Shimmer Java/Android API

User Manual

Rev. 2.8

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Table of Contents

1. Introduction

The current *Shimmer Java/Android API* is a beta release. Bluetooth communication from the Shimmer device to the Android device is via the Serial Port Profile (SPP). SPP has been supported on Android since API level 5 (Android 2.0) was introduced, thus the driver will work with any Bluetooth enabled Android device which has version of 2.0 and above.

It should be noted that there is sometimes variability between 'Stock' firmware, manufacturer modified firmware, and custom firmware. Users are advised to investigate whether there are any known issues with their implementation of their Bluetooth stack. For example, Android 4.2 (Stock) uses a new Bluetooth Stack.

1.1. Scope of this Document

Android Developers provide extensive online documentation[1] for all core Android components. This documentation limits itself to explaining Shimmer based functionality. While effort has been made to provide as much information as is required, the user may need to develop some further understanding through the general study of Android and Java programming respectively.

2. Pre-Requisites

The following are the pre-requisites needed to use the *Shimmer Java/Android API library*:

- JDK installed on your PC.
- Android SDK.
- Eclipse installed on your PC. (While Eclipse is not compulsory it is highly recommended).
- ADT Plugin for Eclipse.
- An Android device with Bluetooth.
- The *Shimmer Java/Android API* can be downloaded from our website[2] and includes the following:

    a. *ShimmerDriver library and ShimmerAndroidDriver library*

    b. Shimmer Android Examples

    Ensure you are using the latest version of the *Shimmer Java/Android API* and Shimmer Driver library by checking the website. Extract the files and follow the installation instructions outlined in the *Getting Started* section on the next page.

- A *Shimmer2/Shimmer2r/Shimmer3* device programmed with the latest version of *BtStream*

[1] http://developer.android.com/index.html
[2] http://www.shimmersensing.com/support/wireless-sensor-networks-documentation/category/45

NOTE: All Shimmers are shipped pre-programmed with the *BtStream* firmware. If for some reason you need to reprogram your Shimmer device the latest *BtStream* firmware image is available for download from http://www.shimmersensing.com/support/wireless-sensor-networks-download/. These images can be loaded onto the Shimmer devices using the *Shimmer Windows Bootstrap Loader* application. See the *Shimmer User Manual* for details.

- Ensure you are using the latest version of the *Shimmer Java/Android API* and User guide, by checking http://www.shimmersensing.com/support/wireless-sensor-networks-download/.

3. Getting Started

First install the appropriate *BtStream* firmware image onto your Shimmer device. These images can be loaded onto the Shimmer using the *Shimmer2/2r Bootstrap Loader* or the *Shimmer3 Bootstrap Loader* application for *Shimmer2/2r* and *Shimmer3*, respectively. See the *Shimmer User Manual* for details.

The next step is setting up Eclipse and the Android SDK. To do as such follow the instructions given in http://developer.android.com/sdk/installing.html.

3.1. Running an example application on your Android platform

1. Open the Eclipse application and select import.

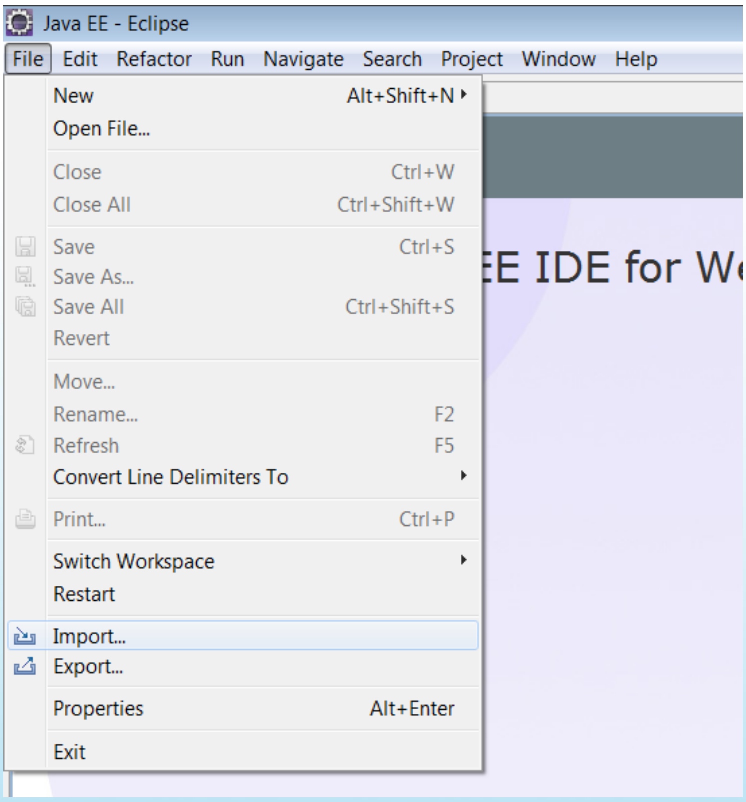
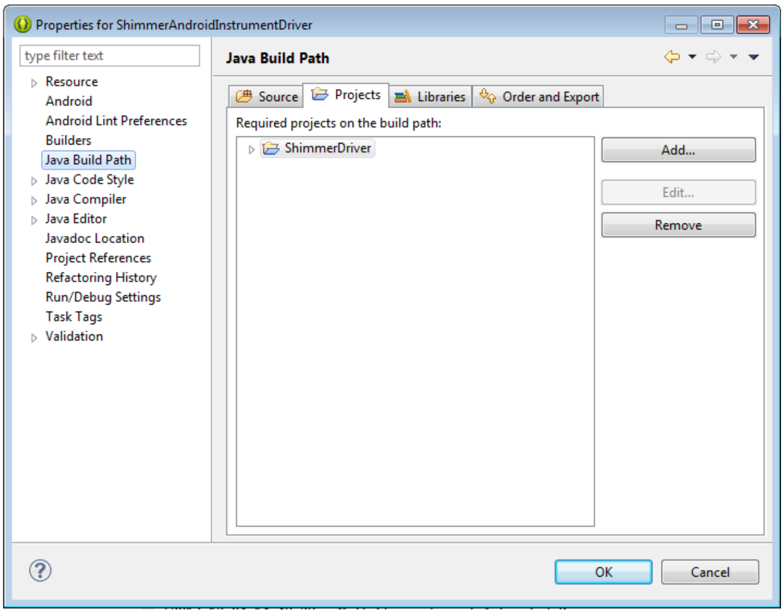


Figure 1: Import Project

2. Import the generic ShimmerDriver, this can be done by choosing Import -> Existing Projects into Workspace, and choosing the ShimmerDriver folder.

3. Import the ShimmerAndroidInstrumentDriver. The reason ShimmerAndroidInstrumentDriver and ShimmerDriver are separate is to allow the ShimmerDriver to be used on a PC (*Windows/Linux/Mac OSx*). As an example of its usage on the PC please refer to Section 7.

4. Once the ShimmerAndroidInstrumentDriver is imported ensure the project ShimmerDriver has been added to the Build Path as shown below.



