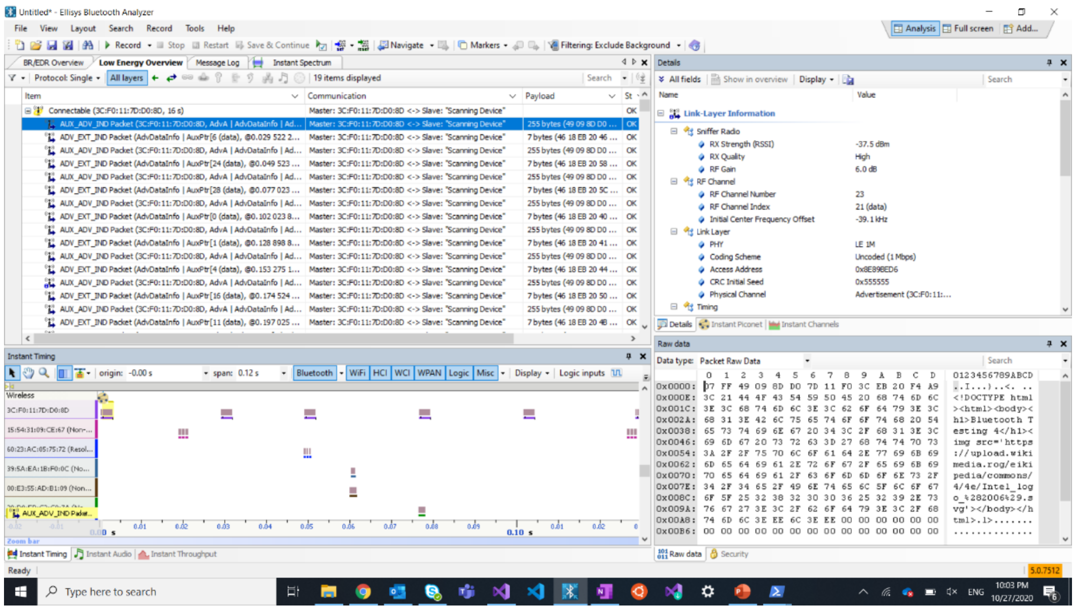


```
Non-Connectable (05:D7:26:36:FD:0E (Non-Resolvable), 6.2 s)                 Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...                                         OK
  AUX_ADV_IND Packet (05:D7:26:36:FD:0E (Non-Resolvable), AdvA | ...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            172 bytes (09 09 0E FD ...   Wa
  ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[13 (data), @0.260 131 ...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            7 bytes (06 18 E0 10 4D ...  Wa
  ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[13 (data), @0.260 131 ...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            7 bytes (06 18 E0 10 4D ...  Wa
  ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[13 (data), @0.260 131 ...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            7 bytes (06 18 E0 10 4D ...  Wa
  AUX_ADV_IND Packet (05:D7:26:36:FD:0E (Non-Resolvable), AdvA | ...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            172 bytes (09 09 0E FD ...   Wa
  ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[8 (data), @0.413 883 2...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            7 bytes (06 18 E0 10 48 ...  Wa
  ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[8 (data), @0.413 883 2...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            7 bytes (06 18 E0 10 48 ...  Wa
  ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[8 (data), @0.413 883 1...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            7 bytes (06 18 E0 10 48 ...  Wa
  AUX_ADV_IND Packet (05:D7:26:36:FD:0E (Non-Resolvable), AdvA | ...        Master: 05:D7:26:36:FD:0E (Non-Resolvable) <-> Slave: "S...            172 bytes (09 09 0E FD ...   Wa
```



```
Data type: Packet Raw Data                                          Search

          0  1  2  3  4  5  6  7  8  9  A  B  C  D    0123456789ABCD
0x0000:  47 AC 09 09 0E FD 36 26 D7 05 E0 10 A1 FF    G.....6&......
0x000E:  FE FF 3C 21 44 4F 43 54 59 50 45 20 68 74    ..<!DOCTYPE ht
0x001C:  6D 6C 3E 3C 68 74 6D 6C 3E 3C 62 6F 64 79    ml><html><body
0x002A:  3E 3C 68 31 3E 42 6C 75 65 74 6F 6F 74 68    ><h1>Bluetooth
0x0038:  20 54 65 73 74 69 6E 67 20 34 3C 2F 68 31     Testing 4</h1
0x0046:  3E 3C 69 6D 67 20 73 72 63 3D 27 68 74 74    ><img src='htt
0x0054:  70 73 3A 2F 2F 75 70 6C 6F 61 64 2E 77 69    ps://upload.wi
0x0062:  6B 69 6D 65 64 69 61 2E 6F 72 67 2F 77 69    kimedia.org/wi
0x0070:  6B 69 70 65 64 69 61 2F 63 6F 6D 6D 6F 6E    kipedia/common
0x007E:  73 2F 34 2F 34 65 2F 49 6E 74 65 6C 5F 6C    s/4/4e/Intel_l
0x008C:  6F 67 6F 5F 25 32 38 32 30 30 36 25 32 39    ogo_%282006%29
0x009A:  2E 73 76 67 27 3E 3C 2F 62 6F 64 79 3E 3C    .svg'></body><
0x00A8:  2F 68 74 6D 6C 3E 46 75 C0                   /html>Fu.
```

HCItool Sender (see through Ellisys)
Device : Big PC

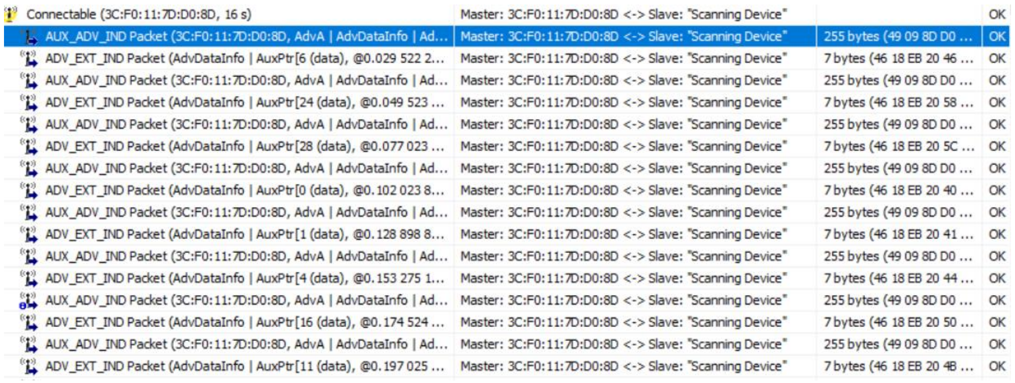


Details

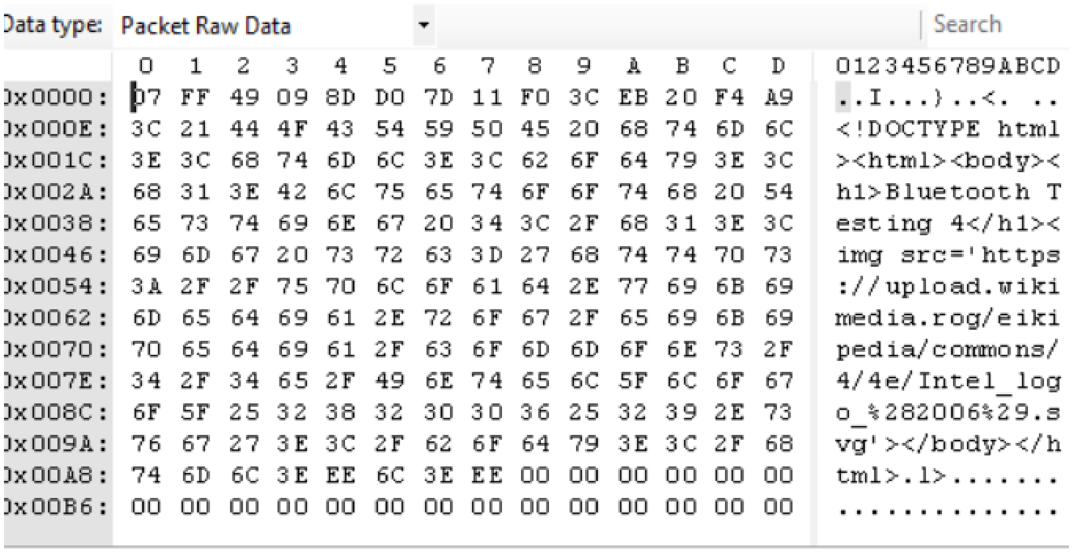
Name	Value
Link-Layer Information	
Sniffer Radio	
RX Strength (RSSI)	-37.5 dBm
RX Quality	High
RF Gain	6.0 dB
RF Channel	
RF Channel Number	23
RF Channel Index	21 (data)
Initial Center Frequency Offset	-39.1 kHz
Link Layer	
PHY	LE 1M
Coding Scheme	Uncoded (1 Mbps)
Access Address	0x8E89BED6
CRC Initial Seed	0x555555
Physical Channel	Advertisement (3C:F0:11:...
Timing	

