<table>
<thead>
<tr>
<th>Info</th>
<th>Content</th>
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<tbody>
<tr>
<td>Keywords</td>
<td>QPP Server, QPP client in Android, QPP client in IOS</td>
</tr>
<tr>
<td>Abstract</td>
<td>This document demonstrates with example about how to create application working as QPP server in BLE peripherals device and application as QPP client role in BLE central device.</td>
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</tr>
<tr>
<td>0.1</td>
<td>20140519</td>
</tr>
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<td>20150330</td>
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<td></td>
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<tr>
<td>1.1</td>
<td>20150925</td>
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<td>1.2</td>
<td>20180404</td>
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</tbody>
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Contact information
For more information, please visit: http://www.nxp.com
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1. Introduction

The QPP (Proprietary Profile) is used to transfer the raw data between BLE devices. This document demonstrates with example about how to create application working as QPP server in BLE peripherals device and application as QPP client role in BLE central device.

2. QPP Server

2.1 Project Example

The project can be opened with the following IAR and KEIL workspace file:
C:\QBlue\QN9020\QBlue-X.X.X\Projects\BLE\prj_qpps\iar\qpps.eww
C:\QBlue\QN9020\QBlue-X.X.X\Projects\BLE\prj_qpps\keil\qpps.uvproj

2.2 Software Description

The QPP application is implemented in the following files:

- app_qpps.c: Application QPPS API
- app_qpps_task.c: Task handling functions
- qpp.lib and qpps_task.h and qpp_common.h: QPP Profile

2.2.1 User Configuration

The following macro shall be defined in the ‘usr_config.h’.

- #define CFG_PRF_QPPS
- #define CFG_TASK_QPPS TASK_PRF8 (Mandatory)
- #define QPPS_NOTIFY_NUM 7 (Max: 7, Min: 0)

2.2.2 Initialization

The initialization of the application occurs in two phases: Firstly, the qpps_init() function is called by the profiles register function(prf_init_reg(prf_init)). This function register QPPS task into kernel. Secondly, the app_qpps_create_db(uint8_t char_num) function is called by the app_create_server_service_DB() function. This function used to create server service database, the application can define the number of Characteristics used to send data to a client through notify.

NOTE: char_num: Max=7 Min = 0. If char_num increases, transmission speed will be faster, but more and more space will be occupied.

2.2.3 Data Processing

The application has three data processing functions, app_qpps_data_send(), app_qpps_data_send_cfm_handler() and app_qpps_data_ind_handler(). The app_qpps_data_send() function is used by the application to send raw data. The app_qpps_data_send_cfm_handler() function is used to report to the application a confirmation. The app_qpps_data_ind_handler() function is used to handle the data sent form peer device.
The diagrams below show the relationships between APP and Profile:

![Data Sending Diagram](image1)

**Figure 1 Data Sending**

![Data Receiving Diagram](image2)

**Figure 2 Data Receiving**

### 2.3 API and Handler

#### 2.3.1 qpps_init()

**Prototype:**
```c
void qpps_init(void);
```

**Description:**
This function performs all the initializations of the QPPS module.

#### 2.3.2 qpps_set_service_uuid()

**Prototype:**
```c
void qpps_set_service_uuid(uint8_t param[ATT_UUID_128_LEN]);
```

**Parameters:**
- **in** `param` QPPS’s UUID

**Description:**
This function should be called before adding QPP service into the database.

#### 2.3.3 app_qpps_create_db()

**Prototype:**
```c
void app_qpps_create_db (uint8_t char_num);
```

**Parameters:**
- **in** `char_num` The number of Characteristic used to send data
Response:
QPPS_CREATE_DB_CFM

Description:
This function shall be used to add an instance of the Proprietary Profile service into the database. This should be done during the initialization phase of the device.

Note:
Application can define the number of Characteristic used to send data to client through notify.

2.3.4 app_qpps_enable_req()

Prototype:
void app_qpps_enable_req (uint16_t conhdl, uint8_t sec_lvl, uint8_t con_type, uint16_t ntf_en).

Parameters:

<table>
<thead>
<tr>
<th>in</th>
<th>conhdl</th>
<th>Connection handle</th>
</tr>
</thead>
<tbody>
<tr>
<td>in</td>
<td>sec_lvl</td>
<td>Security level required for protection of HRS attributes: Service Hide and Disable are not permitted. Possible values are: PERM_RIGHT_ENABLE, PERM_RIGHT_UNAUTH, PERM_RIGHT_AUTH</td>
</tr>
<tr>
<td>in</td>
<td>con_type</td>
<td>Connection type: configuration(0) or discovery(1)</td>
</tr>
<tr>
<td>in</td>
<td>ntf_en</td>
<td>Notification configuration</td>
</tr>
</tbody>
</table>

Response:
None

Description:
This function is used for enabling the Server role of the Proprietary service.