5. Import your first Shimmer Android Project example through import -> Existing Android Code Into Workspace.

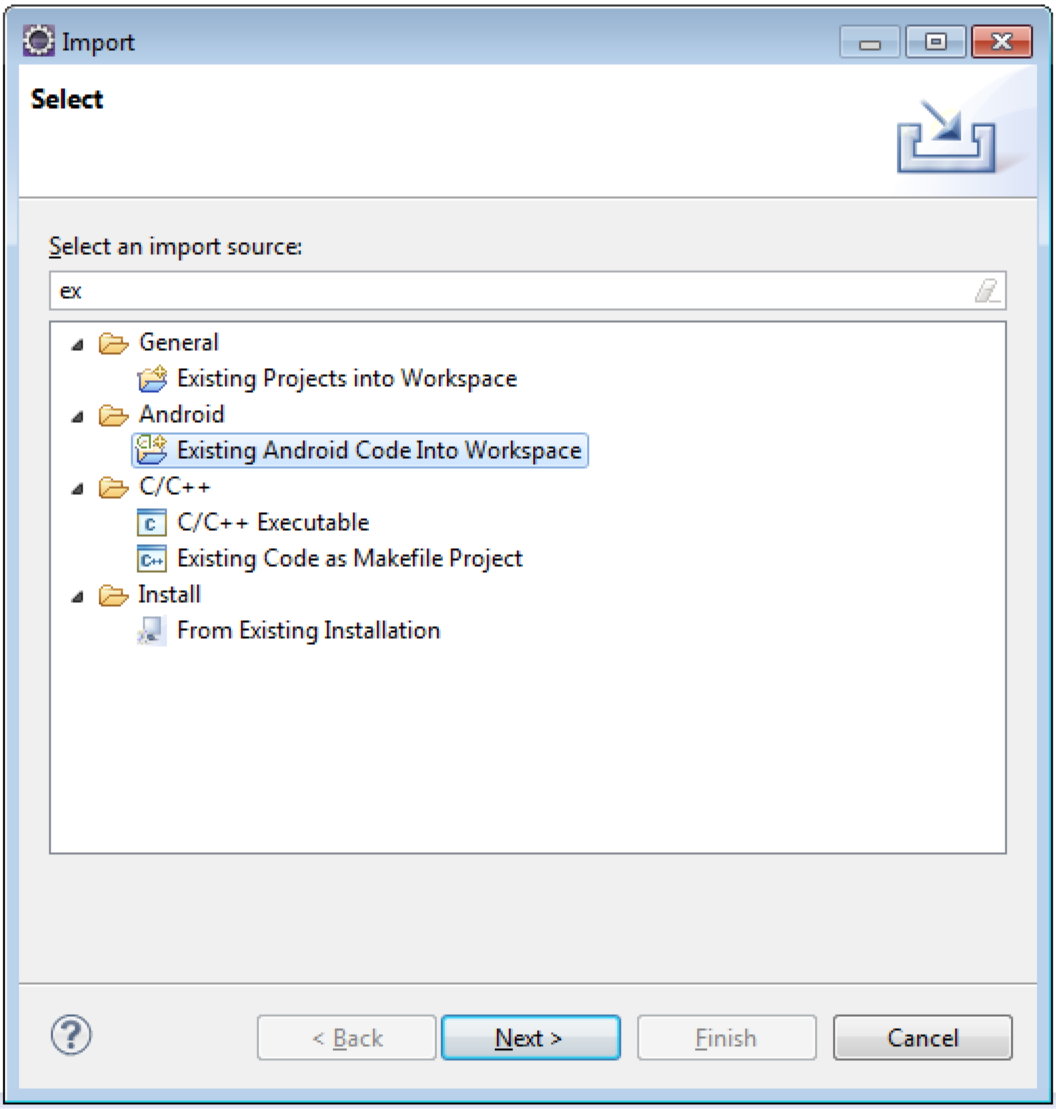


Figure 2: Select Existing Projects

6. Scroll to the example folder and select an example.

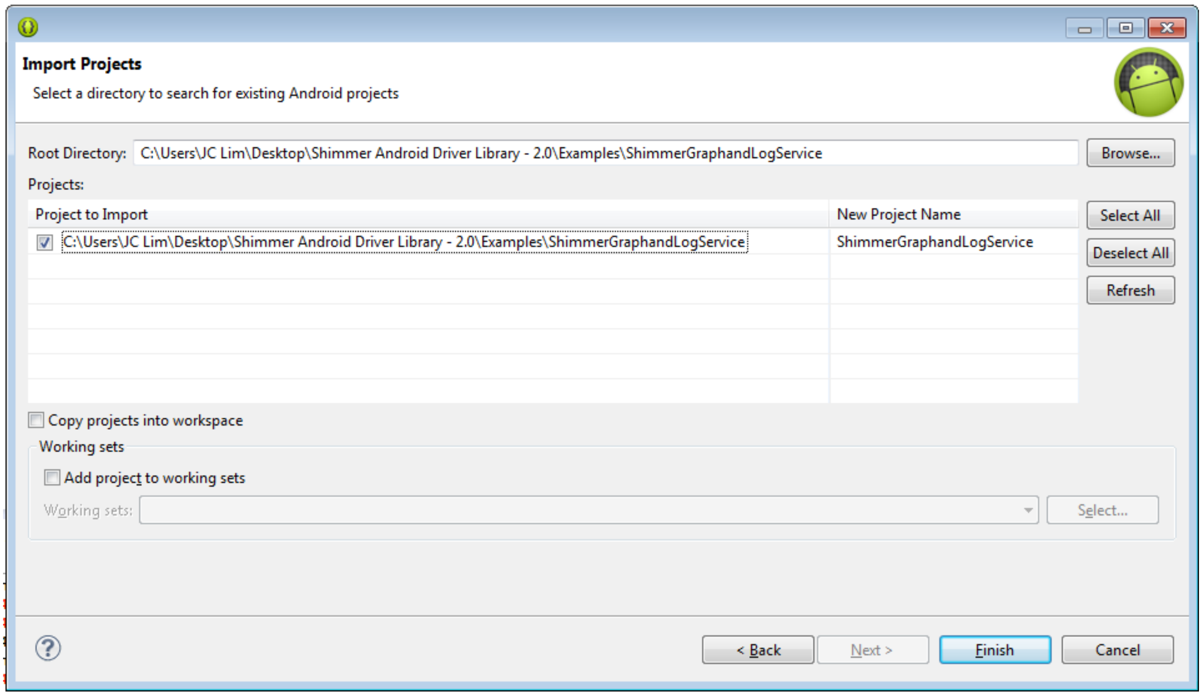


Figure 3: Select an Example

7. Click Finish and go to your workbench.

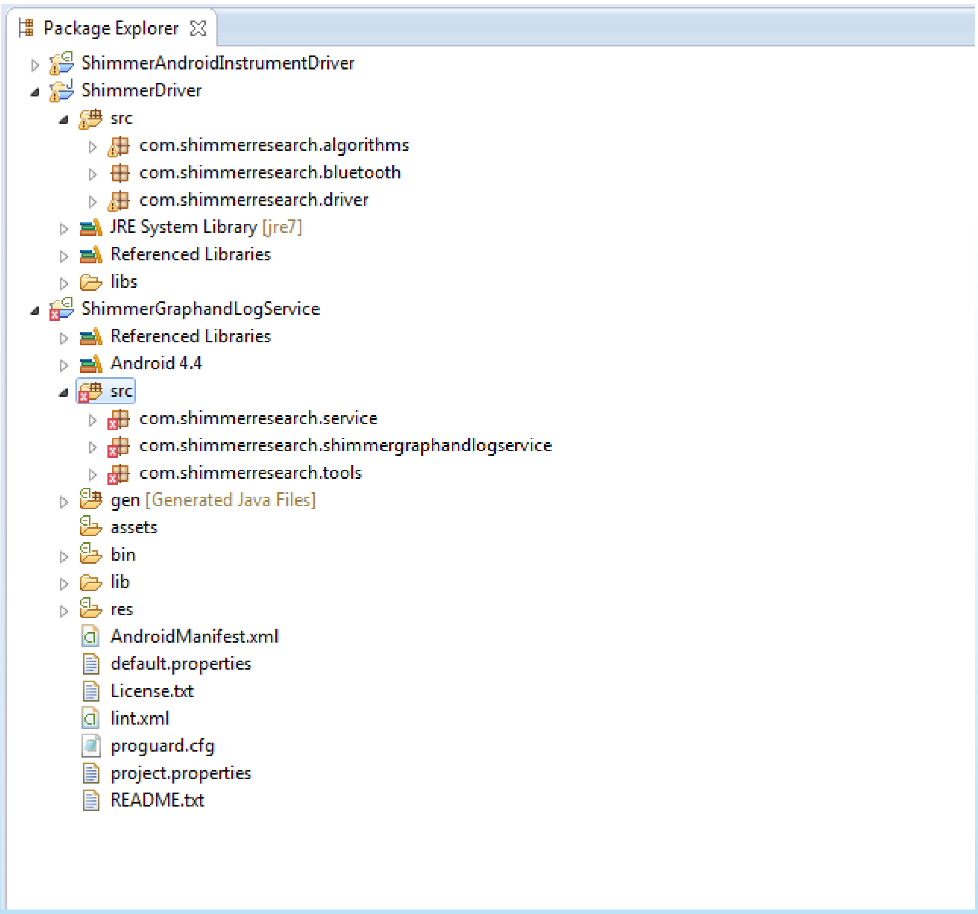


Figure 4: ShimmerGraphandLogService Project Error

8. If you see the above errors, it is because the path to the referenced library is either incorrect or has been corrupted. To fix this either, re-point via ConfigureBuildPath-->Android and reselecting the ShimmerAndroidInstrumentDriver folder in the library view. If that fails, restart eclipse, and the error should be gone.

9. Next install the application onto your target Android device, readers should note that the Android emulator does not support Bluetooth. Connect your Android device to your computer via USB and enable USB debugging on your Android device. This option can be found on your Android device here:-

   Settings-> Developer options -> USB debugging

   Also ensure that the drivers for your Android device have been installed on your computer. On certain Android versions, the developer console tab is hidden, and to uncover it requires pressing the Build Number seven times.

10. Set the Deployment Target Selection Mode to manual. This can be found under Run -> Debug Configurations -> Target.

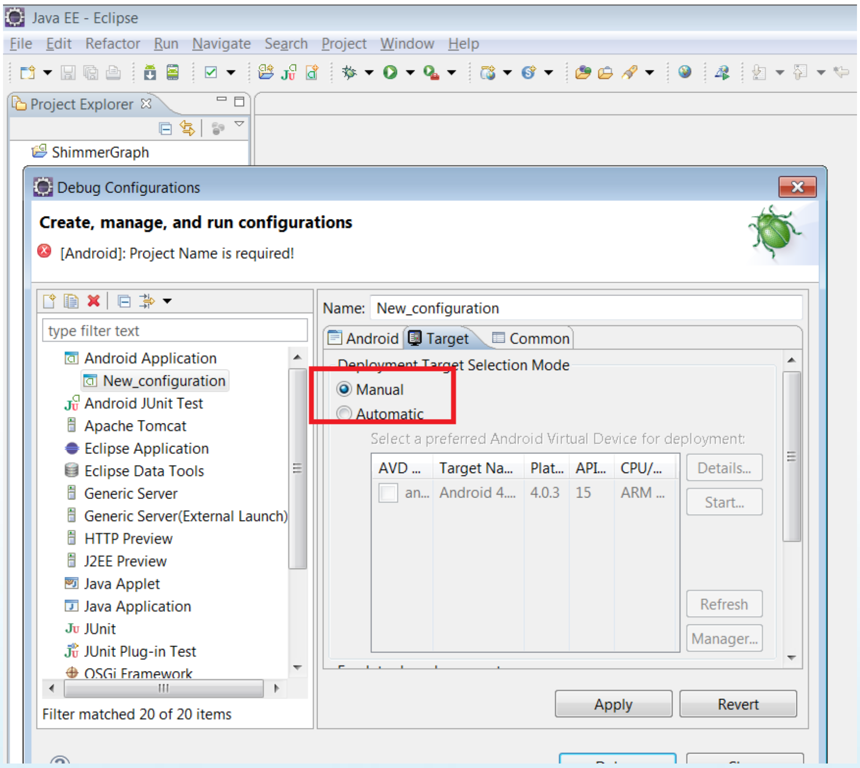


Figure 5: Select Manual Deployment Target Selection

11. Next run the application as an Android application as shown below.

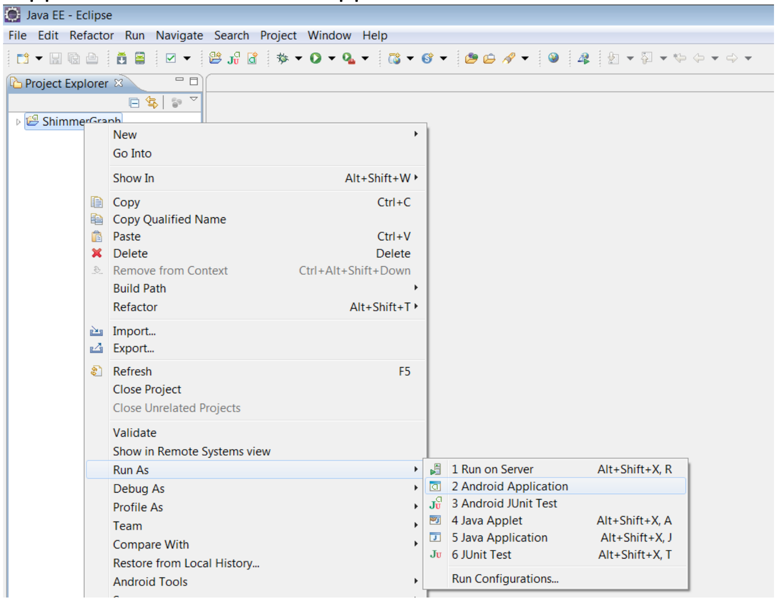


Figure 6: Run the Application

You should now see the ShimmerGraphandLogService App loaded onto your Android device.

12. Watch the ***related*** tutorial video on YouTube[3] to see an explanation of the application.
13. Next you will want to load LogCat to view messages logged by the Android device. This can be done by going to:

Window → Show View → Other… → Android → LogCat

You can use this logging mechanism to debug as you start working on your implementation.

