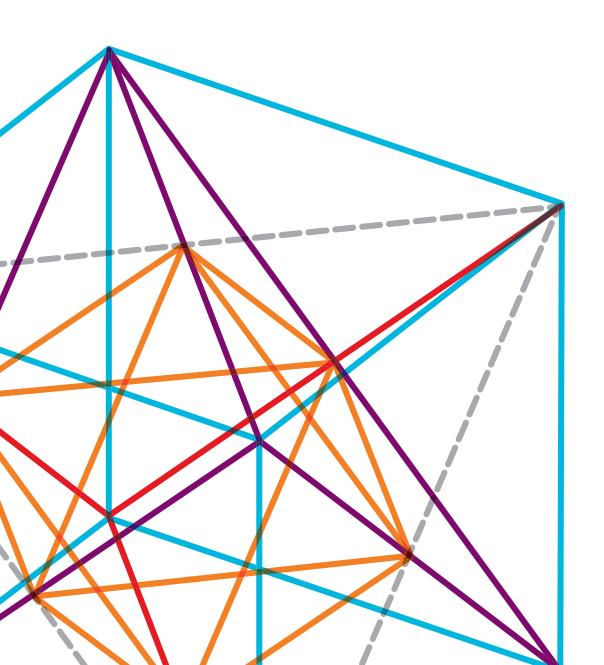Link-OS® Environment Bluetooth® Low Energy
AppNote 2456934.977326
October 4, 2014

INTRODUCTION

Bluetooth Low Energy, also referred to as Bluetooth LE, BTLE or Bluetooth Smart, is a new communication protocol that has been added to the Bluetooth (BT) 4.0 specification. It is offered as supplement to the legacy Bluetooth protocol (now referred to as "Bluetooth Classic"). Bluetooth LE is intended to provide a low-power use, low-speed alternative to Bluetooth Classic. The first Zebra® printer to offer Bluetooth LE as an option is ZQ500™ series.

Bluetooth LE operates on the same 2.4GHz band as BT Classic and Wi-Fi®. It uses a frequency-hopping scheme similar to Bluetooth Classic, but with fewer channels (37 vs. the 81 in Bluetooth Classic). Bluetooth LE is optimized for both power use and short data transmission events, so the connection process is extremely fast (0.01 seconds).

However, the Bluetooth LE specification requires that devices transfer data at significantly slower rates than those using Bluetooth Classic. Data transfer speeds to printers using Bluetooth LE have been benchmarked at 80 bytes per second when used in an isolation chamber. Given this, the Bluetooth LE protocol is best used for discovering devices and light-duty, data-transfer events.

At typical Bluetooth LE data transfer rates, retrieving the printers "personality data" (using the allcv command) could take longer than 6 minutes. A firmware download could take up to 72 hours to complete, dependent on how many other Bluetooth LE devices are in the environment. Using Bluetooth Classic is recommended when data transfer times are the priority.

Bluetooth Classic used the concept of "Profiles" to describe the methods used to support a specific use case. For example, Zebra printers support the Serial Port Profile (SPP), which is used to enable devices to communicate with Zebra printers over Bluetooth Classic as if an RS-232 cable was being used. Bluetooth LE has replaced the "Profiles" concept with "Services".

Bluetooth LE Services exist for a number of specific use cases. Since the Bluetooth LE specification does not have an equivalent to the Serial Port Profile, Zebra has developed a custom service to enable communication with the printer. This Service is called the "Zebra Bluetooth LE Parser Service", described below.

PRINTER CONFIGURATION

To support Bluetooth LE, a new group of SetGetDo (SGD) commands has been added to the Link-OS printer operating system. In addition to this new group of commands, some of the existing Bluetooth SetGetDo commands will now have an effect on classic and BTLE behavior.

bluetooth.enable

Purpose: This SGD enables or disables the Bluetooth radio for both Classic and LE
Range: on or off
Default: on

bluetooth.connected

Purpose: Indicates whether there is an active Bluetooth connection for either classic or LE
Range: no or yes
Default: (shows current state)

bluetooth.friendly_name

Purpose: Used as the "friendly name" or "display name" shown during Bluetooth and BTLE discovery
                events on the master device
Range: Any string up to 17 Characters
Default: The default value is the printer's serial number

bluetooth.address

Purpose: The Bluetooth address (BDADDR) of the printer with octets delimited by ":"
Range: (This value is set to the radio's MAC address)
Default: (This value is set to the radio's MAC address)

bluetooth.short_address

Purpose: The Bluetooth address (BDADDR) of the printer without the ":" character
Range: (This value is set to the radio's MAC address)
Default: (This value is set to the radio's MAC address)

bluetooth.le.minimum_security

Purpose: Sets the minimum LE security level that the printer will allow; higher security levels are always
                allowed if requested by the master device
Range: none,unauth_key_signing,auth_key_signing,unauth_key_encrypt,auth_key_encrypt
Default: none

bluetooth.le.controller_mode

Purpose: Controls which Bluetooth modes (classic, LE or both) are enabled
Range: both,classic,le
Default: both

DETAILS FOR DEVELOPERS

The following content is provided for developers creating solutions for use with the ZQ500 series printers. This same information will apply to future Link-OS printers that offer the Bluetooth LE radio option.

