

LAB #3: INSTALLING AND USING BLUETOOTH ON THE RASPBERRY PI

SOFE 4610U: Internet of Things



Devante Wilson - 100554361

Youssef Osman - 100715637

Introduction and Objectives

The proceedings of this lab report will detail our team learning the fundamentals of LED (Low Energy Device) Bluetooth. We will go through the setup of bluetooth on Raspberry Pi. Afterwards, we will communicate with the Raspberry Pi by reading and writing data over Bluetooth serial connection.

Lab Activity

The first section of the lab consists of developing a basic understanding of the Bluetooth stack, installing the utility programs for working with Bluetooth in Linux, and becoming familiar with these utility programs.

Software Setup

In order to share the laptop's wireless Internet connection with the Raspberry Pi via Ethernet, we followed the *Internet Connection Sharing Tutorial* posted on Blackboard.

There were a few updates we needed to run to make sure that our Raspberry Pi's software packages are all up to date and correct before we proceed to installing the software we need for the Bluetooth dongle. To facilitate this, the following commands were run.

Update the operating system of the RPi:

```
pi@raspberrypi:~ $ sudo apt-get update
Hit http://archive.raspberrypi.org jessie InRelease
Hit http://mirrordirector.raspbian.org jessie InRelease
Hit http://archive.raspberrypi.org jessie/main armhf Packages
Hit http://archive.raspberrypi.org jessie/ui armhf Packages
Hit http://mirrordirector.raspbian.org jessie/main armhf Packages
Hit http://mirrordirector.raspbian.org jessie/contrib armhf Packages
Hit http://mirrordirector.raspbian.org jessie/non-free armhf Packages
Hit http://mirrordirector.raspbian.org jessie/rpi armhf Packages
Ign http://archive.raspberrypi.org jessie/main Translation-en_GB
Ign http://archive.raspberrypi.org jessie/main Translation-en
Ign http://archive.raspberrypi.org jessie/ui Translation-en_GB
Ign http://archive.raspberrypi.org jessie/ui Translation-en
Ign http://mirrordirector.raspbian.org jessie/contrib Translation-en_GB
Ign http://mirrordirector.raspbian.org jessie/contrib Translation-en
Ign http://mirrordirector.raspbian.org jessie/main Translation-en_GB
Ign http://mirrordirector.raspbian.org jessie/main Translation-en
Ign http://mirrordirector.raspbian.org jessie/non-free Translation-en_GB
Ign http://mirrordirector.raspbian.org jessie/non-free Translation-en
Ign http://mirrordirector.raspbian.org jessie/rpi Translation-en_GB
Ign http://mirrordirector.raspbian.org jessie/rpi Translation-en
Reading package lists... Done
```

Lab #3: Installing and Using Bluetooth on the Raspberry Pi

Update the list of available packages and their versions:

```
pi@raspberrypi:~ $ sudo apt-get upgrade
Reading package lists... Done
Building dependency tree
Reading state information... Done
Calculating upgrade... Done
The following packages have been kept back:
  pix-icons pix-plym-splash pixel-wallpaper python-openssl python3-openssl
  raspberrypi-ui-mods
The following packages will be upgraded:
  bind9-host binutils bluez-firmware ca-certificates cpp-4.9 cups-bsd
  cups-client cups-common curl debconf debconf-i18n debconf-utils e2fslibs
  e2fsprogs file firmware-atheros firmware-brcm80211 firmware-libertas
  firmware-ralink firmware-realtek fuse g++-4.9 gcc-4.9 gcc-4.9-base
  gir1.2-gdkpixbuf-2.0 git git-core git-man gnupg gnupg-agent gnupg2 gpgv
  gpicsview gtk2-engines-pixbuf idle-python2.7 idle-python3.4 initramfs-tools
  isc-dhcp-client isc-dhcp-common libasan1 libasound2 libasound2-data
  libatomic1 libavcodec56 libavformat56 libavresample2 libavutil54 libbind9-90
  libblas-common libblas3 libbluray1 libc-ares2 libc-bin libc-dev-bin libc6
  libc6-dbg libc6-dev libcomerr2 libcups2 libcupsfilters1 libcupsimage2
```