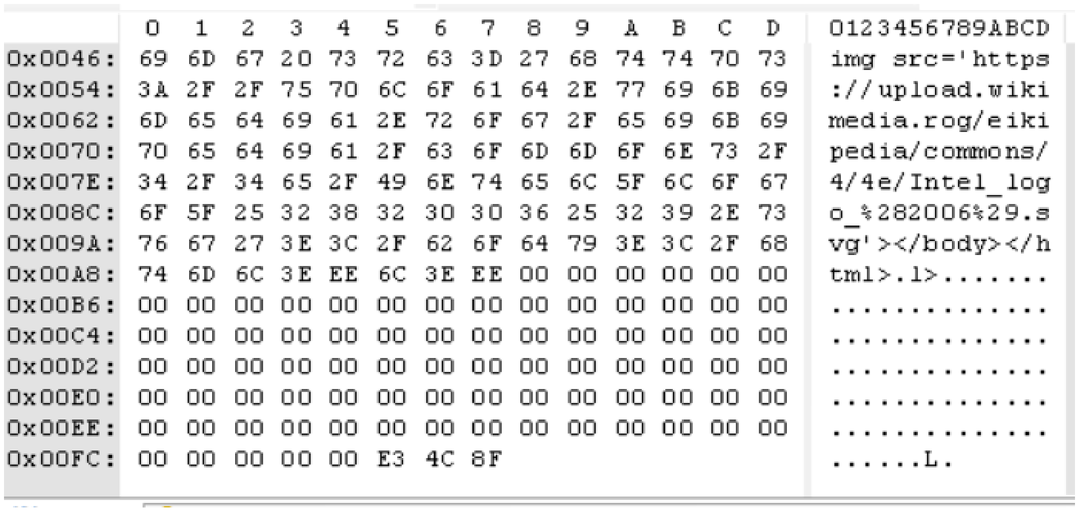
Raw data — Data type: Packet Raw Data

```
          0  1  2  3  4  5  6  7  8  9  A  B  C  D   0123456789ABCD
0x0000:  07 FF 49 09 8D D0 7D 11 F0 3C EB 20 F4 A9   ..I...}..<. ..
0x000E:  3C 21 44 4F 43 54 59 50 45 20 68 74 6D 6C   <!DOCTYPE html
0x001C:  3E 3C 68 74 6D 6C 3E 3C 62 6F 64 79 3E 3C   ><html><body><
0x002A:  68 31 3E 42 6C 75 65 74 6F 6F 74 68 20 54   h1>Bluetooth T
0x0038:  65 73 74 69 6E 67 20 34 3C 2F 68 31 3E 3C   esting 4</h1><
0x0046:  69 6D 67 20 73 72 63 3D 27 68 74 74 70 73   img src='https
0x0054:  3A 2F 2F 75 70 6C 6F 61 64 2E 77 69 6B 69   ://upload.wiki
0x0062:  6D 65 64 69 61 2E 72 6F 67 2F 65 69 6B 69   media.rog/eiki
0x0070:  70 65 64 69 61 2F 63 6F 6D 6D 6F 6E 73 2F   pedia/commons/
0x007E:  34 2F 34 65 2F 49 6E 74 65 6C 5F 6C 6F 67   4/4e/Intel_log
0x008C:  6F 5F 25 32 38 32 30 30 36 25 32 39 2E 73   o_%282006%29.s
0x009A:  76 67 27 3E 3C 2F 62 6F 64 79 3E 3C 2F 68   vg'></body></h
0x00A8:  74 6D 6C 3E EE 6C 3E EE 00 00 00 00 00 00   tml>.l>.......
0x00B6:  00 00 00 00 00 00 00 00 00 00 00 00 00 00   ..............
```