2.3.5 app_qpps_data_send()

Prototype:
void app_qpps_data_send (uint16_t conhdl, uint8_t index, uint8_t length, uint8_t * data).

Parameters:

<table>
<thead>
<tr>
<th>in</th>
<th>conhdl</th>
<th>Connection handle</th>
</tr>
</thead>
<tbody>
<tr>
<td>in</td>
<td>index</td>
<td>Index of Characteristic to be sent</td>
</tr>
<tr>
<td>in</td>
<td>length</td>
<td>Length of data to be sent</td>
</tr>
<tr>
<td>in</td>
<td>data</td>
<td>Pointer to data to be sent</td>
</tr>
</tbody>
</table>
2.3.6  app_qpps_create_db_cfm_handler ()
Prototype:
```c
int app_qpps_create_db_cfm_handler (ke_msg_id_t const msgid, struct qpps_create_db_cfm * param, ke_task_id_t const dest_id, ke_task_id_t const src_id)
```
Parameters:
<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>in</td>
<td>msgid</td>
</tr>
<tr>
<td>in</td>
<td>param</td>
</tr>
<tr>
<td>in</td>
<td>dest_id</td>
</tr>
<tr>
<td>in</td>
<td>src_id</td>
</tr>
</tbody>
</table>

Returns:
As it is a message handler, the related handling result for the message will be saved in related ‘struct qpps_create_db_cfm * param’ depending on whether the message was handled or not.

Description:
This handler will be triggered after a database creation. It contains status of database creation.

2.3.7  app_qpps_disable_ind_handler ()
Prototype:
```c
int app_qpps_disable_ind_handler (ke_msg_id_t const msgid, struct qpps_disable_ind * param, ke_task_id_t const dest_id, ke_task_id_t const src_id)
```
Parameters:
<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>in</td>
<td>msgid</td>
</tr>
<tr>
<td>in</td>
<td>param</td>
</tr>
<tr>
<td>in</td>
<td>dest_id</td>
</tr>
<tr>
<td>in</td>
<td>src_id</td>
</tr>
</tbody>
</table>

Returns:
As it is a message handler, the related handling result for the message will be saved in related ‘struct qpps_disable_ind * param’ depending on whether the message was handled or not.

Description:
This handler is used to inform the Application of a correct disable. The configuration that the client has set in ntf_en field must be conserved for bonded devices.

### 2.3.8 app_qpps_error_ind_handler()

**Prototype:**

```c
int app_qpps_error_ind_handler (ke_msg_id_t const msgid, struct qpps_error_ind * param, ke_task_id_t const dest_id, ke_task_id_t const src_id)
```

**Parameters:**

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>in</td>
<td>msgid</td>
<td>QPPS_ERROR_IND</td>
</tr>
<tr>
<td>in</td>
<td>param</td>
<td>Pointer to the struct qpps_error_ind</td>
</tr>
<tr>
<td>in</td>
<td>dest_id</td>
<td>TASK_APP</td>
</tr>
<tr>
<td>in</td>
<td>src_id</td>
<td>TASK_QPPS</td>
</tr>
</tbody>
</table>

**Returns:**

As a message handler, the result will be saved in the related ‘struct qpps_error_ind * param’ depending on whether the message was handled or not.

**Description:**

This handler is used to inform the Application of an occurred error.

### 2.3.9 app_qpps_data_send_cfm_handler()

**Prototype:**

```c
int app_qpps_data_send_cfm_handler (ke_msg_id_t const msgid, struct qpps_data_send_cfm * param, ke_task_id_t const dest_id, ke_task_id_t const src_id)
```

**Parameters:**

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>in</td>
<td>msgid</td>
<td>QPPS_DATA_SEND_CFM</td>
</tr>
<tr>
<td>in</td>
<td>param</td>
<td>Pointer to the struct qpps_data_send_cfm</td>
</tr>
<tr>
<td>in</td>
<td>dest_id</td>
<td>TASK_APP</td>
</tr>
<tr>
<td>in</td>
<td>src_id</td>
<td>TASK_QPPS</td>
</tr>
</tbody>
</table>

**Returns:**

As a message handler, the result will be saved in the related ‘struct qpps_error_ind * param’ depending on whether the message was handled or not.

**Description:**

This handler is used to report to the application a confirmation or error status of a notification request being sent by application.