Remove all of the redundant packages after the latest upgrade:

```
pi@raspberrypi:~ $ sudo apt-get autoremove
Reading package lists... Done
Building dependency tree
Reading state information... Done
0 upgraded, 0 newly installed, 0 to remove and 6 not upgraded.
```

Install the software we need to interact with the Bluetooth dongle (Bluetooth support, the BlueZ utilities and tools, and a GUI Bluetooth manager):

```
pi@raspberrypi:~ $ sudo apt-get install Bluetooth blueman bluez python-gobject python-gobject-2 python-bluez
Reading package lists... Done
Building dependency tree
Reading state information... Done
python-gobject is already the newest version.
python-gobject set to manually installed.
python-gobject-2 is already the newest version.
python-gobject-2 set to manually installed.
bluez is already the newest version.
bluez set to manually installed.
The following extra packages will be installed:
  ghostscript gir1.2-appindicator3-0.1 gir1.2-gconf-2.0 gir1.2-notify-0.7 imagemagick-common indicator-application libappindicator3-7
  libblqr-1-0 libmagickcore-6.q16-2 libmagickwand-6.q16-2 libopenobex1 libpaper-utils libpaper1 libpulse-mainloop-glib0 not
Suggested packages:
  bluez-cups bluez-obexd ghostscript-x libmagickcore-6.q16-2-extra
The following NEW packages will be installed:
  blueman bluetooth ghostscript gir1.2-appindicator3-0.1 gir1.2-gconf-2.0 gir1.2-notify-0.7 imagemagick-common indicator-ap
  libindicator3-7 libjbig2dec0 liblqr-1-0 libmagickcore-6.q16-2 libmagickwand-6.q16-2 libopenobex1 libpaper-utils libpaper1
0 upgraded, 27 newly installed, 0 to remove and 6 not upgraded.
Need to get 8,880 kB of archives.
After this operation, 26.7 MB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://archive.raspberrypi.org/debian/ jessie/main bluetooth all 5.23-2+rp12 [36.5 kB]
Get:2 http://mirrordirector.raspbian.org/raspbian/ jessie/main imagemagick-common all 8:6.8.9-5+deb8u14 [155 kB]
Get:3 http://mirrordirector.raspbian.org/raspbian/ jessie/main libdbusmenu-glib4 armhf 12.10.2-1 [95.6 kB]
```

The RPi was switched off, the Bluetooth dongle was plugged in, and the RPi was switched back on. To check if the dongle is recognized by the RPi, the following command was used:

Lab #3: Installing and Using Bluetooth on the Raspberry Pi

```
pi@raspberrypi:~ $ lsusb
Bus 001 Device 004: ID 0a5c:21e8 Broadcom Corp. BCM20702A0 Bluetooth 4.0
Bus 001 Device 003: ID 0424:ec00 Standard Microsystems Corp. SMSC9512/9514 Fast Ethernet Adapter
Bus 001 Device 002: ID 0424:9514 Standard Microsystems Corp.
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
```