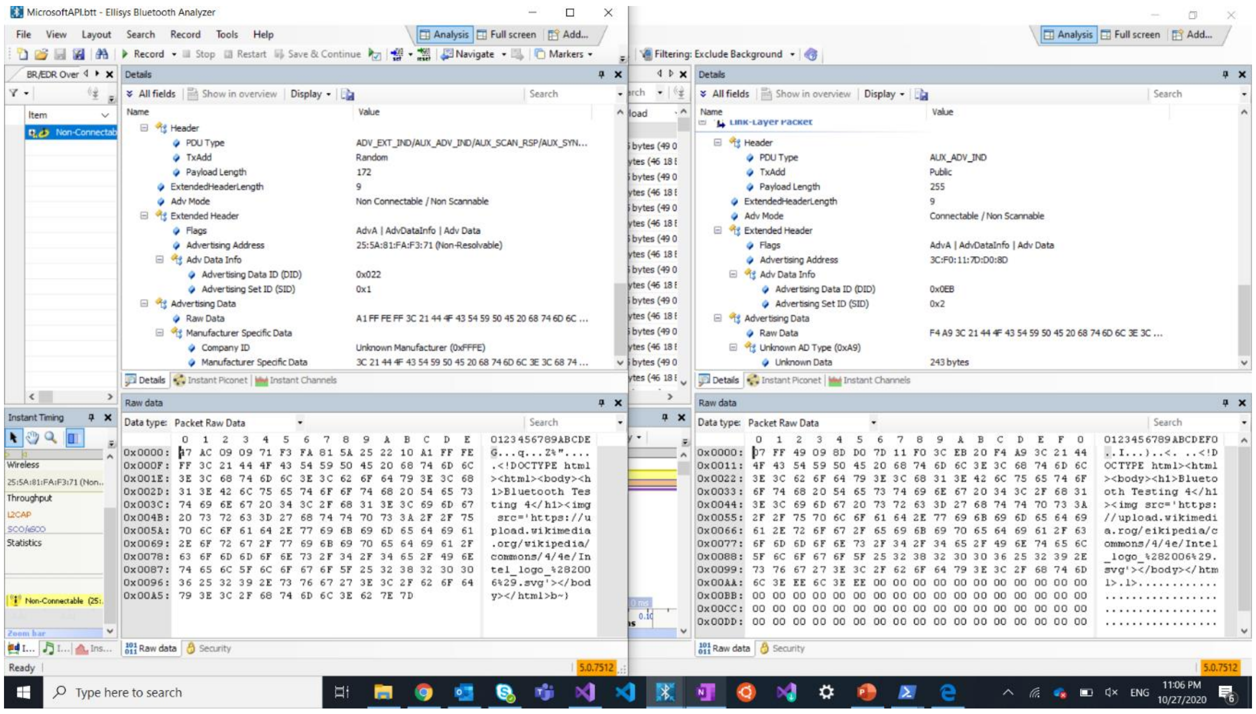
Item	Communication	Payload	St
Connectable (3C:F0:11:7D:D0:8D, 16 s)	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"		OK
AUX_ADV_IND Packet (3C:F0:11:7D:D0:8D, AdvA | AdvDataInfo | Ad...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	255 bytes (49 09 8D D0 ...	OK
ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[6 (data), @0.029 522 2...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	7 bytes (46 18 EB 20 46 ...	OK
AUX_ADV_IND Packet (3C:F0:11:7D:D0:8D, AdvA | AdvDataInfo | Ad...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	255 bytes (49 09 8D D0 ...	OK
ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[24 (data), @0.049 523 ...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	7 bytes (46 18 EB 20 58 ...	OK
AUX_ADV_IND Packet (3C:F0:11:7D:D0:8D, AdvA | AdvDataInfo | Ad...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	255 bytes (49 09 8D D0 ...	OK
ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[28 (data), @0.077 023 ...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	7 bytes (46 18 EB 20 5C ...	OK
AUX_ADV_IND Packet (3C:F0:11:7D:D0:8D, AdvA | AdvDataInfo | Ad...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	255 bytes (49 09 8D D0 ...	OK
ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[0 (data), @0.102 023 8...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	7 bytes (46 18 EB 20 40 ...	OK
AUX_ADV_IND Packet (3C:F0:11:7D:D0:8D, AdvA | AdvDataInfo | Ad...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	255 bytes (49 09 8D D0 ...	OK
ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[1 (data), @0.128 898 8...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	7 bytes (46 18 EB 20 41 ...	OK
AUX_ADV_IND Packet (3C:F0:11:7D:D0:8D, AdvA | AdvDataInfo | Ad...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	255 bytes (49 09 8D D0 ...	OK
ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[4 (data), @0.153 275 1...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	7 bytes (46 18 EB 20 44 ...	OK
AUX_ADV_IND Packet (3C:F0:11:7D:D0:8D, AdvA | AdvDataInfo | Ad...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	255 bytes (49 09 8D D0 ...	OK
ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[16 (data), @0.174 524 ...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	7 bytes (46 18 EB 20 50 ...	OK
AUX_ADV_IND Packet (3C:F0:11:7D:D0:8D, AdvA | AdvDataInfo | Ad...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	255 bytes (49 09 8D D0 ...	OK
ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[11 (data), @0.197 025 ...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	7 bytes (46 18 EB 20 4B ...	OK





```
         0  1  2  3  4  5  6  7  8  9  A  B  C  D   0123456789ABCD
0x0046: 69 6D 67 20 73 72 63 3D 27 68 74 74 70 73   img src='https
0x0054: 3A 2F 2F 75 70 6C 6F 61 64 2E 77 69 6B 69   ://upload.wiki
0x0062: 6D 65 64 69 61 2E 72 6F 67 2F 65 69 6B 69   media.rog/eiki
0x0070: 70 65 64 69 61 2F 63 6F 6D 6D 6F 6E 73 2F   pedia/commons/
0x007E: 34 2F 34 65 2F 49 6E 74 65 6C 5F 6C 6F 67   4/4e/Intel_log
0x008C: 6F 5F 25 32 38 32 30 30 36 25 32 39 2E 73   o_%282006%29.s
0x009A: 76 67 27 3E 3C 2F 62 6F 64 79 3E 3C 2F 68   vg'></body></h
0x00A8: 74 6D 6C 3E EE 6C 3E EE 00 00 00 00 00 00   tml>.l>.......
0x00B6: 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ..............
0x00C4: 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ..............
0x00D2: 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ..............
0x00E0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ..............
0x00EE: 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ..............
0x00FC: 00 00 00 00 00 E3 4C 8F                     ......L.
```

Compare the Two of Them :


MicrosoftAPI.btt - Ellisys Bluetooth Analyzer
File View Layout Search Record Tools Help
Analysis Full screen Add...
Record Stop Restart Save & Continue Navigate Markers
Filtering: Exclude Background
Details
All fields Show in overview Display Search
Details Instant Piconet Instant Channels
Raw data Security
Ready
5.0.7512
Type here to search
11:06 PM 10/27/2020

Name	Value
Header	
PDU Type	ADV_EXT_IND/AUX_ADV_IND/AUX_SCAN_RSP/AUX_SYN...
TxAdd	Random
Payload Length	172
ExtendedHeaderLength	9
Adv Mode	Non Connectable / Non Scannable
Extended Header	
Flags	AdvA | AdvDataInfo | Adv Data
Advertising Address	25:5A:81:FA:F3:71 (Non-Resolvable)
Adv Data Info	
Advertising Data ID (DID)	0x022
Advertising Set ID (SID)	0x1
Advertising Data	
Raw Data	A1 FF FE FF 3C 21 44 4F 43 54 59 50 45 20 68 74 6D 6C ...
Manufacturer Specific Data	
Company ID	Unknown Manufacturer (0xFFFE)
Manufacturer Specific Data	3C 21 44 4F 43 54 59 50 45 20 68 74 6D 6C 3E 3C 68 74 ...

Data type: Packet Raw Data

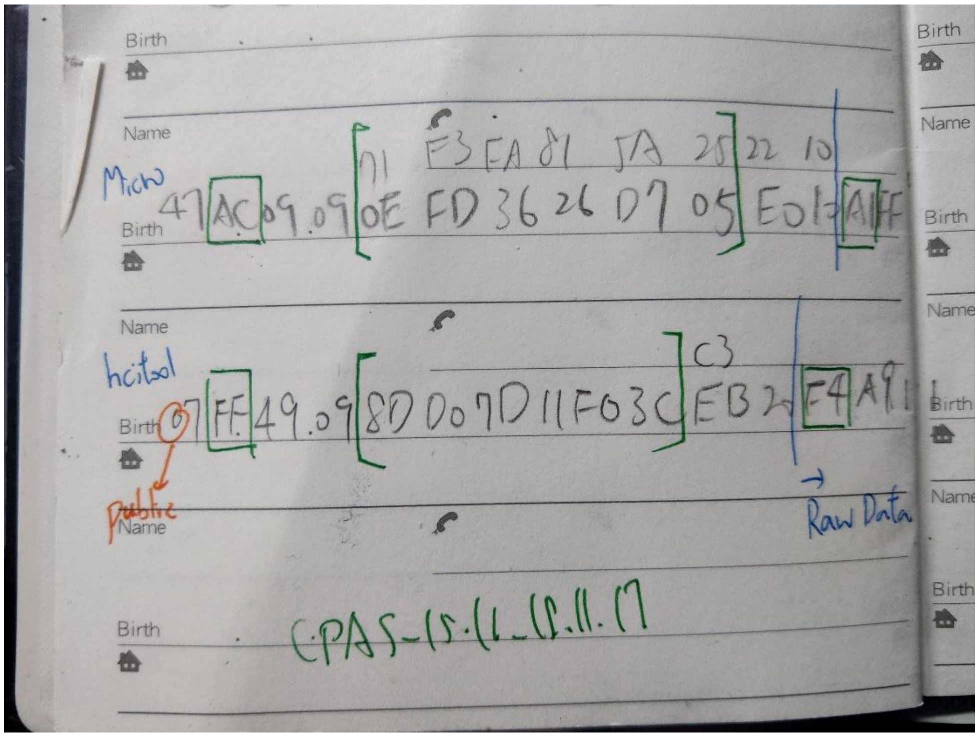
```
          0  1  2  3  4  5  6  7  8  9  A  B  C  D  E   0123456789ABCDE
0x0000:  47 AC 09 09 71 F3 FA 81 5A 25 22 10 A1 FF FE   G...q...Z%"....
0x000F:  FF 3C 21 44 4F 43 54 59 50 45 20 68 74 6D 6C   .<!DOCTYPE html
0x001E:  3E 3C 68 74 6D 6C 3E 3C 62 6F 64 79 3E 3C 68   ><html><body><h
0x002D:  31 3E 42 6C 75 65 74 6F 6F 74 68 20 54 65 73   1>Bluetooth Tes
0x003C:  74 69 6E 67 20 34 3C 2F 68 31 3E 3C 69 6D 67   ting 4</h1><img
0x004B:  20 73 72 63 3D 27 68 74 74 70 73 3A 2F 2F 75    src='https://u
0x005A:  70 6C 6F 61 64 2E 77 69 6B 69 6D 65 64 69 61   pload.wikimedia
0x0069:  2E 6F 72 67 2F 77 69 6B 69 70 65 64 69 61 2F   .org/wikipedia/
0x0078:  63 6F 6D 6D 6F 6E 73 2F 34 2F 34 65 2F 49 6E   commons/4/4e/In
0x0087:  74 65 6C 5F 6C 6F 67 6F 5F 25 32 38 32 30 30   tel_logo_%28200
0x0096:  36 25 32 39 2E 73 76 67 27 3E 3C 2F 62 6F 64   6%29.svg'></bod
0x00A5:  79 3E 3C 2F 68 74 6D 6C 3E 62 7E 7D            y></html>b~}
```