Supported GAP Roles

The ZQ500 series supports the *Peripheral* role.

Supported Generic Attribute Profile (GATT) Services

GENERIC ACCESS PROFILE (GAP)

The standard GAP is supported on the ZQ500 (UUID 0x1800):

Characteristic	UUID	Description
Device Name	0x2A00	device.friendly_name; same as Classic "friendly name"
Appearance	0x2A01	Currently 0x0000 ("Unknown")

DEVICE INFORMATION SERVICE (DIS)

The standard DIS is supported on the ZQ500 (UUID 0x180A).

All characteristics in this service are optional. The following characteristics are supported:

Characteristic	UUID	Description
Model Name	0x2A24	device.product_name; e.g., "ZQ510"
Serial Number	0x2A25	device.unique_id; e.g., "XXQLJ1251000001"
Firmware Revision	0x2A26	appl.name; e.g., "V68.19.10Z"
Hardware Revision	0x2A27	PCC (device.configuration_number); e.g., ZQ51-AUE0000-00
Software Revision	0x2A28	appl.link_os_version (e.g., "2.5")
Manufacturer Name	0x2A29	device.oem.manufacturer_name (e.g., "Zebra Technologies")

All other DIS characteristics are omitted, as they do not apply to Zebra devices

ZEBRA BLUETOOTH LE PARSER SERVICE

The Zebra Bluetooth LE Parser Service is a minimal GATT service designed to facilitate parser communication in as similar a fashion to SPP as the GATT model allows.

UUID	Type	Description
38eb4a80-c570-11e3-9507-0002a5d5c51b	Service UUID	
38eb4a81-c570-11e3-9507-0002a5d5c51b	Characteristic	"From Printer Data"
38eb4a82-c570-11e3-9507-0002a5d5c51b	Characteristic	"To Printer Data"

PUSHING DATA INTO THE PRINTER

To push data into the printer, you can use the following ATT operations on the "To Printer Data" characteristic:
• Write Value Without Response
• Write Value With Response
• Write Value with Authentication (Signed)
• Write Long

The data will be buffered and sent to the printer for processing. "Write With Response" or "Write Value with Authentication" are preferred if high reliability is desired. The amount of data that can be written to the characteristic is the minimum of the remote connection's ATT MTU and 512 bytes.

RECEIVING DATA FROM THE PRINTER

To receive data from the printer via Bluetooth LE, the remote device must support the *ATT Indication* operation. By default, reverse data sent from the printer is not buffered and goes nowhere if the current parser connection is over LE. One possible use case is if the LE port is only being used for printer configuration, not for acquiring printer status.

To activate indication support, you must write GCCC_ INDICATION (16-bits, 0x0002 in host order) to the *Client Characteristic Config* (CCC) for the "From Printer Data" characteristic. Once this value is written, the printer will send an indication to the Central role device whenever reverse data is to be sent over Bluetooth LE. The value of the characteristic provided in the indication is raw data from the parser. The amount of data that will be indicated is the smaller of the remote connection's ATT MTU and the amount of data remaining in the reverse data buffer.

Indications shall be sent in order with respect to the reverse data returned from the printer. The next indication will not be sent until the Central device acknowledges the indication.

BLUETOOTH LE / USB DONGLE

When developing a solution, developers may need to use a Bluetooth LE USB dongle, a device that enables Bluetooth LE communications from devices that do not natively support BTLE.

One such device is the Bluegiga BLED112. This device is a USB dongle that contains a microcontroller with Bluetooth LE radio and stack. It presents itself to the host computer as a Serial port, allowing it to be used for Bluetooth LE communications even if the OS on the host computer does not have a native BLE stack (e.g.

Windows® 7). Included with the BLED112 is a simple GUI tool for accessing BTLE services.

NOTE: References to Bluegiga BLED112 and Rapid Tables do not imply endorsement or support by Zebra Technologies. These details are offered for informational purposes only. For Technical Support on Bluegiga devices, please contact Bluegigga at https://www.bluegiga.com/en-US/support/.