Check if Bluetooth is live:

```
sudo hciconfig hci0 up
```

Scan for devices (in range of the dongle):

```
pi@raspberrypi:~ $ bluetoothctl
[NEW] Controller 5C:F3:70:84:AC:85 raspberrypi [default]
[bluetooth]# scan on
Invalid argument on
[bluetooth]# scan on
Discovery started
[CHG] Controller 5C:F3:70:84:AC:85 Discovering: yes
[NEW] Device 42:2D:13:6C:73:6A 42-2D-13-6C-73-6A
[NEW] Device 61:D1:8C:D5:05:0E 61-D1-8C-D5-05-0E
[NEW] Device 4D:69:2F:B6:A8:AF 4D-69-2F-B6-A8-AF
[NEW] Device 48:06:FC:5B:47:BC 48-06-FC-5B-47-BC
[NEW] Device 4D:66:6F:B2:85:5F 4D-66-6F-B2-85-5F
[NEW] Device 49:0E:EA:A3:D8:A2 49-0E-EA-A3-D8-A2
[NEW] Device 72:6D:41:22:53:F9 72-6D-41-22-53-F9
[NEW] Device 4E:2E:FA:28:53:84 4E-2E-FA-28-53-84
[NEW] Device 4A:73:04:DE:11:3A 4A-73-04-DE-11-3A
[NEW] Device E8:55:C5:A7:A6:E7 Tile
[NEW] Device 00:28:F8:E2:F6:02 maaz-Precision-3520
[NEW] Device 00:28:F8:BF:6A:75 UOSL18-1QYD4H2
[NEW] Device 00:28:F8:EC:1B:88 UOSL17-8H8M3H2
[NEW] Device 1C:4D:70:D6:93:B7 UOSL18-C91HFH2
[NEW] Device D0:57:7B:0D:19:BF DESKTOP-SQD1FPN
[NEW] Device 00:28:F8:E5:68:F6 DESKTOP-ALHQ5TI
[NEW] Device 00:28:F8:E2:F6:E3 00-28-F8-E2-F6-E3
[NEW] Device 00:28:F8:EB:7D:18 UOSL18-G9XV4H2
[NEW] Device 00:28:F8:E0:2F:17 UOSL18-57HM4H2
[NEW] Device 64:A2:F9:5C:84:63 OnePlus 6
[NEW] Device 00:28:F8:E5:22:42 UOSL18-C9JC4H2
[CHG] Device 00:28:F8:E2:F6:E3 RSSI: -64
[CHG] Device 00:28:F8:E2:F6:E3 Name: UOSL17-DXYN4H2
[CHG] Device 00:28:F8:E2:F6:E3 Alias: UOSL17-DXYN4H2
[NEW] Device 94:53:30:75:1E:84 LAPTOP-FBCLFL0B
[NEW] Device 56:82:94:99:30:92 56-82-94-99-30-92
[CHG] Device 4D:66:6F:B2:85:5F RSSI: -86
```