Link-Layer Packet

Name	Value
Header	
PDU Type	AUX_ADV_IND
TxAdd	Public
Payload Length	255
ExtendedHeaderLength	9
Adv Mode	Connectable / Non Scannable
Extended Header	
Flags	AdvA | AdvDataInfo | Adv Data
Advertising Address	3C:F0:11:7D:D0:8D
Adv Data Info	
Advertising Data ID (DID)	0x0EB
Advertising Set ID (SID)	0x2
Advertising Data	
Raw Data	F4 A9 3C 21 44 4F 43 54 59 50 45 20 68 74 6D 6C 3E 3C ...
Unknown AD Type (0xA9)	
Unknown Data	243 bytes

Data type: Packet Raw Data

```
          0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F  0   0123456789ABCDEF0
0x0000:  07 FF 49 09 8D D0 7D 11 F0 3C EB 20 F4 A9 3C 21 44   ..I...}..<. ..<!D
0x0011:  4F 43 54 59 50 45 20 68 74 6D 6C 3E 3C 68 74 6D 6C   OCTYPE html><html
0x0022:  3E 3C 62 6F 64 79 3E 3C 68 31 3E 42 6C 75 65 74 6F   ><body><h1>Blueto
0x0033:  6F 74 68 20 54 65 73 74 69 6E 67 20 34 3C 2F 68 31   oth Testing 4</h1
0x0044:  3E 3C 69 6D 67 20 73 72 63 3D 27 68 74 74 70 73 3A   ><img src='https:
0x0055:  2F 2F 75 70 6C 6F 61 64 2E 77 69 6B 69 6D 65 64 69   //upload.wikimedi
0x0066:  61 2E 72 6F 67 2F 65 69 6B 69 70 65 64 69 61 2F 63   a.rog/eikipedia/c
0x0077:  6F 6D 6D 6F 6E 73 2F 34 2F 34 65 2F 49 6E 74 65 6C   ommons/4/4e/Intel
0x0088:  5F 6C 6F 67 6F 5F 25 32 38 32 30 30 36 25 32 39 2E   _logo_%282006%29.
0x0099:  73 76 67 27 3E 3C 2F 62 6F 64 79 3E 3C 2F 68 74 6D   svg'></body></htm
0x00AA:  6C 3E EE 6C 3E EE 00 00 00 00 00 00 00 00 00 00 00   l>.l>............
0x00BB:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   .................
0x00CC:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   .................
0x00DD:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   .................
```


Micro
71 F3 FA 81 5A 25 22 10
47 AC 09.09 0E FD 36 26 D7 05 E0 1 A1 FF
hcitool
C3
07 FF 49.09 8D 00 7D 11 F0 3C EB 2 F4 A9
Public
Raw Data
CPAS-15.11_15.11.17

1.Change to Manufacturer Specific Data

Change AD(Advertising Data) Type from *A9* to *FF*

Advertising_Data: *Size: Advertising_Data_Length octets*

Value	Parameter Description
	Advertising data formatted as defined in [Vol 3] Part C, Section 11 Note: This parameter has a variable length.

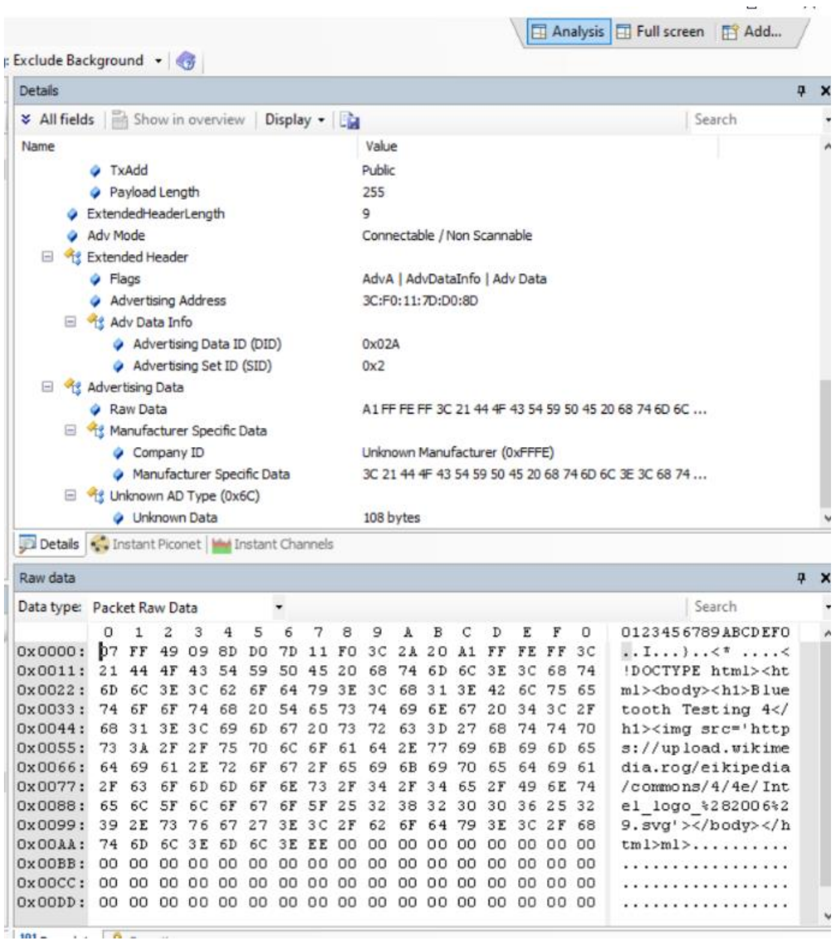
b. .\hcitool.exe -c

```
3BFCFC3720F9030301F5F4A9626C7565746F6F74682E626C7565746F6F74682E626C7565746F6F74682E626C7565
746F6F74682E626C7565746F6F74682E626C7565746F6F74682E626C7565746F6F74682E626C7565746F6F74682E
626C7565746F6F74682E626C7565746F6F74682E79A9626C7565746F6F74682E626C7565746F6F74682E626C7565
746F6F74682E626C7565746F6F74682E626C7565746F6F74682E626C7565746F6F74682E626C7565746F6F74682E
626C7565746F6F74682E626C7565746F6F74682E626C7565746F6F74682E626C7565746F6F74682E626C7565746F
6F74682EEE      ---- Send 245 bytes in one AD
```

OGF: 0x08
OCF: 0x0037
[OGF 10~15][OCF 0~9] = 0x2037
Advertising Handle: 0x03
Operation: 0x03 Complete extended advertising data
Fragment Preference: 0x01 not fragment or should minimize fragmentation
Advertising Data Length: 245 = 0xF5 ---- The max data we can send without header but includes length and AD Type
Unknown AD Type 0xA9
10 bytes data pattern "626C7565746F6F74682E"