### 2.3.10 app_qpps_cfg_indntf_ind_handler()

**Prototype:**

```c
```
int app_qpps_cfg_indntf_ind_handler (ke_msg_id_t const msgid, struct qpps_cfg_indntf_ind * param, ke_task_id_t const dest_id, ke_task_id_t const src_id)

Parameters:

<table>
<thead>
<tr>
<th>in</th>
<th>msgid</th>
<th>QPPS_CFG_INDNTF_IND</th>
</tr>
</thead>
<tbody>
<tr>
<td>in</td>
<td>param</td>
<td>Pointer to the struct qpps_cfg_indntf_ind</td>
</tr>
<tr>
<td>in</td>
<td>dest_id</td>
<td>TASK_APP</td>
</tr>
<tr>
<td>in</td>
<td>src_id</td>
<td>TASK_QPPS</td>
</tr>
</tbody>
</table>

Returns:

As it is a message handler, the related handling result for the message will be saved in related 'struct qpps_cfg_indntf_ind * param' depending on the message was handled or not.

Description:

This handler is used to inform application that peer device has changed notification configuration.

2.3.11 app_qpps_data_ind_handler ()

Prototype:

int app_qpps_data_ind_handler (ke_msg_id_t const msgid, struct qpps_data_val_ind * param, ke_task_id_t const dest_id, ke_task_id_t const src_id)

Parameters:

<table>
<thead>
<tr>
<th>in</th>
<th>msgid</th>
<th>QPPS_DATA_VAL_IND</th>
</tr>
</thead>
<tbody>
<tr>
<td>in</td>
<td>param</td>
<td>Pointer to the struct qpps_data_val_ind</td>
</tr>
<tr>
<td>in</td>
<td>dest_id</td>
<td>TASK_APP</td>
</tr>
<tr>
<td>in</td>
<td>src_id</td>
<td>TASK_QPPS</td>
</tr>
</tbody>
</table>

Returns:

As it is a message handler, the related handling result for the message will be saved in related 'struct qpps_data_val_ind * param' depending on the message was handled or not.

Description:

This handler is used to handle the data sent form peer device.
3. QPP Client Overview

The QPP (Proprietary Profile) is used to transfer the raw data between BLE devices.
The libQBlueQPP library acts as QPP client role, which is used by application to transfer and receive the raw data between BLE devices.

3.1 Features
Transmit free raw data between BLE devices. Single free raw data package maximum length is 20bytes, minimal is 1byte.

3.2 Overview
The QPP client diagram consists of three parts:

App Layer:
- Send connection requests to BluetoothGatt, and configure API layer.
- Send data to API layer.
- Receive data from API layer.

API Layer:
- Receive data from App layer and deliver the data received to BluetoothGatt.
- Receive data from BluetoothGatt and deliver the data received to App layer.

BluetoothGatt Layer:
- Receive request from API layer.
- Update value to API layer.

The QPP client diagram for Android is shown in Figure 1
4. QPP Client Integration - Android

4.1 Flowchart

The QPP client general flowchart is the following:

- Scan BLE devices around.
Establish a connection with the device which is built-in QPP profile server.
Discover services and characteristics.
Register user's special UUIDs (including QPP service UUID and write characteristic UUID), here you’d call the method: qppEnable.
User receives data in the onQppReceiveData function, or sends data by the QppSendData function.

**QPP TX flowchart is shown in Figure 5:**

![QPP Client TX flowchart](image)

**QPP RX flowchart is shown in Figure 6:**

![QPP Client RX flowcharts](image)

### 1.1 API and Callback Description

There are one public class `QppApi` and one interface `iQppCallback` in the libQblueQpp library. The class `QppApi` defines APIs. The interface `iQppCallback` declares callbacks. There are five functions relevant: three API functions and two callback functions. These API functions are responsible to enable register service’s UUIDs, transfer data. These callback functions are used to receive data, get QPP service status.
4.1.1 Class QppApi

4.1.1.1 General Definition

```java
public class QppApi {
    public static boolean qppEnable(BluetoothGatt bluetoothGatt, String qppServiceUUID, String writeCharUUID);
    public static boolean qppSendData(BluetoothGatt bluetoothGatt, byte[] qppData);
    public static boolean setQppNextNotify(BluetoothGatt bluetoothGatt, boolean EnableNotifyChara);
    public static void updateValueForNotification(BluetoothGatt bluetoothGatt, BluetoothGattCharacteristic characteristic);
    public static void setCallback(iQppCallback mCb);
}
```

4.1.1.2 API Description

**public static boolean qppEnable()**

**Function**

public static boolean qppEnable(BluetoothGatt bluetoothGatt, String qppServiceUUID, String writeCharUUID);

**Brief**

Register customer’s UUIDs, in order to support customer’s devices using customized QPP UUIDs.