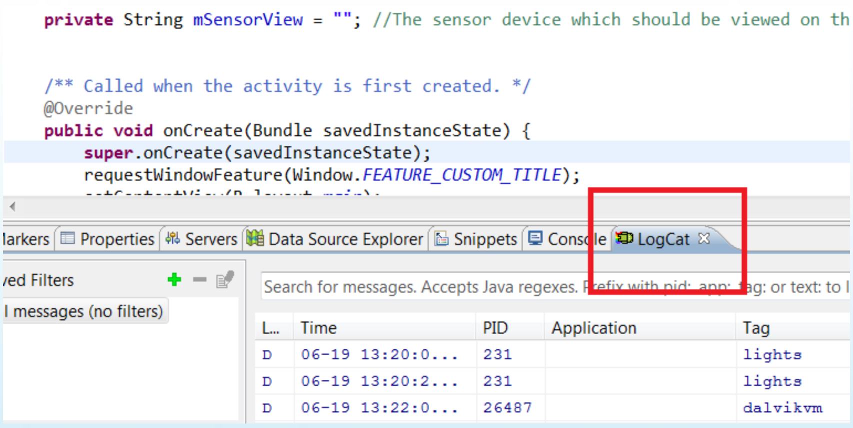


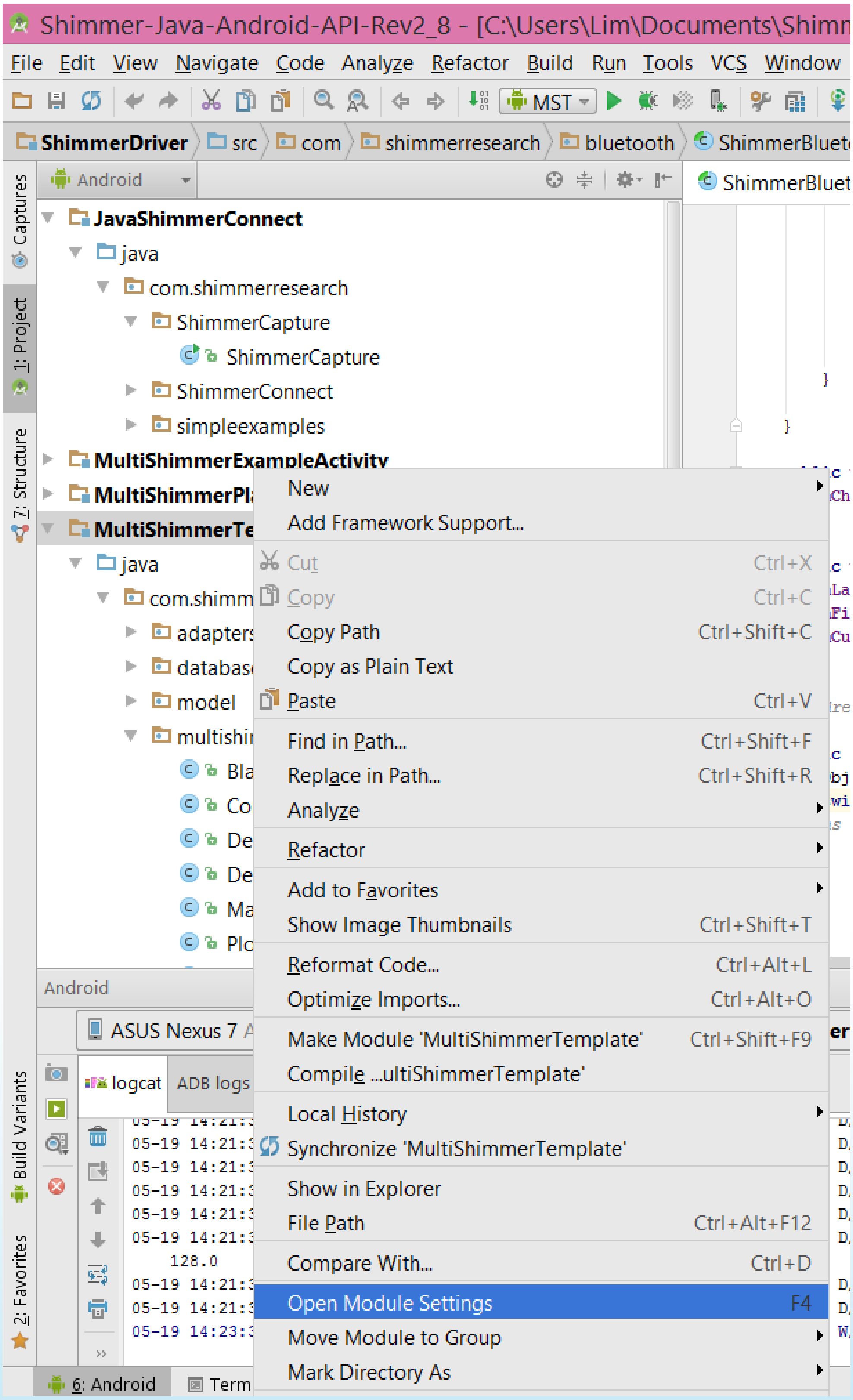
Figure 7: Load LogCat

[3] http://www.youtube.com/watch?feature=player_embedded&v=-wf4yq968EM

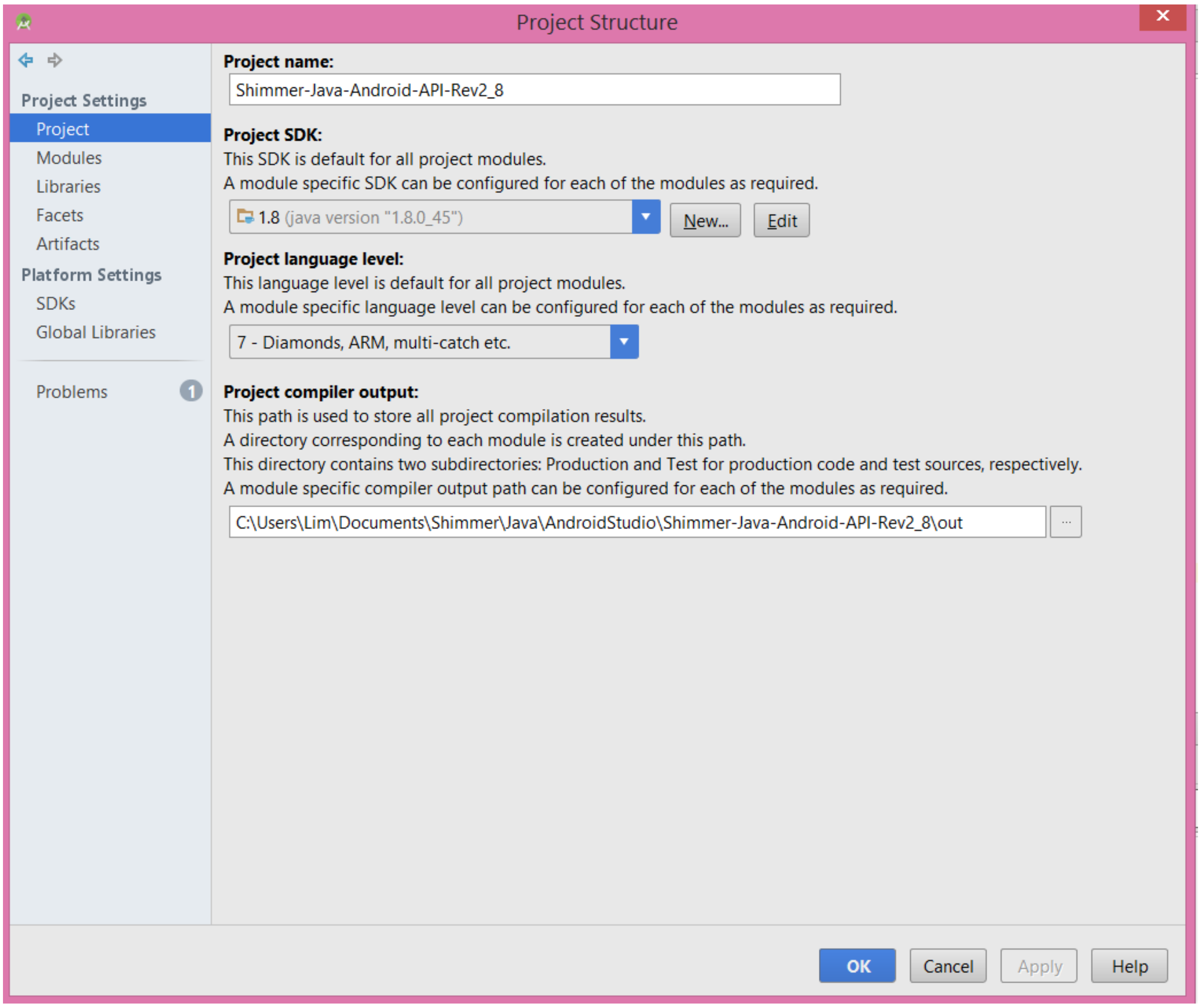
3.2. Android Studio

To import projects got to, File → New → Import Project, select the directory of which you have unzipped your files. In the next window select Create Project from Existing Source. Select Next for the rest of the options until Finish.

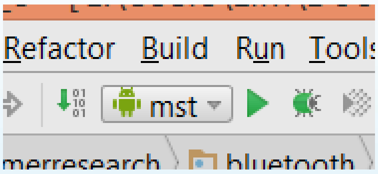
Once done, update your project language level to 7. This can be done by opening module settings.



In the project structure window select project and set Project language level to 7.



To run an Android application click Run→Edit Configurations. Add a new Android Application configuration. Name the Configuration, select the module and set the target device. Click Apply. You should now be able to run the configuration.



4. Shimmer Android API

4.1. General Overview

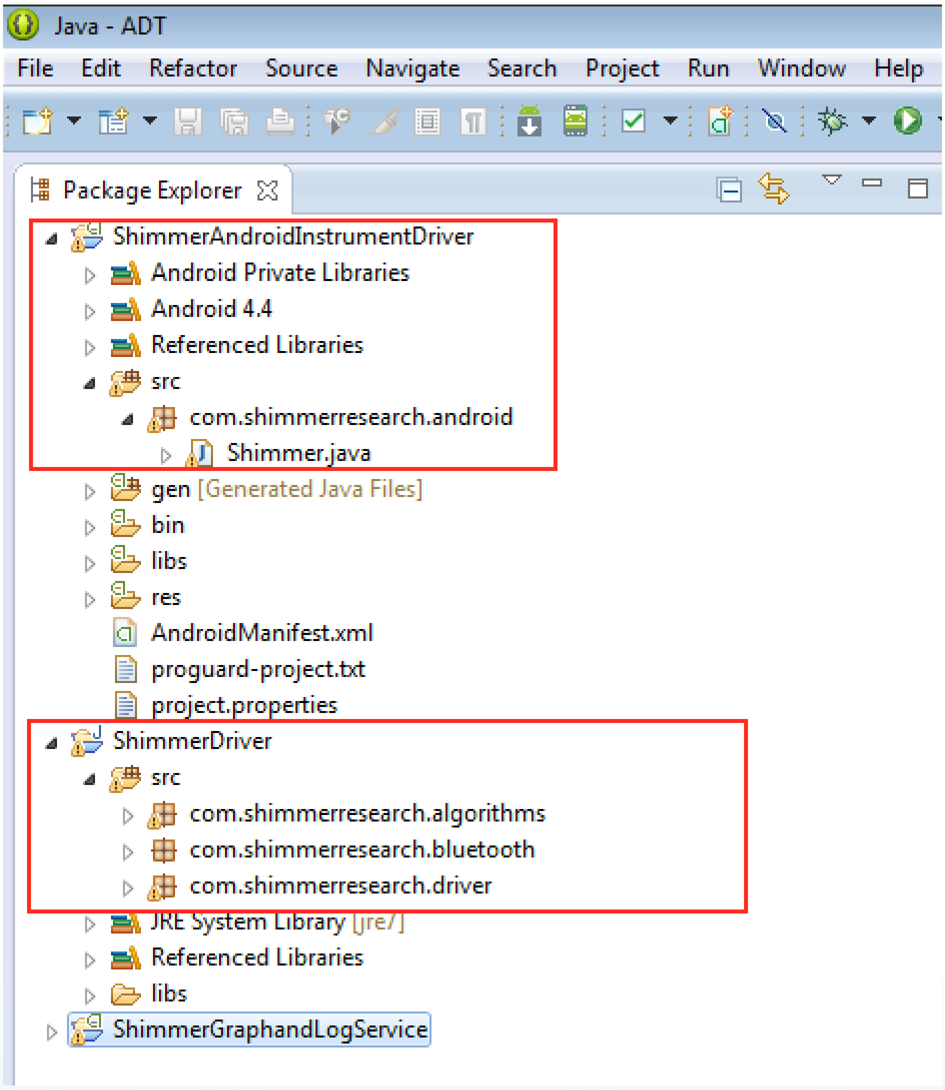


Figure 8: Set of Packages which make up the Shimmer Android Instrument Driver Library

The *Shimmer Java/Android API* is made up of the ShimmerDriver project and the ShimmerAndroidInstrumentDriver project. The Shimmer Driver contains the package *com.shimmerresearch.driver* which has three main files. The first file, ShimmerObject class, is the main generic driver file, which allows a Shimmer device to be defined. Depending on the communication medium other classes should extend this class. An example is given Figure 9, where Bluetooth, BluetoothLowEnergy and the 802.15.4, all extend the ShimmerObject class. Note that as of only Bluetooth is supported at the moment. The two files (FormatCluster and ObjectCluster) within the ***com.shimmerresearch.driver*** package defines the data structure.