2. Count Length Well

If didn't count length well



Name	Value
TxAdd	Public
Payload Length	255
ExtendedHeaderLength	9
Adv Mode	Connectable / Non Scannable
Extended Header	
Flags	AdvA | AdvDataInfo | Adv Data
Advertising Address	3C:F0:11:7D:D0:8D
Adv Data Info	
Advertising Data ID (DID)	0x02A
Advertising Set ID (SID)	0x2
Advertising Data	
Raw Data	A1 FF FE FF 3C 21 44 4F 43 54 59 50 45 20 68 74 6D 6C ...
Manufacturer Specific Data	
Company ID	Unknown Manufacturer (0xFFFE)
Manufacturer Specific Data	3C 21 44 4F 43 54 59 50 45 20 68 74 6D 6C 3E 3C 68 74 ...
Unknown AD Type (0x6C)	
Unknown Data	108 bytes

Raw data

Data type: Packet Raw Data

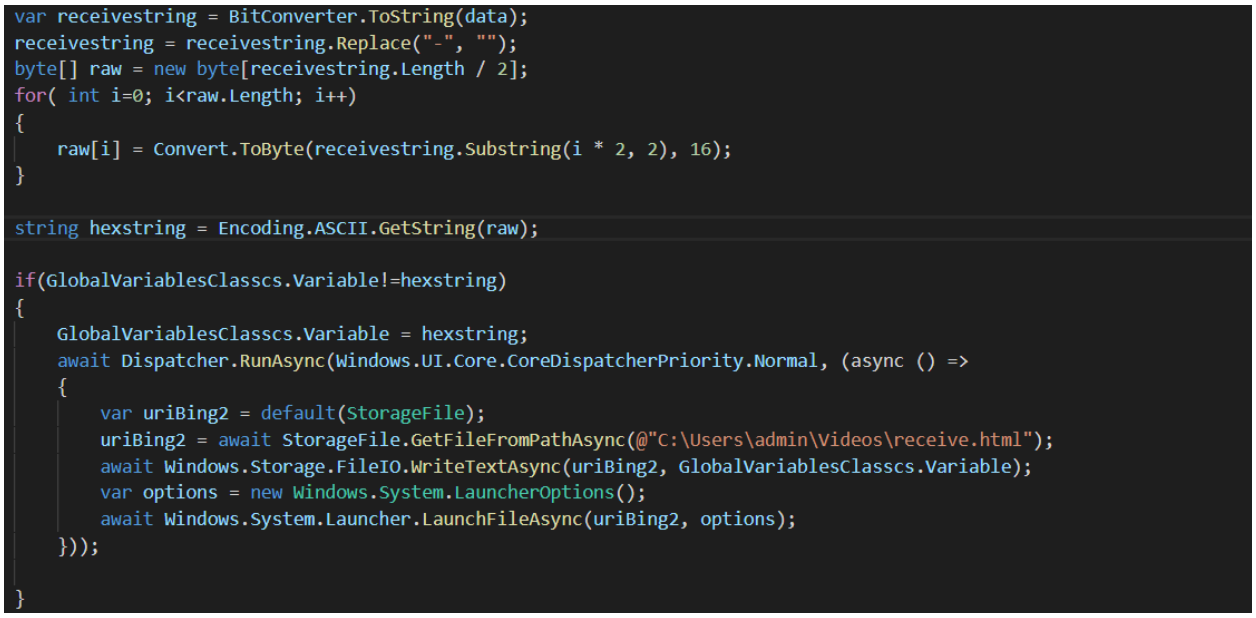
```
          0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F  0    0123456789ABCDEF0
0x0000:  07 FF 49 09 8D D0 7D 11 F0 3C 2A 20 A1 FF FE FF 3C    ..I...}..<* ....<
0x0011:  21 44 4F 43 54 59 50 45 20 68 74 6D 6C 3E 3C 68 74    !DOCTYPE html><ht
0x0022:  6D 6C 3E 3C 62 6F 64 79 3E 3C 68 31 3E 42 6C 75 65    ml><body><h1>Blue
0x0033:  74 6F 6F 74 68 20 54 65 73 74 69 6E 67 20 34 3C 2F    tooth Testing 4</
0x0044:  68 31 3E 3C 69 6D 67 20 73 72 63 3D 27 68 74 74 70    h1><img src='http
0x0055:  73 3A 2F 2F 75 70 6C 6F 61 64 2E 77 69 6B 69 6D 65    s://upload.wikime
0x0066:  64 69 61 2E 72 6F 67 2F 65 69 6B 69 70 65 64 69 61    dia.rog/eikipedia
0x0077:  2F 63 6F 6D 6D 6F 6E 73 2F 34 2F 34 65 2F 49 6E 74    /commons/4/4e/Int
0x0088:  65 6C 5F 6C 6F 67 6F 5F 25 32 38 32 30 30 36 25 32    el_logo_%282006%2
0x0099:  39 2E 73 76 67 27 3E 3C 2F 62 6F 64 79 3E 3C 2F 68    9.svg'></body></h
0x00AA:  74 6D 6C 3E 6D 6C 3E EE 00 00 00 00 00 00 00 00 00    tml>ml>..........
0x00BB:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00    .................
0x00CC:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00    .................
0x00DD:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00    .................
```

Auto Show HTML on Browser:

Because C# does not have Global Variable, I announce Global Variable by self-defined Class.

```
namespace BluetoothAdvertisement
{
    class GlobalVariablesClasscs
    {
        private static string v_Variable = "";
        public static string Variable
        {
            get { return v_Variable; }
            set { v_Variable = value; }
        }
    }
}
```

Use RUNASYNC to handle System Launch

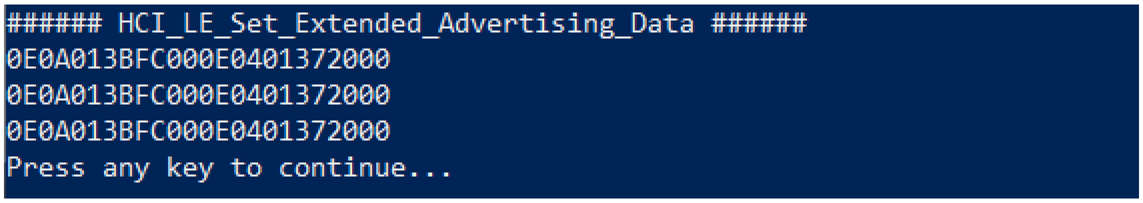

```
var receivestring = BitConverter.ToString(data);
receivestring = receivestring.Replace("-", "");
byte[] raw = new byte[receivestring.Length / 2];
for( int i=0; i<raw.Length; i++)
{
    raw[i] = Convert.ToByte(receivestring.Substring(i * 2, 2), 16);
}

string hexstring = Encoding.ASCII.GetString(raw);

if(GlobalVariablesClasscs.Variable!=hexstring)
{
    GlobalVariablesClasscs.Variable = hexstring;
    await Dispatcher.RunAsync(Windows.UI.Core.CoreDispatcherPriority.Normal, (async () =>
    {
        var uriBing2 = default(StorageFile);
        uriBing2 = await StorageFile.GetFileFromPathAsync(@"C:\Users\admin\Videos\receive.html");
        await Windows.Storage.FileIO.WriteTextAsync(uriBing2, GlobalVariablesClasscs.Variable);
        var options = new Windows.System.LauncherOptions();
        await Windows.System.Launcher.LaunchFileAsync(uriBing2, options);
    }));

}
```

2.Multiple Strings (Data > 255 Bytes)

2-1.
Sender : Used hcitool to send Bluetooth LE Extended Advertisement and used "fragment_preference"
Receiver : Used Windows API to catch Bluetooth LE Extended Advertisement and collected all fragments. In the end, showed sending strings on screen and auto opened html file through Chrome.