**Parameters:**

| In | BluetoothGatt | Android BluetoothGatt client handler |
| In | qppServiceUUID | UUID for QPP service in string |
| In | writeCharUUID | UUID for write Characteristic in string |

**Returns:**

| True | The service is found and bluetoothGatt is not null. |
| False | The service is not found or bluetoothGatt is null. |

**Note:**

The qppServiceUUID must match the QPP UUID on the device side.

**public static boolean qppSendData()**

**Function**

public static boolean qppSendData(BluetoothGatt bluetoothGatt, byte[] qppData);

**Brief**

Send raw data to QPP Profile.

**Parameters:**

| In | BluetoothGatt | Android BluetoothGatt client handler |
| In | qppData | Data to send, the length should not be larger than 20bytes |

**Returns:**

| True | Argument is valid and sends data is successful. |
| False | Argument is invalid or sends data is failed. |

**public static boolean setQppNextNotify()**

**Function**

public static boolean setQppNextNotify(BluetoothGatt bluetoothGatt,
boolean EnableNotifyChara);

**Brief** Enable characteristics notification.

**Parameters:**

<table>
<thead>
<tr>
<th>In</th>
<th>bluetoothGatt</th>
<th>Android BluetoothGatt client handler</th>
</tr>
</thead>
<tbody>
<tr>
<td>In</td>
<td>EnableNotifyChara</td>
<td>‘true’ to enable and ‘false’ to disable</td>
</tr>
</tbody>
</table>

**Returns:**

- True set characteristics is successful.
- False set characteristics is failed.

---

```java
public static boolean updateValueForNotification ()
Function public static void updateValueForNotification(BluetoothGatt bluetoothGatt, BluetoothGattCharacteristic characteristic);
**Brief** Notify libQblueQpp that data have been received.

**Parameters:**

<table>
<thead>
<tr>
<th>In</th>
<th>bluetoothGatt</th>
<th>Android BluetoothGatt client handler</th>
</tr>
</thead>
<tbody>
<tr>
<td>In</td>
<td>characteristic</td>
<td>Notify characteristic</td>
</tr>
</tbody>
</table>

**Returns:**

None.

**Note:**

This function should be invoked in BluetoothGattCallback.onCharacteristicChanged.

---

```java
public void boolean setCallback ()
Function public static void setCallback(iQppCallback mCb);
**Brief** Set callback function handler.

**Parameters:**

<table>
<thead>
<tr>
<th>In</th>
<th>mCb</th>
<th>iQppCallback object</th>
</tr>
</thead>
</table>

**Returns:**

None.

---

### 4.1.2 Interface iQppCallback

#### 4.1.2.1 General Definition

```java
public interface iQppCallback {
    void onQppReceiveData(BluetoothGatt bluetoothGatt, String qppUUIDForNotifyChar, byte[] qppData);
}
```

#### 4.1.2.2 API Description

```java
void onQppReceiveData()
Function void onQppReceiveData(BluetoothGatt bluetoothGatt, String qppUUIDForNotifyChar, byte[] qppData);
**Brief** Process the data that received from QPP Profile.

**Parameters:**

| In  | bluetoothGatt | Android BluetoothGatt client handler |
```
4.2 Integration Note

4.2.1 Initialize

4.2.1.1 Add ‘QppApi.qppEnable’ method

The method is used by the application to register user’s UUIDs in order to support customer’s devices using customized QPP UUIDs. The qppServiceUUID must match the QPP UUID on the device side. Then profile discovery the service, characteristic from bluetoothGatt and enable notification characteristics to bluetoothGatt. The parameter bluetoothGatt is a connected BluetoothGatt.

Add this method in following function:

```java
private final BluetoothGattCallback mGattCallback = new BluetoothGattCallback(){
    {
        ...
        public void onServicesDiscovered(BluetoothGatt bluetoothGatt, int status) {
            if(QppApi.qppEnable(bluetoothGatt, uuidQppService, uuidQppCharWrite))
                isInitialize = true;
        }
        ...
    }
```

4.2.2 Rx Data

4.2.2.1 Add ‘QppApi.setQppNotify()’ method

This method is to enable the QPP notification characteristics.

Add this method in following function:

```java
public void onDescriptorWrite(BluetoothGatt bluetoothGatt, BluetoothGattDescriptor descriptor, int status)
{
    QppApi.setQppNextNotify(bluetoothGatt, true);
    // user code
}
```

4.2.2.2 Add ‘QppApi.updateValueForNotification’ method

This method is to update value for notification characteristic.