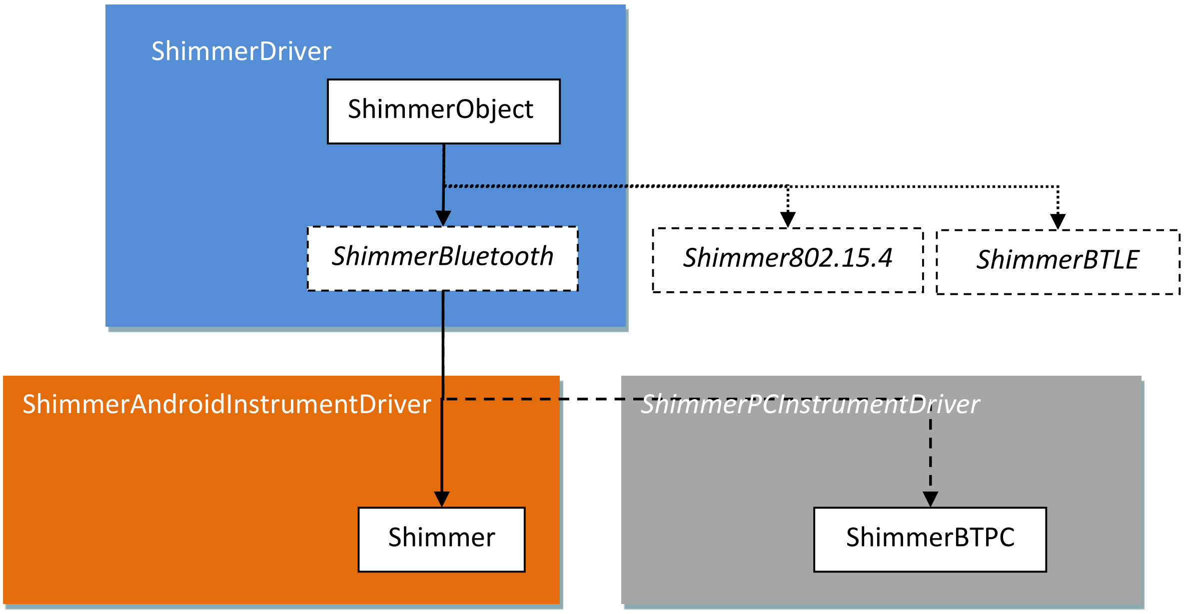


Figure 9: Structure

The *ShimmerAndroidInstrumentDriver* holds the *Shimmer* Class. The *Shimmer* Class (should really be called *ShimmerBTAndroid* but for backward compatibility *Shimmer* is used) extends ShimmerObject and handles the Android Bluetooth API and provides a number of functions which allows an Android application to communicate with the Shimmer Device. More information concerning the Android Bluetooth API can be found on the Android developers website[4]. As can be seen in Figure 9, this structure (separating native Android calls) allows greater code flexibility and usability of the Bluetooth interface (Serial Port Profile) thus allowing the code to be used as the basis of a PC based driver. For a PC example please refer to Section 7. Users should note that in theory, the *ShimmerBluetooth* class is also extensible to other radio technologies, as long as the abstract methods (Read, Write..etc..) are implemented correctly and that the same communication flow as *BtStream* is used.

The *Shimmer* Class allows the main Android application to interact with the Shimmer device (e.g. setting the sampling rate, changing the accelerometer range, enabling/disabling sensors). Multiple Shimmer devices can be connected simultaneously to an Android device using multiple instances of the *Shimmer* Class object.

[4] http://developer.android.com/guide/topics/wireless/bluetooth.html

4.2. The Shimmer Class

As mentioned the Shimmer class is an object oriented piece of code which allows your Android application to interact with a Shimmer device. It is located in the package *com.shimmerresearch.android.*

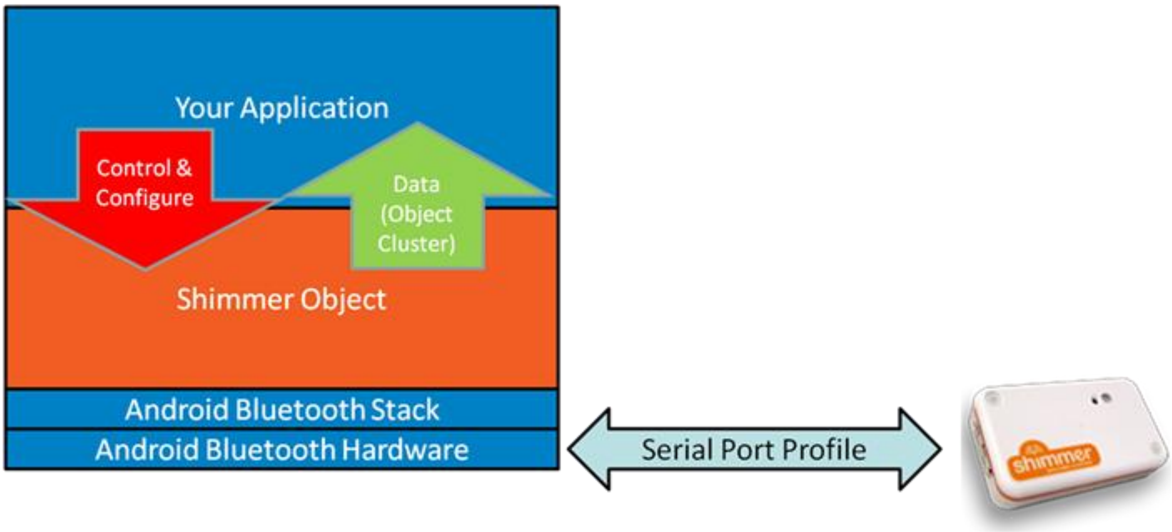


Figure 10: Shimmer Object

The *Shimmer* Class relies on the Bluetooth stack provided by Android to connect with the Shimmer device via the Serial Port Profile (SPP). SPP emulates a serial cable link over Bluetooth wireless technology. Each Shimmer device connected to the Android Device is represented by a Shimmer object which is an instance of the *Shimmer* Class. For example:-

```
Shimmer mShimmerDevice1 = new Shimmer(this, mHandler,"RightArm",false);
Shimmer mShimmerDevice2 = new Shimmer(this, mHandler,"LeftArm",false);
```

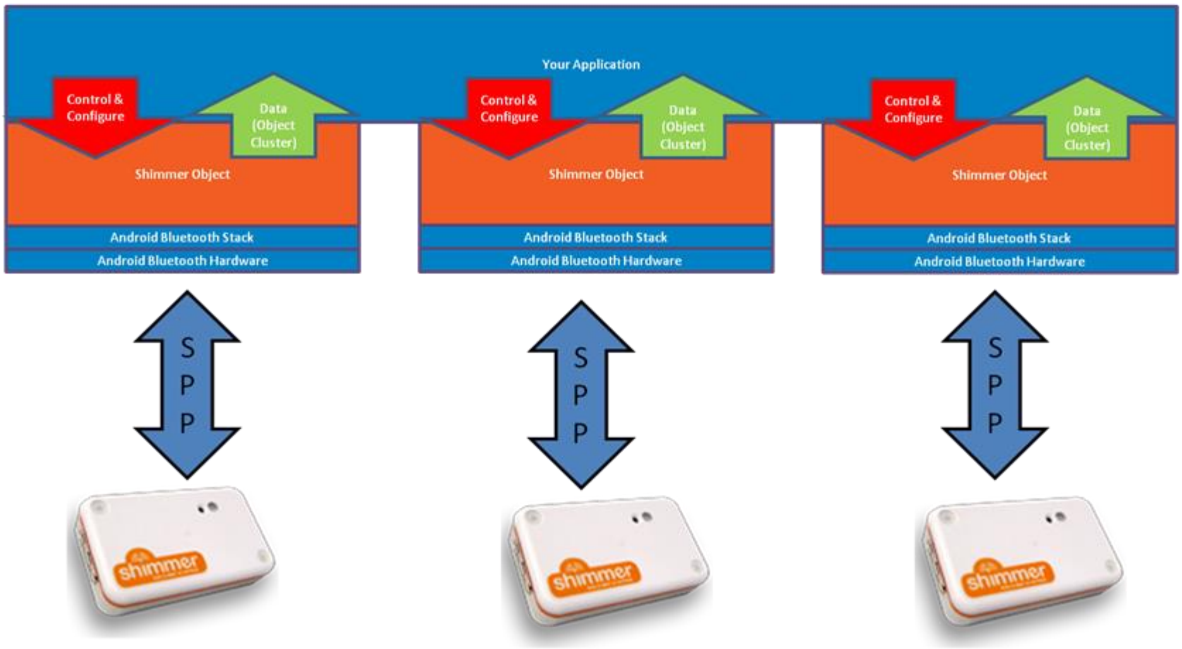


Figure 11: Multiple Shimmer Objects

There are other constructors provided for the Shimmer class, which allows you to immediately set the configuration of the Shimmer device you will be connecting to. Once a connection has been established, the Shimmer device is configured according to the specifications of the constructor.

The *Shimmer* Class exposes a number of functions to allow the Android Device to individually control each Shimmer device. The reader should note that functions that start with either write or read are direct commands to the Shimmer device, while functions that start with get or set are commands that only access the *Shimmer* class object.

The Shimmer device responds with an Acknowledge packet whenever a command is received. In some cases after sending an Acknowledge packet the Shimmer device proceeds in transmitting a response packet or data packets. This occurs when a read or streaming command is transmitted.

The following are among the few primary functions provided by the class:-

- *Connect*; e.g. *mShimmerDevice1.connect(bluetoothAddress,"default");*
    - Attempts to connect the Android device to the Shimmer device. There are two separate library options provided *default* and *gerdavax*. Only in cases where the *default* library does not meet your expectations should you attempt to use the *gerdavax* library.
- *startStreaming*
    - Starts streaming of the Shimmer Device

- *stopStreaming*
    - Stops streaming of the Shimmer Device
- *Inquiry*
    - An inquiry command allows the Android device to learn the current setup of the Shimmer device. Upon the reception of an inquiry command the Shimmer device will transmit an acknowledge packet and an inquiry response packet. The response packet contains information concerning the current setup of the Shimmer device, such as the sensors which have been enabled, the data packet size, and the contents of the data packet. For further information on the inquiry command please refer to the *BtStream* on Github for *Shimmer2r* [5]and *Shimmer3* [6].
- *writeEnabledSensors*
    - This command is used to enable specified sensors on the Shimmer device. After the acknowledge packet is received an inquiry command is executed to ensure the packet format is updated. When enabling multiple sensors on the Shimmer device use the following format where an Or operator is used. *E.g. mShimmerDevice1.writeEnabledSensors(Shimmer.SENSOR_ACCEL|Shimmer.SENSOR_GYRO);*
- *writeSamplingRate*
    - Transmits a command to the Shimmer unit, configuring its sampling rate.
- *writeAccelRange*
    - Transmits a command setting the range of the accelerometer on the Shimmer device

By default the Shimmer class will retrieve the calibration parameters from the Shimmer device. In the event calibration parameters are not found. The Shimmer device will use the default calibration parameters. Sensor data with units ending with * (e.g. m/s^2*) means default calibration parameters were used. Please refer to the *Shimmer 9DoF Calibration User Manual* for more information on calibration, available on our website[7].

Sensor data, commands and status messages are passed on from the Shimmer Class to the Android application using the Handler Class provided by the Android library. More information concerning the Handler Class is provided on the Android developer website[8]. In examples it is important to note how toast messages and data packets are sent from the Shimmer class to the main activity via the Handler.

[5] https://github.com/ShimmerResearch/tinyos-shimmer/tree/master/apps/BtStream
[6] https://github.com/ShimmerResearch/shimmer3/tree/master/apps/BtStream
[7] http://www.shimmersensing.com/support/wireless-sensor-networks-documentation/category/21
[8] http://developer.android.com/reference/android/os/Handler.html

4.3. Data Structure

The ObjectCluster and Property Cluster class describes the data structure used within this library. The data structure is used to encapsulate data from the driver. The ObjectCluster is made up of a MultiMap (PropertyCluster) where each key represents a Property (e.g. Accelerometer X) and each value the FormatCluster of that property. The FormatCluster is an object which holds the format (e.g. Calibrated), units and data of the property. An example of the data structure is shown in Figure 12.

This design was chosen to allow new properties such as Linear Acceleration and orientation to be included easily in the future along with new formats such as filtered (low pass, high pass, etc). Through the use of MultiMaps, properties within the data structure can be found easily. More information on MultiMaps can be found here[9].