->Unexpected
After Continuing Testing
To send file fragmented
-> Set_Parameters
-> Enable
......Pause........
-> Disable
-> Set_Data
-> Disable
-> Enable
-> Disable

Key Make Me Find Out the Answer

1. 

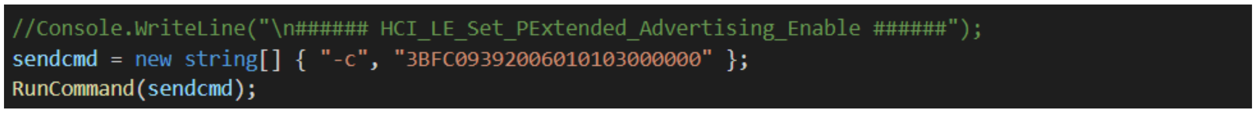
```
###### HCI_LE_Set_Extended_Advertising_Data ######
0E0A013BFC000E0401372000
0E0A013BFC000E0401372000
0E0A013BFC000E0401372000
Press any key to continue...
```

   This means correct.

   If the last three digits is 042, then it’s wrong,.

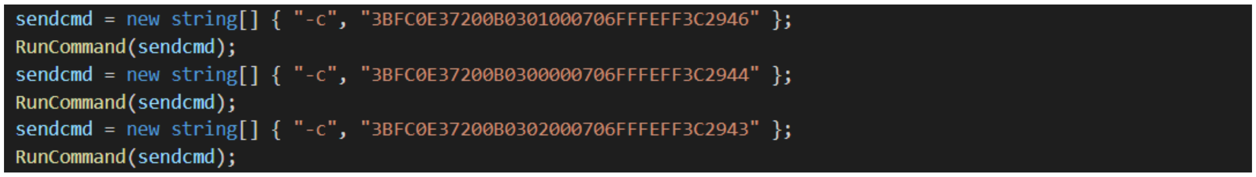
2. Pause Every Command

3. Remember ench data command need to “RunCommand”!

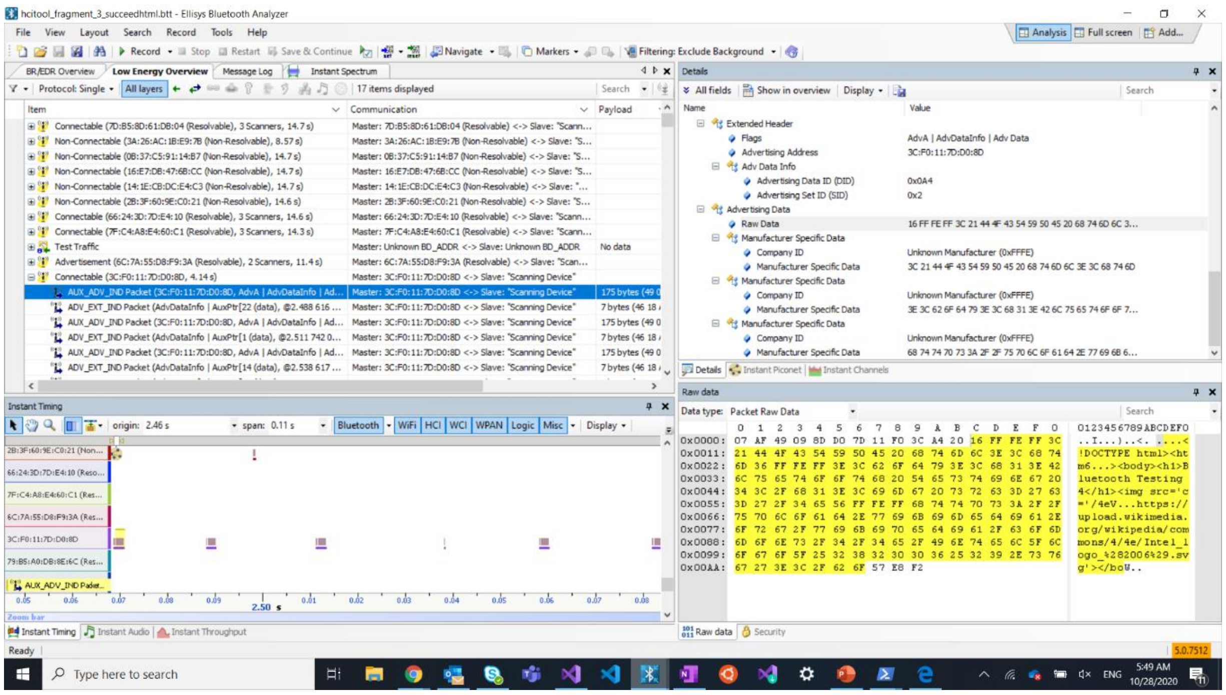


```
//Console.WriteLine("\n###### HCI_LE_Set_PExtended_Advertising_Enable ######");
sendcmd = new string[] { "-c", "3BFC093920060101030000000" };
RunCommand(sendcmd);
```

Result:



```
sendcmd = new string[] { "-c", "3BFC0E37200B0301000706FFFEFF3C2946" };
RunCommand(sendcmd);
sendcmd = new string[] { "-c", "3BFC0E37200B0300000706FFFEFF3C2944" };
RunCommand(sendcmd);
sendcmd = new string[] { "-c", "3BFC0E37200B0302000706FFFEFF3C2943" };
RunCommand(sendcmd);
```



hcitool_fragment_3_succeedhtml.btt - Ellisys Bluetooth Analyzer

Low Energy Overview — 17 items displayed

Item	Communication	Payload
Connectable (7D:B5:8D:61:DB:04 (Resolvable), 3 Scanners, 14.7 s)	Master: 7D:B5:8D:61:DB:04 (Resolvable) <-> Slave: "Scann...	
Non-Connectable (3A:26:AC:1B:E9:7B (Non-Resolvable), 8.57 s)	Master: 3A:26:AC:1B:E9:7B (Non-Resolvable) <-> Slave: "S...	
Non-Connectable (0B:37:C5:91:14:B7 (Non-Resolvable), 14.7 s)	Master: 0B:37:C5:91:14:B7 (Non-Resolvable) <-> Slave: "S...	
Non-Connectable (16:E7:DB:47:6B:CC (Non-Resolvable), 14.7 s)	Master: 16:E7:DB:47:6B:CC (Non-Resolvable) <-> Slave: "S...	
Non-Connectable (14:1E:CB:DC:E4:C3 (Non-Resolvable), 14.7 s)	Master: 14:1E:CB:DC:E4:C3 (Non-Resolvable) <-> Slave: "...	
Non-Connectable (2B:3F:60:9E:C0:21 (Non-Resolvable), 14.6 s)	Master: 2B:3F:60:9E:C0:21 (Non-Resolvable) <-> Slave: "S...	
Connectable (66:24:3D:7D:E4:10 (Resolvable), 3 Scanners, 14.6 s)	Master: 66:24:3D:7D:E4:10 (Resolvable) <-> Slave: "Scann...	
Connectable (7F:C4:A8:E4:60:C1 (Resolvable), 3 Scanners, 14.3 s)	Master: 7F:C4:A8:E4:60:C1 (Resolvable) <-> Slave: "Scann...	
Test Traffic	Master: Unknown BD_ADDR <-> Slave: Unknown BD_ADDR	No data
Advertisement (6C:7A:55:D8:F9:3A (Resolvable), 2 Scanners, 11.4 s)	Master: 6C:7A:55:D8:F9:3A (Resolvable) <-> Slave: "Scan...	
Connectable (3C:F0:11:7D:D0:8D, 4.14 s)	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	
AUX_ADV_IND Packet (3C:F0:11:7D:D0:8D, AdvA | AdvDataInfo | Ad...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	175 bytes (49 0
ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[22 (data), @2.488 616 ...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	7 bytes (46 18
AUX_ADV_IND Packet (3C:F0:11:7D:D0:8D, AdvA | AdvDataInfo | Ad...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	175 bytes (49 0
ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[1 (data), @2.511 742 0...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	7 bytes (46 18
AUX_ADV_IND Packet (3C:F0:11:7D:D0:8D, AdvA | AdvDataInfo | Ad...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	175 bytes (49 0
ADV_EXT_IND Packet (AdvDataInfo | AuxPtr[14 (data), @2.538 617 ...	Master: 3C:F0:11:7D:D0:8D <-> Slave: "Scanning Device"	7 bytes (46 18