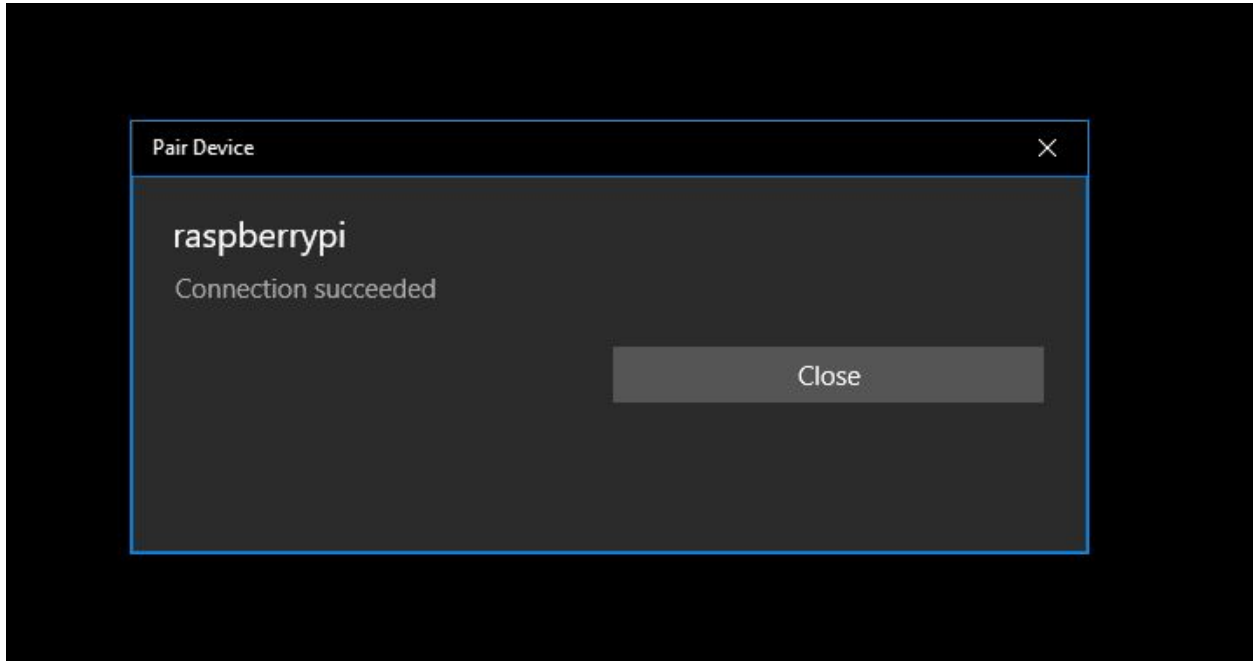

Lab #3: Installing and Using Bluetooth on the Raspberry Pi

```
[bluetooth]# devices
Device 42:2D:13:6C:73:6A 42-2D-13-6C-73-6A
Device 61:D1:8C:D5:05:0E 61-D1-8C-D5-05-0E
Device 4D:69:2F:B6:A8:AF 4D-69-2F-B6-A8-AF
Device 48:06:FC:5B:47:BC 48-06-FC-5B-47-BC
Device 4D:66:6F:B2:85:5F 4D-66-6F-B2-85-5F
Device 49:0E:EA:A3:D8:A2 49-0E-EA-A3-D8-A2
Device 72:6D:41:22:53:F9 72-6D-41-22-53-F9
Device 4E:2E:FA:28:53:84 4E-2E-FA-28-53-84
Device 4A:73:04:DE:11:3A 4A-73-04-DE-11-3A
Device E8:55:C5:A7:A6:E7 Tile
Device 00:28:F8:E2:F6:02 maaz-Precision-3520
Device 00:28:F8:BF:6A:75 UOSL18-1QYD4H2
Device 00:28:F8:EC:1B:88 UOSL17-8H8M3H2
Device 1C:4D:70:D6:93:B7 UOSL18-C91HFBH2
Device D0:57:7B:0D:19:BF DESKTOP-SQD1FPN
Device 00:28:F8:E5:68:F6 DESKTOP-ALHQ5TI
Device 00:28:F8:E2:F6:E3 UOSL17-DXYN4H2
Device 00:28:F8:EB:7D:18 UOSL18-G9XV4H2
Device 00:28:F8:E0:2F:17 UOSL18-57HM4H2
Device 64:A2:F9:5C:84:63 OnePlus 6
Device 00:28:F8:E5:22:42 UOSL18-C9JC4H2
Device 94:53:30:75:1E:84 LAPTOP-FBCLFL0B
Device 56:82:94:99:30:92 56-82-94-99-30-92
Device A4:C1:7B:44:05:F8 MS1020
[CHG] Device 00:28:F8:E2:F6:02 RSSI: -68
[CHG] Device 00:28:F8:E5:68:F6 Class: 0x0a010c
[CHG] Device 00:28:F8:E5:68:F6 Icon: computer
```

Pair up the Bluetooth with the laptop, by entering into the bluetoothctl shell:

```
[bluetooth]# pair D0:57:7B:0D:19:BF
attempting to pair with D0:57:7B:0D:19:BF
[CHG] Device D0:57:7B:0D:19:BF Connected: yes
[CHG] Device D0:57:7B:0D:19:BF Modalias: bluetooth:v
[CHG] Device D0:57:7B:0D:19:BF UUIDs:
        00001000-0000-1000-8000-00805f9b34fb
        0000110a-0000-1000-8000-00805f9b34fb
        0000110c-0000-1000-8000-00805f9b34fb
        0000110e-0000-1000-8000-00805f9b34fb
        00001115-0000-1000-8000-00805f9b34fb
        0000111f-0000-1000-8000-00805f9b34fb
        00001200-0000-1000-8000-00805f9b34fb
        c7f94713-891e-496a-a0e7-983a0946126e
[CHG] Device D0:57:7B:0D:19:BF Paired: yes
Pairing successful
```

Lab #3: Installing and Using Bluetooth on the Raspberry Pi



On the RPI, the following was run:

```
pi@raspberrypi:~ $ sdptool browse D0:57:7B:0D:19:BF
Browsing D0:57:7B:0D:19:BF ...
Service Name: Service Discovery
Service Description: Publishes services to remote devices
Service Provider: Microsoft
Service RecHandle: 0x0
Service Class ID List:
  "SDP Server" (0x1000)
Protocol Descriptor List:
  "L2CAP" (0x0100)
    PSM: 1
  "SDP" (0x0001)
Language Base Attr List:
  code_ISO639: 0x656e
  encoding:    0x6a
  base_offset: 0x100
```

This command listed all the available services by the device.