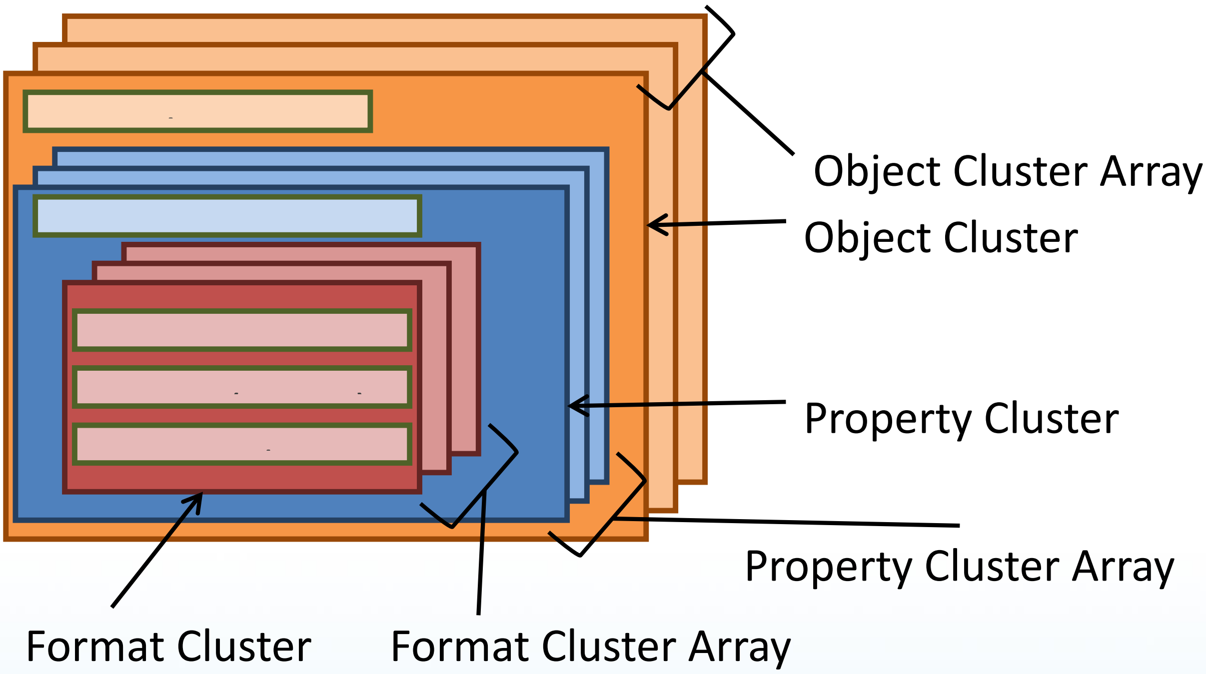


Figure 12: Data Structure

These seven lines of code show the basic operation of the Object Cluster. In the first line a new ObjectCLuster with the name RightArm is created. Lines 2-5 show how new properties are added to the object cluster. The resulting object cluster is shown in Figure 12. For better details users should refer to the *buildMsg* function within the ShimmerObject class.

```
1.  ObjectCluster objectCluster=new ObjectCluster("RightArm");
2.  objectCluster.mPropertyCluster.put("Accelerometer X",new FormatCluster("CAL","m/(sec^2)",0.5));
3.  objectCluster.mPropertyCluster.put("Accelerometer X",new FormatCluster("RAW","no units",50));
4.  objectCluster.mPropertyCluster.put("Accelerometer Y",new FormatCluster("CAL"," m/(sec^2)",0.5));
5.  objectCluster.mPropertyCluster.put("Accelerometer Y",new FormatCluster("RAW","no units",50))
```

[9] http://guava-libraries.googlecode.com/svn/tags/release03/javadoc/com/google/common/collect/Multimap.html

```
6. Collection<FormatCluster> accelXFormats = objectCluster.mPropertyCluster.get("Accelerometer X");
   // first retrieve all the possible formats for the current sensor device
7. FormatCluster formatCluster =
   ((FormatCluster)objectCluster.returnFormatCluster(accelXFormats,"CAL")); // retrieve the
   calibrated data
8. dataValue = formatCluster.mData;
```

Line 6 - 8 show how data is retrieved from a data structure. Initially the MultiMap (PropertyCluster) is searched for the property “Accelerometer X”. The result of this search is a Collection of different format clusters of Accelerometer X. More information on the Collection class can be found here[10]. Next in line 7 the returnFormatCluster function is used to return the Calibrated Data of Accelerometer X. Finally line 8 shows the data being passed to the variable dataValue.

The list of properties within an object cluster is built based on the inquiry response received from the Shimmer device which specifies what the channel contents will be for a data packet. The lists of properties currently supported by the Shimmer class are shown below.
Note that since Rev2.8 the property names have been updated. In order to continue using legacy names. User can continue using legacy signal properties by using the command

Configuration.setTooLegacyObjectClusterSensorNames();

Currently all examples still use legacy names. All calibrated data do not have a Channel identifier, because calibration is not down on the Shimmer device but within the API.

SHIMMER2

List of supported properties	**Format**	**Unit**	**Description**	**Inquiry Response Channel Identifier**
Timestamp	Raw	No Unit	Raw timestamp data is generated from the crystal oscillator on the Shimmer which has a frequency of 32768 Hz. Signal Data Type U12 which loop around 0 when it exceeds 65536	None
Accel_X	Raw	No Unit	Signal Data Type u12	0
Accel_Y	Raw	No Unit	Signal Data Type u12	1
Accel_Z	Raw	No Unit	Signal Data Type u12	2
Gyros_X	Raw	No Unit	Signal Data Type u12	3
Gyro_Y	Raw	No Unit	Signal Data Type u12	4
Gyros_Z	Raw	No Unit	Signal Data Type u12	5
Mag_X	Raw	No Unit	Signal Data Type i16	6
Mag_Y	Raw	No Unit	Signal Data Type i16	7
Mag_Z	Raw	No Unit	Signal Data Type i16	8

[10] http://docs.oracle.com/javase/1.4.2/docs/api/java/util/Collection.html

ECG_RA-LL	Raw	No Unit	Signal Data Type u12	9
ECG_LA-LL	Raw	No Unit	Signal Data Type u12	0A
GSR	Raw	No Unit	Signal Data Type u16, two MSBs signify the range, 12 bits only contain data	0B
EMG	Raw	No Unit	Signal Data Type u12	0D
Exp_Board_A0	Raw	No Unit	Signal Data Type u12	0E
Exp_Board_A7	Raw	No Unit	Signal Data Type u12	0F
Bridge_Amp_High	Raw	No Unit	Signal Data Type u12	10
Bridge_Amp_Low	Raw	No Unit	Signal Data Type u12	11
Heart_Rate	Raw	No Unit	Signal Data Type u16, this is not to be confused with ECG and is not derived from the ECG module	12
VsenseReg	Raw	No Unit	Pmux must be switched on, which switches the mux input used for expboardA0 to the battery	0E
Battery	Raw	No Unit	Pmux must be switched on, which switches the mux input used for expboardA7 to the battery	0F
Timestamp	CAL	mSecs		None
Accel_X	CAL	m/(Sec^2)	For best performance calibrate using Shimmer 9DOF Calibration Application	None
Accel_Y	CAL	m/(Sec^2)	See Shimmer 9DOF Cal App	None
Accel_Z	CAL	m/(Sec^2)	See Shimmer 9DOF Cal App	None
Gyros_X	CAL	deg/Sec	See Shimmer 9DOF Cal App	None
Gyro_Y	CAL	deg/Sec	See Shimmer 9DOF Cal App	None
Gyros_Z	CAL	deg/Sec	See Shimmer 9DOF Cal App	None
Mag_X	CAL	local	See Shimmer 9DOF Cal App	None
Mag_Y	CAL	local	See Shimmer 9DOF Cal App	None
Mag_Z	CAL	local	See Shimmer 9DOF Cal App	None
GSR	CAL	kOhms	Conductance is the inverse of this value	None
ECG_RA-LL	CAL	mVolts		None
ECG_LA-LL	CAL	mVolts		None
EMG	CAL	mVolts		None
Bridge_Amp_High	CAL	mVolts		None
Bridge_Amp_Low	CAL	mVolts		None
Heart Rate	CAL	BPM	Does not work with ECG, requires the extension radio module, and a polar heart rate strap	None
Exp_Board_A0	CAL	mVolts		None
Exp_Board_A7	CAL	mVolts		None
VSenseReg	CAL	mVolts		None
Battery	CAL	mVolts		None

Quat_Madge_9DOF_W	CAL	local	3D Orientation must be enabled using the following method enable3DOrientation()	None
Quat_Madge_9DOF_X	CAL	local	see enable3dOrientation()	None
Quat_Madge_9DOF_Y	CAL	local	see enable3dOrientation()	None
Quat_Madge_9DOF_Z	CAL	local	see enable3dOrientation()	None
Axis_Angle_A	CAL	local	see enable3dOrientation()	None
Axis_Angle_X	CAL	local	see enable3dOrientation()	None
Axis_Angle_Y	CAL	local	see enable3dOrientation()	None
Axis_Angle_Z	CAL	local	see enable3dOrientation()	None

Shimmer3

List of supported properties	Format	Unit	Description	Inquiry Response Channel Identifier
Timestamp	RAW	No Unit	Raw timestamp data is generated from the crystal oscillator on the Shimmer which has a frequency of 32768 Hz. Signal Data Type U12 which loop around 0 when it exceeds 65536	None
ACCEL_LN_X	RAW	No Unit	Signal Data Type u12	0x00
ACCEL_LN_Y	RAW	No Unit	Signal Data Type u12	0x01
ACCEL_LN_Z	RAW	No Unit	Signal Data Type u12	0x02
ACCEL_WR_X	RAW	No Unit	Signal Data Type i16	0x04
ACCEL_WR_Y	RAW	No Unit	Signal Data Type i16	0x05
ACCEL_WR_Z	RAW	No Unit	Signal Data Type i16	0x06
Gyro_X	RAW	No Unit	Signal Data Type i16r	0x0A
Gyro_Y	RAW	No Unit	Signal Data Type i16r	0x0B
Gyro_Z	RAW	No Unit	Signal Data Type i16r	0x0C
Mag_X	RAW	No Unit	Signal Data Type i16r	0x07
Mag_Y	RAW	No Unit	Signal Data Type i16r	0x08
Mag_Z	RAW	No Unit	Signal Data Type i16r	0x09
Battery	RAW	No Unit	Signal Data Type i16	0x03
Ext_Exp_A7	RAW	No Unit	Signal Data Type u12	0x0D
Ext_Exp_A6	RAW	No Unit	Signal Data Type u12	0x0E
Ext_Exp_A15	RAW	No Unit	Signal Data Type u12	0x0F
Int_Exp_A1	RAW	No Unit	Signal Data Type u12	0x10
Int_Exp_A12	RAW	No Unit	Signal Data Type u12	0x11
Int_Exp_A13	RAW	No Unit	Signal Data Type u12	0x12
Int_Exp_A14	RAW	No Unit	Signal Data Type u12	0x13
Pressure_BMP 180	RAW	No Unit	Signal Data Type u24r	0x1B
Temperature_ BMP180	RAW	No Unit	Signal Data Type u16r	0x1A
GSR	RAW	No Unit	Signal Data Type u16	0x1C

ECG_EMG_Status1	RAW	No unit	Signal Data Type u8	0x1D
ECG_EMG_Status2	RAW	No unit	Signal Data Type u8	0x20
ECG_LL-RA_24BIT	RAW	No unit	When EXG1 and EXG2 is enabled and EXG configuration is set to default ECG, see *enableDefaultECGConfiguration*	0x1E
ECG_LA-RA_24BIT	RAW	No unit	When EXG1 and EXG2 is enabled and EXG configuration is set to default ECG, see *enableDefaultECGConfiguration*	0x1F
EMG_CH1_24BIT	RAW	No unit	When EXG1 and EXG2 is and EXG configuration is set to default EMG, see *enableDefaultEMGConfiguration*	0x1E
EMG_CH2_24BIT	RAW	No unit	When EXG1 and EXG2 is enabled and EXG configuration is set to default EMG, see *enableDefaultEMGConfiguration n*	0x1F
EXG1_CH1_24BIT	RAW	No unit	When EXG1 is enabled, and default ECG/EMG configuration is not used. Signal Data Type i24r	0x1E
EXG1_CH2_24BIT	RAW	No unit	When EXG1 is enabled, and default ECG/EMG configuration is not used. Signal Data Type i24r	0x1F
ECG_Vx-RL_24BIT	RAW	No unit	When EXG2 is enabled, and default EXG configuration is set to ECG, see *enableDefaultECGConfiguration*	0x22
EXG2_CH1_24BIT	RAW	No unit	When EXG2 is enabled. Signal Data Type i24r	0x21
EXG2_CH2_24BIT	RAW	No unit	When EXG2 is enabled and default ECG configuration is not used. Signal Data Type i24r	0x22
EXG1_CH1_16BIT	RAW	No unit	When EXG1 16 bit is enabled, and default ECG/EMG configuration is not used. Signal Data Type i16r	0x23
EXG1_CH2_16BIT	RAW	No unit	When EXG1 16 bit is enabled, and default ECG/EMG configuration is not used. Signal Data Type i16r	0x24
EXG2_CH1_16BIT	RAW	No unit	When EXG2 16 bit is enabled, and default ECG/EMG configuration is not used. Signal Data Type i16r	0x25
EXG2_CH2_16BIT	RAW	No unit	When EXG2 16 bit is enabled, and default ECG/EMG configuration is not used. Signal Data Type i16r	0x26
Bridge_Amp_High	RAW	No unit	Signal Data Type u12	0x27
Bridge_Amp_Low	RAW	No unit	Signal Data Type u12	0x28