Details

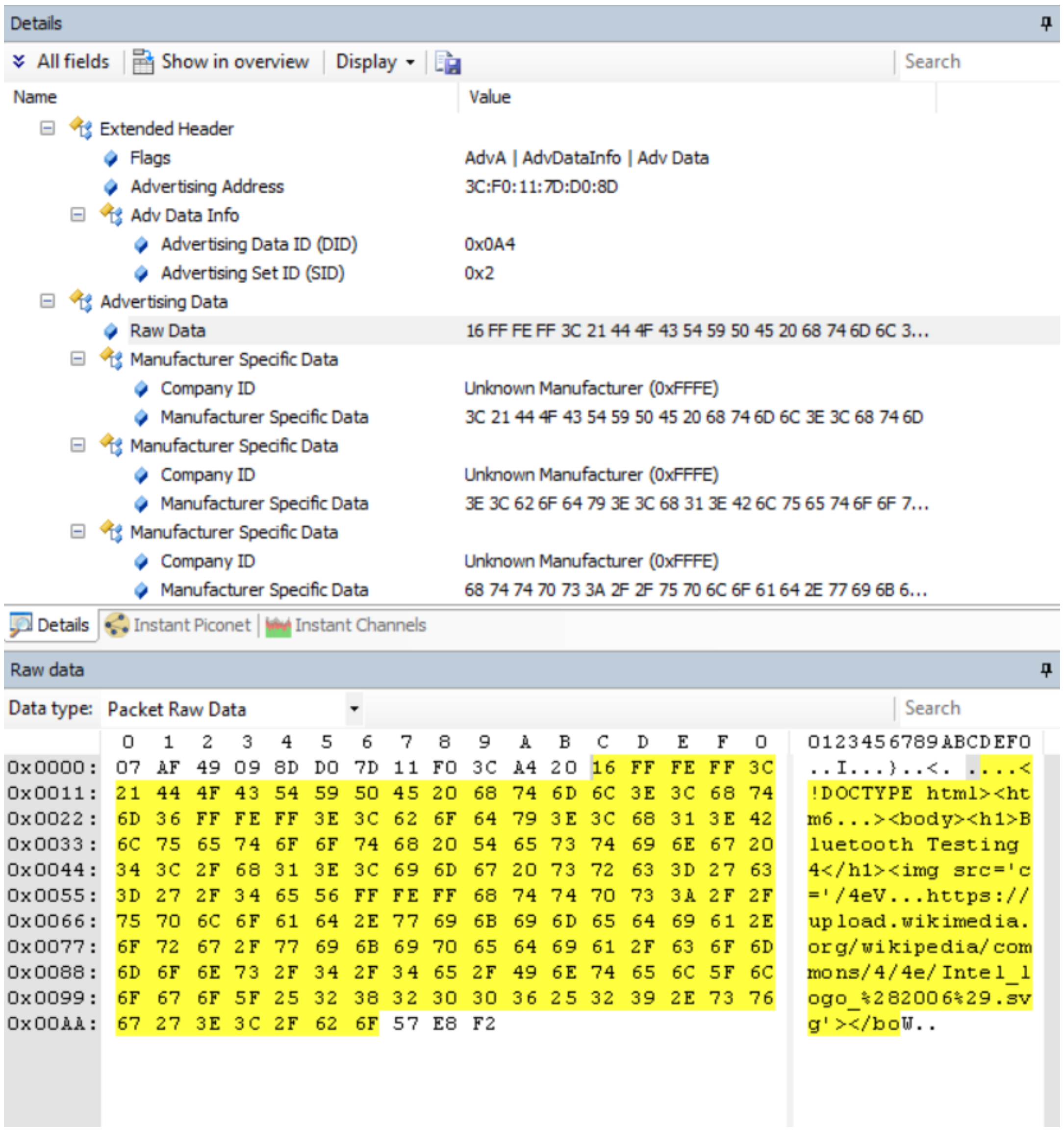
Name	Value
Extended Header	
Flags	AdvA | AdvDataInfo | Adv Data
Advertising Address	3C:F0:11:7D:D0:8D
Adv Data Info	
Advertising Data ID (DID)	0x0A4
Advertising Set ID (SID)	0x2
Advertising Data	
Raw Data	16 FF FE FF 3C 21 44 4F 43 54 59 50 45 20 68 74 6D 6C 3...
Manufacturer Specific Data	
Company ID	Unknown Manufacturer (0xFFFE)
Manufacturer Specific Data	3C 21 44 4F 43 54 59 50 45 20 68 74 6D 6C 3E 3C 68 74 6D
Manufacturer Specific Data	
Company ID	Unknown Manufacturer (0xFFFE)
Manufacturer Specific Data	3E 3C 62 6F 64 79 3E 3C 68 31 3E 42 6C 75 65 74 6F 6F 7...
Manufacturer Specific Data	
Company ID	Unknown Manufacturer (0xFFFE)
Manufacturer Specific Data	68 74 74 70 73 3A 2F 2F 75 70 6C 6F 61 64 2E 77 69 6B 6...

Instant Timing — origin: 2.46 s — span: 0.11 s

Raw data — Data type: Packet Raw Data

```
         0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F  0    0123456789ABCDEF0
0x0000: 07 AF 49 09 8D D0 7D 11 F0 3C A4 20 16 FF FE FF 3C    ..I...)..<. ....<
0x0011: 21 44 4F 43 54 59 50 45 20 68 74 6D 6C 3E 3C 68 74    !DOCTYPE html><ht
0x0022: 6D 36 FF FE FF 3E 3C 62 6F 64 79 3E 3C 68 31 3E 42    m6...><body><h1>B
0x0033: 6C 75 65 74 6F 6F 74 68 20 54 65 73 74 69 6E 67 20    luetooth Testing 
0x0044: 34 3C 2F 68 31 3E 3C 69 6D 67 20 73 72 63 3D 27 63    4</h1><img src='c
0x0055: 3D 27 2F 34 65 56 FF FE FF 68 74 74 70 73 3A 2F 2F    ='/4eV...https://
0x0066: 75 70 6C 6F 61 64 2E 77 69 6B 69 6D 65 64 69 61 2E    upload.wikimedia.
0x0077: 6F 72 67 2F 77 69 6B 69 70 65 64 69 61 2F 63 6F 6D    org/wikipedia/com
0x0088: 6D 6F 6E 73 2F 34 2F 34 65 2F 49 6E 74 65 6C 5F 6C    mons/4/4e/Intel_l
0x0099: 6F 67 6F 5F 25 32 38 32 30 30 36 25 32 39 2E 73 76    ogo_%282006%29.sv
0x00AA: 67 27 3E 3C 2F 62 6F 57 E8 F2                         g'></boW..
```