Add this method in following function:

```java
```
4.2.3 Receive data
Refer to chapter 4.2.2 on QppReceiveData().

4.2.3 Tx Data
Call QppApi.qppSendData() to write data

```java
public void onCharacteristicChanged(BluetoothGatt bluetoothGatt,
                                BluetoothGattCharacteristic characteristic)
{
    QppApi.updateValueForNotification(bluetoothGatt, characteristic);
    /// user code
}
```

5. QPP Client Integration-iOS

5.1 Flowchart
The QPP general flowchart is the following:
- Register user’s special UUIDs (including QPP service UUID and write characteristic UUID), here you’d call the method: qppRegUUIDs.
- Scan BLE peripherals around.
- Establish a connection with the device which is built-in QPP profile server.
- Discover services and characteristics.
- User receives data in the didQppReceiveData delegate function, or sends data by the qppSendData function.

```java
public void onCharacteristicWrite(BluetoothGatt bluetoothGatt,
                                  BluetoothGattCharacteristic characteristic, int status)
{
    handlersend.postDelayed(runnableSend,20);
}

private Handler handlersend = new Handler();

final Runnable runnableSend = new Runnable()
{
    public void run()
    {
        QppApi.qppSendData(bluetoothGatt, qppDataSend);
    }
};
```
5.2 API and Delegate Description

These functions consist of two API functions and one delegate function. API functions implement to register user’s UUIDs and to transfer data, delegate function used to receive data.

5.2.1 qppRegUUIDs()

Prototype:

```c
(void)qppRegUUIDs : (NSString *)qppServiceUUID
withWrChar : (NSString *)writeCharUUID
```

Parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>in qppServiceUUID</td>
<td>UUID for QPP service in string</td>
</tr>
<tr>
<td>in writeCharUUID</td>
<td>UUID for write Characteristic in string</td>
</tr>
</tbody>
</table>

Returns:

None.

Description: The method is used by the application to register user's UUIDs in order to support customer's devices using customized QPP UUIDs. The qppServiceUUID must match the QPP UUID on the device side. The method is called before discovery procedure.
5.2.2 qppSendData()

**Prototype:**

```c
(void)qppSendData : (CBPeripheral *)aPeripheral
withData : (NSData*)qppData;
```

**Parameters:**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>in</td>
<td>aPeripheral</td>
<td>The peripheral must be built-in QPP profile server</td>
</tr>
<tr>
<td>in</td>
<td>qppData</td>
<td>The raw data</td>
</tr>
</tbody>
</table>

**Returns:**

None.

**Description:**
The function is used by application to send raw data to QPP Profile.

5.2.3 didQppReceiveData()

**Prototype:**

```c
(void)didQppReceiveData : (CBPeripheral *)aPeripheral
withCharUUID : (CBUUID *)qppUUIDForNotifyChar
withData : (NSData *)qppData;
```

**Parameters:**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out</td>
<td>aPeripheral</td>
<td>The data received is from the peripheral.</td>
</tr>
<tr>
<td>Out</td>
<td>qppUUIDForNotifyChar</td>
<td>The UUID for notify characteristics.</td>
</tr>
<tr>
<td>Out</td>
<td>qppData</td>
<td>The data received is from the notify characteristics.</td>
</tr>
</tbody>
</table>

**Returns:**

None.

**Description:**
The function is used by application to process the data received from QPP Profile.

5.3 Integration Note

a) Please insert the "bleDidUpdateCharForQppService" delegate method in the `didDiscoverCharacteristicsForService` delegate. The delegate is to update write characteristic and notify characteristic for QPP service.

```c
- (void) peripheral : (CBPeripheral *)aPeripheral
didDiscoverCharacteristicsForService : (CBService *)service error : (NSError *)error
{
    /// for QPP profile delegate
    `[bleUpdateForQppDelegate bleDidUpdateCharForQppService : aPeripheral
```
5.4 Example code
There is an example iOS project named ‘QPP_IOS_xxx.zip’ in Collabnet. It shows how to use the libQBlueQPP library to implement transfer raw data between QN902x device and QppDemo.

6. References
Included with QBue-X.X.X Release. The QBue-X.X.X software has been installed to the default path ‘C:\QBue\QBue-X.X.X’:
[1] C:\QBue\QN9020\QBue-X.X.X\Documents\QN9020 Device Database for IDE User Manual v1.0.pdf
[2] C:\QBue\QN9020\QBue-X.X.X\Documents\QN9020 API Programming Guide v1.0.pdf
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