The following procedure describes how to use the BLED112 software GUI to communicate with Zebra printers over BLE:

1. Open the Bluegiga BLE GUI Tool

2. Connect to your Bluegiga dongle

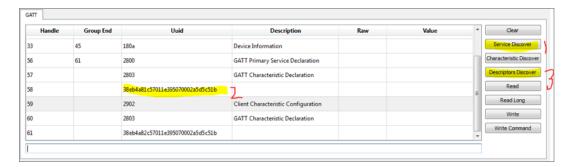

3. Click "Start" button on left side to perform a scan
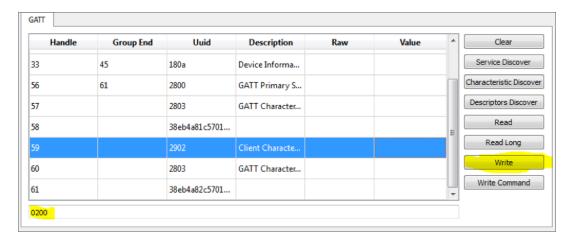

4. After a few seconds, click "Stop" to end the scan

5. Connect to your printer

6. Click "Service Discover", then select the line with Handle 58, then click "Descriptors Discover"
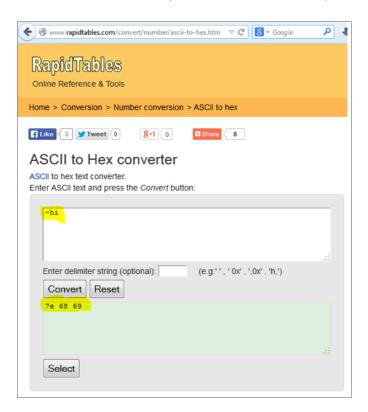

7. Select line Handle 59/UUID 2902; enter "0200" in the text box and click "Write"; this writes the CCC so as to enable indications as described in earlier sections
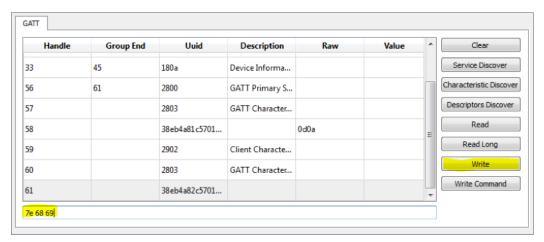

8. As an example, we will send ~hi to the printer and retrieve the response

IMPORTANT NOTE: at the time of this writing, the Bluegiga product only allows the user to send 20 characters at a time – dividing up longer commands into groups of 20 characters is allowed.

9. All ASCII text sent via the Bluegiga tool needs to be converted to hexadecimal. An easy-to-use tool for this conversion is called Rapid Tables, available at: http://www.rapidtables.com/convert/number/ascii-to-hex.htm
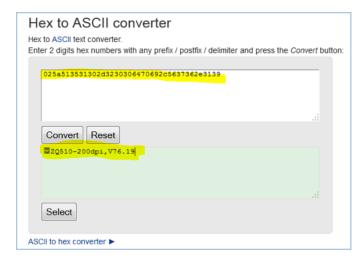

10. In the Bluegiga software GUI, select Handle 61; copy the hex value from RapidTables into text box and click "Write"

11. Data should be received back from the printer on Handle 58:


```
2014.08.25 14:48:13.498 ble_evt_attclient_attribute_value atthandle: 58 (0x003a) type: 2 (0x02) value:025a513531302d3230306470692c5637362e3139
2014.08.25 14:48:13.498 RX: 80190405003a000214025a513531302d3230306470692c5637362e3139
2014.08.25 14:48:13.643 ble_evt_attclient_attribute_value atthandle: 58 (0x003a) type: 2 (0x02) value:2e31305a5032363830352c382c383139324b4203
2014.08.25 14:48:13.644 RX: 80190405003a0002142e31305a5032363830352c382c383139324b4203
2014.08.25 14:48:13.868 ble_evt_attclient_attribute_value atthandle: 58 (0x003a) type: 2 (0x02) value:0d0a
2014.08.25 14:48:13.869 RX: 80070405003a0002020d0a
```

12. Copy the hex values into the RapidTables Hex-to-ASCII webpage to convert back to ASCII:
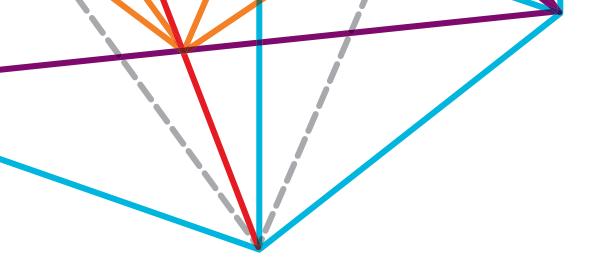http://www.rapidtables.com/convert/number/hex-to-ascii.htm

13. You may have to manually concatenate the printer responses in the RapidTables interface if they exceed 20 characters

Further Reading

• http://chapters.comsoc.org/vancouver/BTLER3.pdf

• https://www.bluetooth.org/DocMan/handlers/DownloadDoc.ashx?doc_id=227336

All links and information provided within this document are correct at time of writing.

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