Timestamp	CAL	mSecs		None
ACCEL_LN_X	CAL	m/(Sec^2)	For best performance calibrate using Shimmer 9DOF Calibration Application	None
ACCEL_LN_Y	CAL	m/(Sec^2)	See Shimmer 9DOF Cal App	None
ACCEL_LN_Z	CAL	m/(Sec^2)	See Shimmer 9DOF Cal App	None
ACCEL_WR_X	CAL	m/(Sec^2)	See Shimmer 9DOF Cal App	None
ACCEL_WR_Y	CAL	m/(Sec^2)	See Shimmer 9DOF Cal App	None
ACCEL_WR_Z	CAL	m/(Sec^2)	See Shimmer 9DOF Cal App	None
Gyro_X	CAL	deg/Sec	See Shimmer 9DOF Cal App	None
Gyro_Y	CAL	deg/Sec	See Shimmer 9DOF Cal App	None
Gyro_Z	CAL	deg/Sec	See Shimmer 9DOF Cal App	None
Mag_X	CAL	local	See Shimmer 9DOF Cal App	None
Mag_Y	CAL	local	See Shimmer 9DOF Cal App	None
Mag_Z	CAL	local	See Shimmer 9DOF Cal App	None
Battery	CAL	mVolts		None
Ext_Exp_A7	CAL	mVolts		None
Ext_Exp_A6	CAL	mVolts		None
Ext_Exp_A15	CAL	mVolts		None
Int_Exp_A1	CAL	mVolts		None
Int_Exp_A12	CAL	mVolts		None
Int_Exp_A13	CAL	mVolts	Also used for PPG sensor (GSR+ board)	None
Int_Exp_A14	CAL	mVolts		None
Pressure_BMP 180	CAL	kPa		None
Temperature_ BMP180	CAL	Celcius		None
GSR	CAL	kOhms	Conductance is the inverse of this value	None
Quat_Madge_ 9DOF_W	CAL	local	3D Orientation must be enabled using the following method enable3DOrientation()	None
Quat_Madge_ 9DOF_X	CAL	local	see enable3dOrientation()	None
Quat_Madge_ 9DOF_Y	CAL	local	see enable3dOrientation()	None
Quat_Madge_ 9DOF_Z	CAL	local	see enable3dOrientation()	None
Axis_Angle_A	CAL	local	see enable3dOrientation()	None
Axis_Angle_X	CAL	local	see enable3dOrientation()	None
Axis_Angle_Y	CAL	local	see enable3dOrientation()	None
Axis_Angle_Z	CAL	local	see enable3dOrientation()	None
ECG_LL-RA_24BIT	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
ECG_LA-RA_24BIT	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EMG_CH1_24 BIT	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None

EMG_CH2_24 BIT	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG1_CH1_24 BIT	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG1_CH2_24 BIT	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
ECG_Vx-RL_24BIT	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG2_CH1_24 BIT	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG2_CH2_24 BIT	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG1_CH1_16 BIT	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG1_CH2_16 BIT	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG2_CH1_16 BIT	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG2_CH2_16BIT	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
Bridge_Amp_High	CAL	mVolts		None
Bridge_Amp_Low	CAL	mVolts		None

SHIMMER2 (*Legacy*)

List of supported properties	Format	Unit	Description	Inquiry Response Channel Identifier
Timestamp	Raw	No Unit	Raw timestamp data is generated from the crystal oscillator on the Shimmer which has a frequency of 32768 Hz. Signal Data Type U12 which loop around 0 when it exceeds 65536	None
Accelerometer X	Raw	No Unit	Signal Data Type u12	0
Accelerometer Y	Raw	No Unit	Signal Data Type u12	1
Accelerometer Z	Raw	No Unit	Signal Data Type u12	2
Gyroscope X	Raw	No Unit	Signal Data Type u12	3
Gyroscope Y	Raw	No Unit	Signal Data Type u12	4
Gyroscope Z	Raw	No Unit	Signal Data Type u12	5
Magnetometer X	Raw	No Unit	Signal Data Type i16	6
Magnetometer Y	Raw	No Unit	Signal Data Type i16	7
Magnetometer Z	Raw	No Unit	Signal Data Type i16	8
ECG RA-LL	Raw	No Unit	Signal Data Type u12	9
ECG LA-LL	Raw	No Unit	Signal Data Type u12	0A
GSR	Raw	No Unit	Signal Data Type u16, two MSBs signify the range, 12 bits only contain data	0B
EMG	Raw	No Unit	Signal Data Type u12	0D
ExpBoard A0	Raw	No Unit	Signal Data Type u12	0E
ExpBoard A7	Raw	No Unit	Signal Data Type u12	0F
Bridge Amplifier High	Raw	No Unit	Signal Data Type u12	10
Bridge Amplifier Low	Raw	No Unit	Signal Data Type u12	11
Heart Rate	Raw	No Unit	Signal Data Type u16, this is not to be confused with ECG and is not derived from the ECG module	12
VSenseReg	Raw	No Unit	Pmux must be switched on, which switches the mux input used for expboardA0 to the battery	0E
VSenseBatt	Raw	No Unit	Pmux must be switched on, which switches the mux input used for expboardA7 to the battery	0F
Timestamp	CAL	mSecs		None

Accelerometer X	CAL	m/(Sec^2)	For best performance calibrate using Shimmer 9DOF Calibration Application	None
Accelerometer Y	CAL	m/(Sec^2)	See Shimmer 9DOF Cal App	None
Accelerometer Z	CAL	m/(Sec^2)	See Shimmer 9DOF Cal App	None
Gyroscope X	CAL	deg/Sec	See Shimmer 9DOF Cal App	None
Gyroscope Y	CAL	deg/Sec	See Shimmer 9DOF Cal App	None
Gyroscope Z	CAL	deg/Sec	See Shimmer 9DOF Cal App	None
Magnetometer X	CAL	local	See Shimmer 9DOF Cal App	None
Magnetometer Y	CAL	local	See Shimmer 9DOF Cal App	None
Magnetometer Z	CAL	local	See Shimmer 9DOF Cal App	None
GSR	CAL	kOhms	Conductance is the inverse of this value	None
ECG RA-LL	CAL	mVolts		None
ECG LA-LL	CAL	mVolts		None
EMG	CAL	mVolts		None
Bridge Amplifier High	CAL	mVolts		None
Bridge Amplifier Low	CAL	mVolts		None
Heart Rate	CAL	BPM	Does not work with ECG, requires the extension radio module, and a polar heart rate strap	None
ExpBoard A0	CAL	mVolts		None
ExpBoard A7	CAL	mVolts		None
VSenseReg	CAL	mVolts		None
VSenseBatt	CAL	mVolts		None
Quarternion 0	CAL	local	3D Orientation must be enabled using the following method enable3DOrientation()	None
Quarternion 1	CAL	local	see enable3dOrientation()	None
Quarternion 2	CAL	local	see enable3dOrientation()	None
Quarternion 3	CAL	local	see enable3dOrientation()	None
Angle Axis A	CAL	local	see enable3dOrientation()	None
Angle Axis X	CAL	local	see enable3dOrientation()	None
Angle Axis Y	CAL	local	see enable3dOrientation()	None
Angle Axis Z	CAL	local	see enable3dOrientation()	None

Shimmer3 (*Legacy*)

List of supported properties	Format	Unit	Description	Inquiry Response Channel Identifier
Timestamp	RAW	No Unit	Raw timestamp data is generated from the crystal oscillator on the Shimmer which has a frequency of 32768 Hz. Signal Data Type U12 which loop around 0 when it exceeds 65536	None
Low Noise Accelerometer X	RAW	No Unit	Signal Data Type u12	0x00
Low Noise Accelerometer Y	RAW	No Unit	Signal Data Type u12	0x01
Low Noise Accelerometer Z	RAW	No Unit	Signal Data Type u12	0x02
Wide Range Accelerometer X	RAW	No Unit	Signal Data Type i16	0x04
Wide Range Accelerometer Y	RAW	No Unit	Signal Data Type i16	0x05
Wide Range Accelerometer Z	RAW	No Unit	Signal Data Type i16	0x06
Gyroscope X	RAW	No Unit	Signal Data Type i16r	0x0A
Gyroscope Y	RAW	No Unit	Signal Data Type i16r	0x0B
Gyroscope Z	RAW	No Unit	Signal Data Type i16r	0x0C
Magnetometer X	RAW	No Unit	Signal Data Type i16r	0x07
Magnetometer Y	RAW	No Unit	Signal Data Type i16r	0x08
Magnetometer Z	RAW	No Unit	Signal Data Type i16r	0x09
VSenseBatt	RAW	No Unit	Signal Data Type i16	0x03
External ADC A7	RAW	No Unit	Signal Data Type u12	0x0D
External ADC A6	RAW	No Unit	Signal Data Type u12	0x0E
External ADC A15	RAW	No Unit	Signal Data Type u12	0x0F
Internal ADC A1	RAW	No Unit	Signal Data Type u12	0x10
Internal ADC A12	RAW	No Unit	Signal Data Type u12	0x11

Internal ADC A13	RAW	No Unit	Signal Data Type u12	0x12
Internal ADC A14	RAW	No Unit	Signal Data Type u12	0x13
Pressure	RAW	No Unit	Signal Data Type u24r	0x1B
Temperature	RAW	No Unit	Signal Data Type u16r	0x1A
GSR	RAW	No Unit	Signal Data Type u16	0x1C
EXG1 Status	RAW	No unit	Signal Data Type u8	0x1D
EXG2 Status	RAW	No unit	Signal Data Type u8	0x20
ECG LL-RA	RAW	No unit	When EXG1 and EXG2 is enabled (16/24 bit) and EXG configuration is set to default ECG, see *enableDefaultECGConfiguration*	0x1E
ECG LA-RA	RAW	No unit	When EXG1 and EXG2 is enabled (16/24 bit) and EXG configuration is set to default ECG, see *enableDefaultECGConfiguration*	0x1F
EMG CH1	RAW	No unit	When EXG1 and EXG2 is enabled (16/24 bit) and EXG configuration is set to default EMG, see *enableDefaultEMGConfiguration*	0x1E
EMG CH2	RAW	No unit	When EXG1 and EXG2 is enabled (16/24 bit) and EXG configuration is set to default EMG, see *enableDefaultEMGConfiguration n*	0x1F
EXG1 CH1	RAW	No unit	When EXG1 is enabled, and default ECG/EMG configuration is not used. Signal Data Type i24r	0x1E
EXG1 CH2	RAW	No unit	When EXG1 is enabled, and default ECG/EMG configuration is not used. Signal Data Type i24r	0x1F
ECG Vx-RL	RAW	No unit	When EXG2 is enabled, and default EXG configuration is set to ECG, see *enableDefaultECGConfiguration*	0x22
EXG2 CH1	RAW	No unit	When EXG2 is enabled. Signal Data Type i24r	0x21
EXG2 CH2	RAW	No unit	When EXG2 is enabled and default ECG configuration is not used. Signal Data Type i24r	0x22
EXG1 CH1 16 Bit	RAW	No unit	When EXG1 16 bit is enabled, and default ECG/EMG configuration is not used. Signal Data Type i16r	0x23
EXG1 CH2 16Bit	RAW	No unit	When EXG1 16 bit is enabled, and default ECG/EMG configuration is not used. Signal Data Type i16r	0x24
EXG2 CH1 16 Bit	RAW	No unit	When EXG2 16 bit is enabled, and default ECG/EMG configuration is not used.	0x25