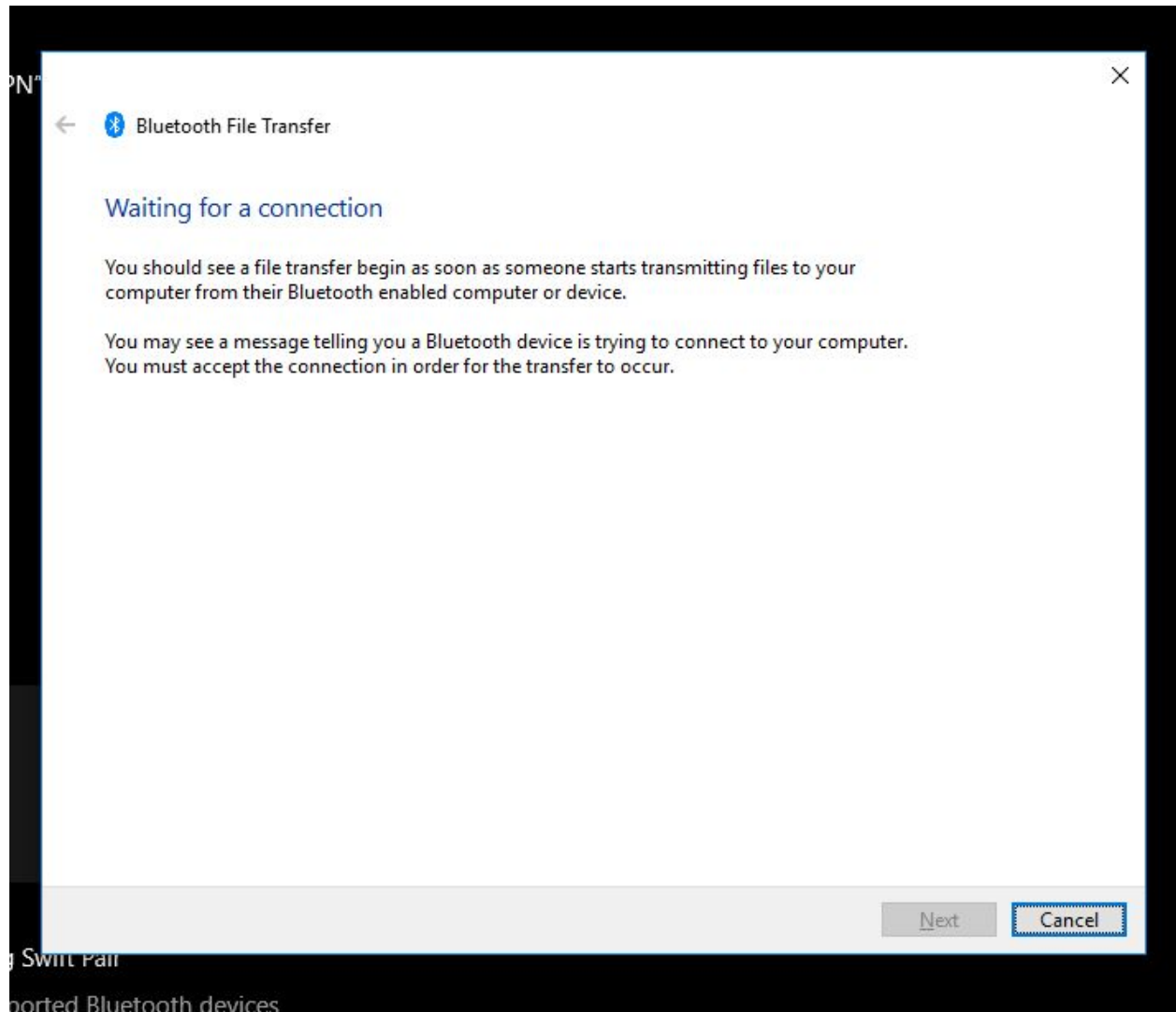
Then:

```
sdptool browse D0:57:7B:0D:19:BF > not_file_listening
```

The output of this command is empty because there is currently no file listener active.