Ready — 5.0.7512 — 5:49 AM 10/28/2020



```
Details
All fields | Show in overview | Display ▾ |                                  Search
Name                                     Value
⊟ Extended Header
      Flags                              AdvA | AdvDataInfo | Adv Data
      Advertising Address                3C:F0:11:7D:D0:8D
  ⊟ Adv Data Info
        Advertising Data ID (DID)        0x0A4
        Advertising Set ID (SID)         0x2
⊟ Advertising Data
      Raw Data                           16 FF FE FF 3C 21 44 4F 43 54 59 50 45 20 68 74 6D 6C 3...
  ⊟ Manufacturer Specific Data
        Company ID                       Unknown Manufacturer (0xFFFE)
        Manufacturer Specific Data       3C 21 44 4F 43 54 59 50 45 20 68 74 6D 6C 3E 3C 68 74 6D
  ⊟ Manufacturer Specific Data
        Company ID                       Unknown Manufacturer (0xFFFE)
        Manufacturer Specific Data       3E 3C 62 6F 64 79 3E 3C 68 31 3E 42 6C 75 65 74 6F 6F 7...
  ⊟ Manufacturer Specific Data
        Company ID                       Unknown Manufacturer (0xFFFE)
        Manufacturer Specific Data       68 74 74 70 73 3A 2F 2F 75 70 6C 6F 61 64 2E 77 69 6B 6...
Details | Instant Piconet | Instant Channels

Raw data
Data type: Packet Raw Data ▾                                                Search
         0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F  0   0123456789ABCDEF0
0x0000: 07 AF 49 09 8D D0 7D 11 F0 3C A4 20 16 FF FE FF 3C   ..I...}..<. ....<
0x0011: 21 44 4F 43 54 59 50 45 20 68 74 6D 6C 3E 3C 68 74   !DOCTYPE html><ht
0x0022: 6D 36 FF FE FF 3E 3C 62 6F 64 79 3E 3C 68 31 3E 42   m6...><body><h1>B
0x0033: 6C 75 65 74 6F 6F 74 68 20 54 65 73 74 69 6E 67 20   luetooth Testing 
0x0044: 34 3C 2F 68 31 3E 3C 69 6D 67 20 73 72 63 3D 27 63   4</h1><img src='c
0x0055: 3D 27 2F 34 65 56 FF FE FF 68 74 74 70 73 3A 2F 2F   ='/4eV...https://
0x0066: 75 70 6C 6F 61 64 2E 77 69 6B 69 6D 65 64 69 61 2E   upload.wikimedia.
0x0077: 6F 72 67 2F 77 69 6B 69 70 65 64 69 61 2F 63 6F 6D   org/wikipedia/com
0x0088: 6D 6F 6E 73 2F 34 2F 34 65 2F 49 6E 74 65 6C 5F 6C   mons/4/4e/Intel_l
0x0099: 6F 67 6F 5F 25 32 38 32 30 30 36 25 32 39 2E 73 76   ogo_%282006%29.sv
0x00AA: 67 27 3E 3C 2F 62 6F 57 E8 F2                        g'></boW..
```

2-2.

Sender ： Used hcitool, cut all data into substrings and sent Bluetooth LE Extended Advertisement.

Receiver ： Used Windows API to catch Bluetooth LE Extended Advertisement, collected all substrings, rearranged them into correct order, and merge them into a big html file. In the end, showed sending strings on screen and auto opened html file through Chrome.

Sender: HCI Tool
=> Cut data into slides
=> Send them with loop

Receiver: Windows API
=> Keep receive slides and if current slide is different from last receiving slide, then merge it into the html file.
=> In the end, show html file automatically with browser.

1. Add Package Index

Use 4 bytes to record the package index.
=> 0001, 0002,…,0009,000A,…

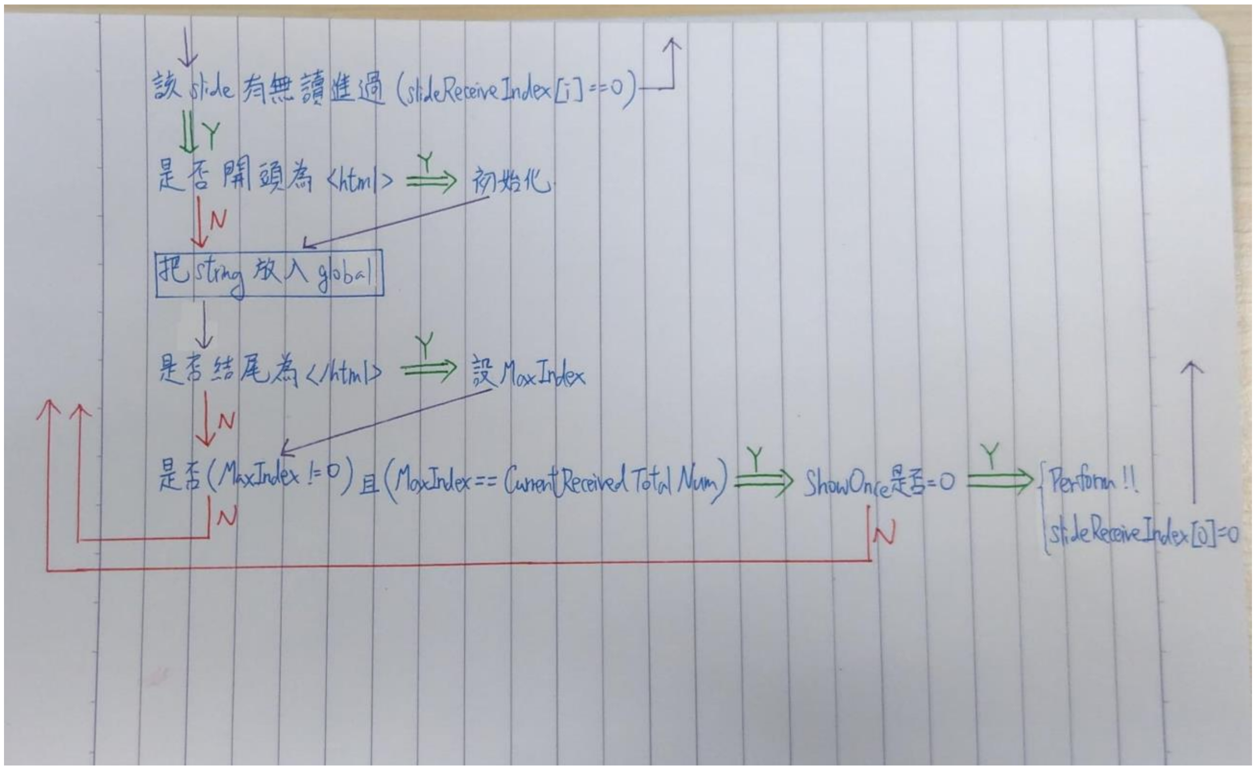
Advantage: Only show html in browser if no slide is missing

2. Rewrite Receiver (Windows API)

Background: Because now packages have Index, my code can be more effective

=> Because Windows API knows every package

Flow Cart:



3. Sender: MultiThread

1. Confirm which part need to include in multithread

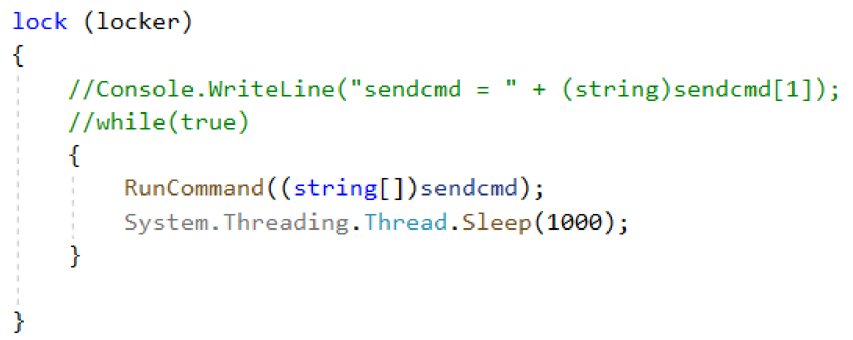
    1. LE_Set_Extended_Advertising_Parameters

2. LE_Set_Extended_Advertising_Enable

3. For Loop (Cut slides): Threads => LE_Set_Extended_Advertising_Data

4. LE_Set_Extended_Advertising_Disable

2. Test With or Without Locker



```
lock (locker)
{
    //Console.WriteLine("sendcmd = " + (string)sendcmd[1]);
    //while(true)
    {
        RunCommand((string[])sendcmd);
        System.Threading.Thread.Sleep(1000);
    }

}
```