			Signal Data Type i16r	
EXG2 CH2 16Bit	RAW	No unit	When EXG2 16 bit is enabled, and default ECG/EMG configuration is not used. Signal Data Type i16r	0x26
Bridge Amplifier High	RAW	No unit	Signal Data Type u12	0x27
Bridge Amplifier Low	RAW	No unit	Signal Data Type u12	0x28
Timestamp	CAL	mSecs		None
Low Noise Accelerometer X	CAL	m/(Sec^2)	For best performance calibrate using Shimmer 9DOF Calibration Application	None
Low Noise Accelerometer Y	CAL	m/(Sec^2)	See Shimmer 9DOF Cal App	None
Low Noise Accelerometer Z	CAL	m/(Sec^2)	See Shimmer 9DOF Cal App	None
Wide Range Accelerometer X	CAL	m/(Sec^2)	See Shimmer 9DOF Cal App	None
Wide Range Accelerometer Y	CAL	m/(Sec^2)	See Shimmer 9DOF Cal App	None
Wide Range Accelerometer Z	CAL	m/(Sec^2)	See Shimmer 9DOF Cal App	None
Gyroscope X	CAL	deg/Sec	See Shimmer 9DOF Cal App	None
Gyroscope Y	CAL	deg/Sec	See Shimmer 9DOF Cal App	None
Gyroscope Z	CAL	deg/Sec	See Shimmer 9DOF Cal App	None
Magnetometer X	CAL	local	See Shimmer 9DOF Cal App	None
Magnetometer Y	CAL	local	See Shimmer 9DOF Cal App	None
Magnetometer Z	CAL	local	See Shimmer 9DOF Cal App	None
VSenseBatt	CAL	mVolts		None
External ADC A7	CAL	mVolts		None
External ADC A6	CAL	mVolts		None
External ADC A15	CAL	mVolts		None
Internal ADC A1	CAL	mVolts		None
Internal ADC A12	CAL	mVolts		None

Internal ADC A13	CAL	mVolts	Also used for PPG sensor (GSR+ board)	None
Internal ADC A14	CAL	mVolts		None
Pressure	CAL	kPa		None
Temperature	CAL	Celcius		None
GSR	CAL	kOhms	Conductance is the inverse of this value	None
Quarternion 0	CAL	local	3D Orientation must be enabled using the following method enable3DOrientation()	None
Quarternion 1	CAL	local	see enable3dOrientation()	None
Quarternion 2	CAL	local	see enable3dOrientation()	None
Quarternion 3	CAL	local	see enable3dOrientation()	None
Angle Axis A	CAL	local	see enable3dOrientation()	None
Angle Axis X	CAL	local	see enable3dOrientation()	None
Angle Axis Y	CAL	local	see enable3dOrientation()	None
Angle Axis Z	CAL	local	see enable3dOrientation()	None
EXG1 Status	CAL	mVolts		None
EXG2 Status	CAL	mVolts		None
ECG LL-RA	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
ECG LA-RA	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EMG CH1	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EMG CH2	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG1 CH1	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG1 CH2	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
ECG Vx-RL	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG2 CH1	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG2 CH2	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG1 CH1 16 Bit	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG1 CH2 16Bit	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG2 CH1 16 Bit	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
EXG2 CH2 16Bit	CAL	mVolts	Depends on EXG register configuration, see comments on RAW	None
Bridge Amplifier High	CAL	mVolts		None

Bridge Amplifier Low	CAL	mVolts		None

5. Android Design Concepts

In this section we go through some basic Android concepts which readers should take note off. Most of the information have been taken from http://developer.android.com/develop/index.html and condensed where possible to suit the needs of this user guide. For a more in depth view the reader should refer to the source.

5.1. Activity and Service

An Activity is an application component that provides a screen with which users can interact in order to do something, such as dial the phone, take a photo, send an email, or view a map. Each activity is given a window in which to draw its user interface. The window typically fills the screen, but may be smaller than the screen and float on top of other windows.

The Android system attempts to keep application process around for as long as possible, but eventually will need to remove old processes when memory runs low. As described in Activity Lifecycle, the decision about which process to remove is intimately tied to the state of the user's interaction with it. In general, there are four states a process can be in based on the activities running in it, listed here in order of importance. The system will kill less important processes (the last ones) before it resorts to killing more important processes (the first ones).

The **foreground activity** (the activity at the top of the screen that the user is currently interacting with) is considered the *most important*. Its process will only be killed as a last resort, if it uses more memory than is available on the device. Generally at this point the device has reached a memory paging state, so this is required in order to keep the user interface responsive.

A **visible activity** (an activity that is visible to the user but not in the foreground, such as one sitting behind a foreground dialog) is considered extremely important and will not be killed unless that is required to keep the foreground activity running.

A **background activity** (an activity that is not visible to the user and has been paused) is no longer critical, so the system may safely kill its process to reclaim memory for other foreground or visible processes. If its process needs to be killed, when the user navigates back to the activity (making it visible on the screen again), its onCreate(Bundle) method will be called with the savedInstanceState it had previously supplied in onSaveInstanceState(Bundle) so that it can restart itself in the same state as the user last left it.

An **empty process** is one hosting no activities or other application components (such as Service or BroadcastReceiver classes). These are killed very quickly by the system as memory becomes low. For this reason, any background operation you do outside of an activity must be executed in the context of an activity BroadcastReceiver or Service to ensure that the system knows it needs to keep your process around.

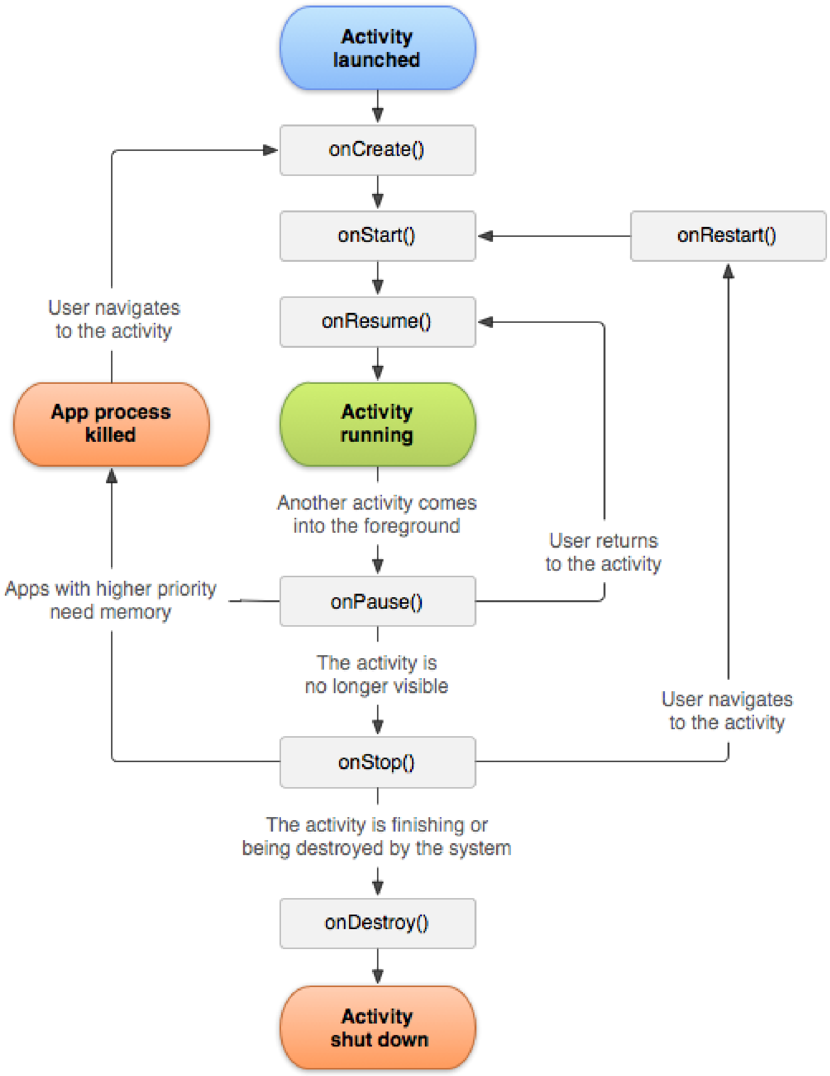


Figure 13: Activity lifecycle[11]

Figure 13 shows the lifecycle of an activity. From the flowchart it can be seen that an Application process can be killed when apps with higher priority need memory. Sometimes an Activity may need to do a long-running operation that exists independently of the activity lifecycle itself. An example is when you are logging data from a Shimmer device. As logging can take a long time, the application should allow the user to leave the application while it is executing. To accomplish this, your Activity should start a Service[12] in which logging takes place. This allows the system to properly prioritize your process (considering it to be more important than other non-visible applications) for the duration of the upload, independent of whether the original activity is paused, stopped, or finished.

[11] http://developer.android.com/reference/android/app/Activity.html
[12] http://developer.android.com/reference/android/app/Service.html

A Service is an application component that can perform long-running operations in the background and does not provide a user interface.

It is important to understand when to use a service when designing an Android application.

An example of how to use a service in logging context in given in the ShimmerGraphandLogService example. Note that the example only uses a background service, and that services too have a priority lifecycle. Users should note the difference between a foreground service and a background service. A foreground service[13] is defined as

- A started service can use the `startForeground(int, Notification)` API to put the service in a foreground state, where the system considers it to be something the user is actively aware of and thus not a candidate for killing when low on memory. (It is still theoretically possible for the service to be killed under extreme memory pressure from the current foreground application, but in practice this should not be a concern.)

5.2. The Handler

When a process is created for your application, its main thread is dedicated to running a message queue that takes care of managing the top-level application objects (activities, broadcast receivers, etc.) and any windows they create. You can create your own threads, and communicate back with the main application thread through a Handler. This is done by calling the *post* or *sendMessage* methods, from your new thread.

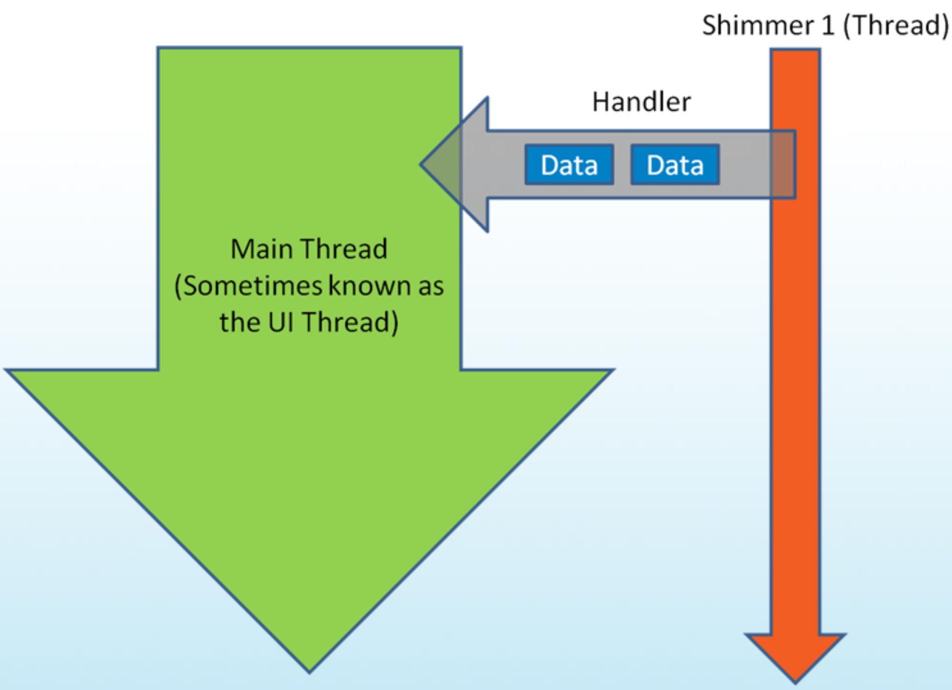


Figure 14: Handler

[13] http://developer.android.com/reference/android/app/Service.html

In Section 6.1 an example which shows some of the different types of messages passed on from the Shimmer thread to the Main UI thread is given. In Section 6.3 an example which shows how to use the Handler to connect to multiple Shimmer devices sequentially without having to lock the Main UI thread is given.