Start listening for files on the laptop (send or receive files via Bluetooth):

Lab #3: Installing and Using Bluetooth on the Raspberry Pi



While the laptop is listening, the following was run on the RPi:

```
sdptool browse AA:BB:CC:DD:EE:FF > file_listening
```

Then:

Lab #3: Installing and Using Bluetooth on the Raspberry Pi

```
pi@raspberrypi:~ $ diff file_listening not_file_listening
127,136d126
< Service Name: OBEX Object Push
< Service RecHandle: 0x10010
< Service Class ID List:
<   "OBEX Object Push" (0x1105)
< Protocol Descriptor List:
<   "L2CAP" (0x0100)
<   "RFCOMM" (0x0003)
<     Channel: 3
<   "OBEX" (0x0008)
<
```

Lab Tasks

Task #1: Find a nearby device

```
from bluetooth import *

target_name = "DESKTOP-SQD1FPN"
target_address = None

nearby_devices = discover_devices()

for address in nearby_devices:
    if target_name == lookup_name(address):
        target_address = address
        break

if target_address is not None:
    print "found target bluetooth device with address ", target_address
else:
    print "could not find target bluetooth device nearby"
```

```
pi@raspberrypi:~ $ nano findmyphone.py
pi@raspberrypi:~ $ python findmyphone.py
found target bluetooth device with address D0:57:7B:0D:19:BF
pi@raspberrypi:~ $
```


Task #2: Client/server communication

In order to pair both devices, we opened the *bluetoothctl* shell as before and ran:

[bluetooth]# discoverable on

[bluetooth]# pairable on

Then: *pair <MAC ADDRESS>*

```
[bluetooth]# pair 5C:F3:70:84:AC:78
Attempting to pair with 5C:F3:70:84:AC:78
[CHG] Device 5C:F3:70:84:AC:78 Connected: yes
[CHG] Device 5C:F3:70:84:AC:78 UUIDs:
        0000110c-0000-1000-8000-00805f9b34fb
        0000110e-0000-1000-8000-00805f9b34fb
        00001200-0000-1000-8000-00805f9b34fb
        00001800-0000-1000-8000-00805f9b34fb
        00001801-0000-1000-8000-00805f9b34fb
[CHG] Device 5C:F3:70:84:AC:78 Paired: yes
Pairing successful
[CHG] Device 5C:F3:70:84:AC:78 Connected: no
```

Server

The server code simply sets up a server socket connection via a Bluetooth socket by binding the socket to an empty address and a port number. The server waits for an incoming request from the client.

```
from bluetooth import *

port = 1
backlog = 1

server_sock = BluetoothSocket(RFCOMM)
server_sock.bind(("",port))
server_sock.listen(backlog)

client_sock, client_info = server_sock.accept()

print "Accepted conection from ",client_info

data= client_sock.recv(1024)
print "received:", data
client_sock.close()
server_sock.close()
```

Client:

On the client, the server address and port number are used to connect to the socket. A message (hello! * 10) is sent over to the server. The connection is then closed.

```
from bluetooth import *  
  
server_address = "5C:F3:70:84:AC:78"  
port = 1  
  
sock = BluetoothSocket(RFCOMM)  
sock.connect((server_address, port))  
  
sock.send("hello!"*10)  
  
sock.close()
```

Output

```
pi@raspberrypi:~$ python rfcomm-server.py  
Accepted connection from ('5C:F3:70:84:AC:78', 1)  
received: hellohellohellohellohellohellohellohellohello
```

Conclusion

After performing all the tasks during the lab session, our group learned the fundamentals of Bluetooth low energy, how to setup bluetooth on Raspberry Pi, and communicate with the Raspberry Pi by reading and writing data over Bluetooth serial connection.