Readers should note that while it is safer to use a static handler, for simplicity many of the examples don't, for an example of a static handler use please refer to the MultiShimmerTemplate example.

6. Examples

There are a number of examples provided with the library. In this section a run through of each example and some of the important design concepts readers should be aware of is presented. Users who are using *Shimmer3*, should pay attention specifically to the examples *ShimmerGraphandLogService* and the *MultiShimmerTemplate*.

6.1. ShimmerExample

The Shimmer example is the most basic example provided. It does not have any UI elements in it. The purpose of the example is to show how to use the Shimmer driver to connect an Android phone to a Shimmer unit. Readers should take note of the *Handler* in *ShimmerExampleActivity*. As mentioned the handler is the means of communicating back with the main application thread from your own created thread.

In the example there are three types of messages sent from the Shimmer thread to the Main UI thread via the handler. The messages are *Shimmer.MESSAGE_READ*, *Shimmer.MESSAGE_STATE_CHANGE* and *Shimmer.MESSAGE_TOAST . Shimmer.MESSAGE_READ is used to send sensor data*. *Shimmer.MESSAGE_STATE_CHANGE* is used to notify the activity page which state the shimmer is in. ***Note that a Shimmer is only deem connected once the Shimmer.MSG_STATE_FULLY_INITIALIZED message has been received, at which point other commands may be transmitted to the Shimmer device, such as startStreaming().*** *Shimmer.MESSAGE_TOAST* is used to receive and post toast messages from the driver onto the screen. Other important things to note is how properties and formats are retrieved from the object cluster.

When using this example the user should have the LogCat open. Sensor data is printed on the LogCat via the following command:-

Log.d("CalibratedData","AccelX: " + formatCluster.mData + " "+ formatCluster.mUnits);

Figure 18 shows an example output of the LogCat.

6.2. ShimmerLogExample

This example builds on the ShimmerExample and shows how to log data. Using the *Logging* class provided in *com.shimmerresearch.tools*. In particular should note the following line of code:-

```
private static String mFileName = "shimmerlogexample";
static Logging log = new Logging(mFileName,"\t"); //insert file name
log.logData(objectCluster);
```

which logs the data in a tab delimited (*"\t"*) format. The file is saved into the *externalstoragedirectory*. See figure below for example of log file, being viewed from an Android device using a file explorer program.

Figure 15: Screenshot of ShimmerLogExample

Readers should note that this example is just to get users started, and that it is better to have log data through a service, than from within an activity. An example of how to do this can be found in the example *ShimmerGraphandLogService*. Also note that if you are running the example while the Android device is connected to the PC, the log file will not show up on the PC side unless you reconnect the USB cable, to force the PC to refresh its view of the Android file system.

6.3. MultiShimmerExample

This example shows how to connect and stream data from two different shimmer devices. In the example the second connection is only executed after the first has been fully initialized. This is demonstrated in the figure. First a command to connect to a shimmer device is executed in the main thread. This creates the Shimmer 1 thread. When the device is connected and initialized, a message (see *Shimmer.MSG_STATE_FULLY_INITIALIZED*) is sent to the Main UI thread which then executes the command to connect to the second Shimmer device. By doing so you can avoid locking up the main UI thread while waiting for the connection to Shimmer1 to finish.

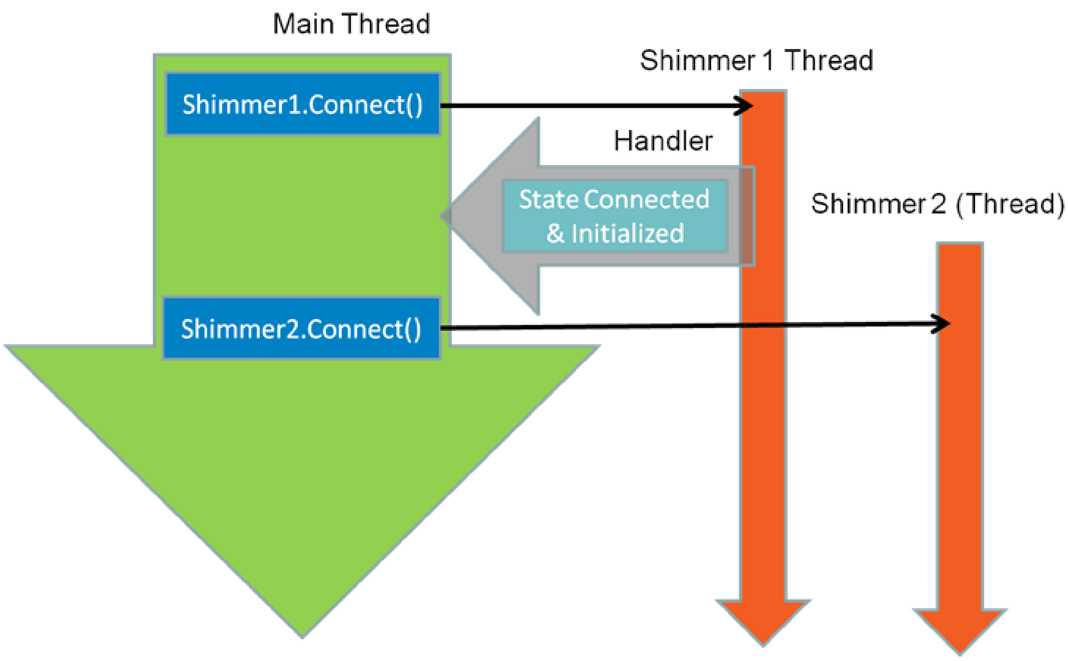


Figure 16: Handler, connecting two Shimmer devices sequentially

6.4. ShimmerGraph

Is a simple UI Legacy example which allows you to connect and stream data from a Shimmer device. Users looking to build on this example should consider using the *ShimmerGraphandLogService* instead.

6.5. MultiShimmerGraph

This legacy example builds on the ShimmerGraph example and extends it for use with multiple Shimmer devices. Users developing applications with multiple shimmer devices may want to consider using a service-like approach similar to the example *ShimmerGraphandLogService* or *MultiShimmerTemplate*.

6.6. Broadcast Service and Receiver Example

An example service which can broadcast sensor data from one Android application to another Android application is provided. The example application on how to receive this broadcast is provided. The broadcast example is provided in the folder ShimmerBroadcastServiceExample. Example application of how to receive the broadcast is provided in the folder ShimmerBroadcastReceiverExample. Brief instructions on how to use both examples follows:-

1. First import ShimmerBroadcastandService into Eclipse

2. Run the example using Eclipse. A screen shot of the app is shown below

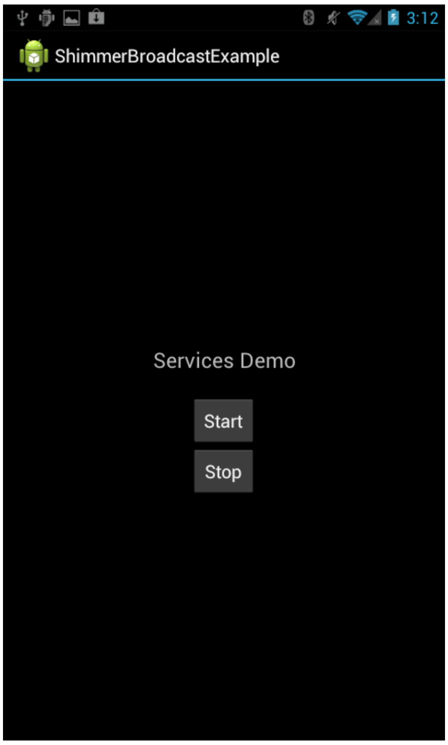
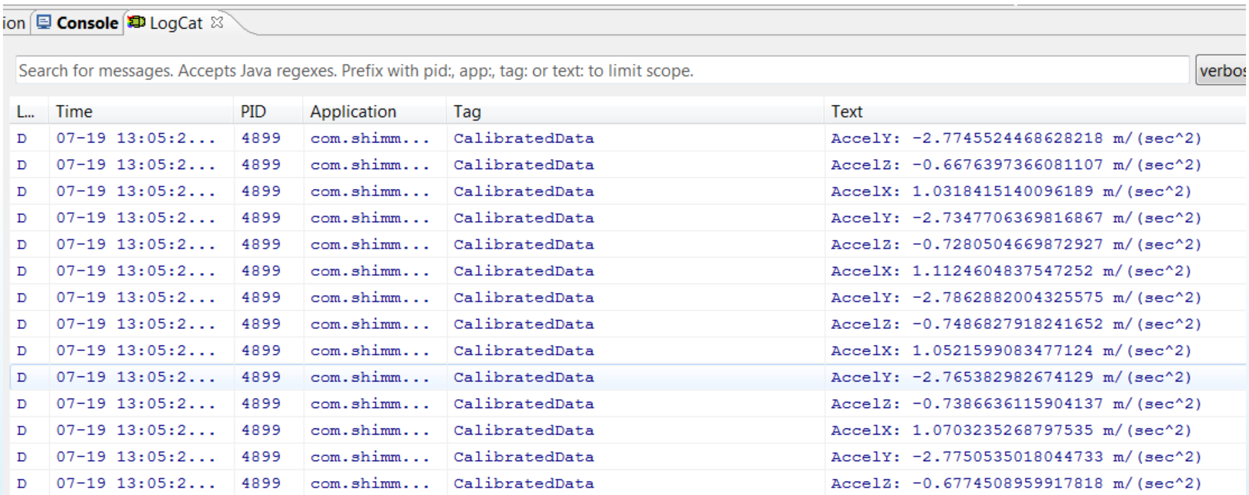


Figure 17: Screenshot of ShimmerBroadcastServiceExample

3. Once the app has been loaded, press start. Figure 18 shows the LogCat once the Shimmer device has started streaming.



L...	Time	PID	Application	Tag	Text
D	07-19 13:05:2...	4899	com.shimm...	CalibratedData	AccelY: -2.7745524468628218 m/(sec^2)
D	07-19 13:05:2...	4899	com.shimm...	CalibratedData	AccelZ: -0.6676397366081107 m/(sec^2)
D	07-19 13:05:2...	4899	com.shimm...	CalibratedData	AccelX: 1.0318415140096189 m/(sec^2)
D	07-19 13:05:2...	4899	com.shimm...	CalibratedData	AccelY: -2.7347706369816867 m/(sec^2)
D	07-19 13:05:2...	4899	com.shimm...	CalibratedData	AccelZ: -0.7280504669872927 m/(sec^2)
D	07-19 13:05:2...	4899	com.shimm...	CalibratedData	AccelX: 1.1124604837547252 m/(sec^2)
D	07-19 13:05:2...	4899	com.shimm...	CalibratedData	AccelY: -2.7862882004325575 m/(sec^2)
D	07-19 13:05:2...	4899	com.shimm...	CalibratedData	AccelZ: -0.7486827918241652 m/(sec^2)
D	07-19 13:05:2...	4899	com.shimm...	CalibratedData	AccelX: 1.0521599083477124 m/(sec^2)
D	07-19 13:05:2...	4899	com.shimm...	CalibratedData	AccelY: -2.765382982674129 m/(sec^2)
D	07-19 13:05:2...	4899	com.shimm...	CalibratedData	AccelZ: -0.7386636115904137 m/(sec^2)
D	07-19 13:05:2...	4899	com.shimm...	CalibratedData	AccelX: 1.0703235268797535 m/(sec^2)
D	07-19 13:05:2...	4899	com.shimm...	CalibratedData	AccelY: -2.7750535018044733 m/(sec^2)
D	07-19 13:05:2...	4899	com.shimm...	CalibratedData	AccelZ: -0.6774508959917818 m/(sec^2)

Figure 18: LogCat of ShimmerBroadcastServiceExample

4. Next import *ShimmerBroadcastReceiverExample* and run it. Figure 19 shows the LogCat when this application has been loaded. An additional Tag named Receiver is seen in addition to the

CalibratedData. Data is being passed from the Service to the receiver application via a broadcast. More information can be found here [14]

	Application	Tag	Text
.	com.shimmerresearch.service	CalibratedData	AccelY: -2.805183096957099 m/(sec^2)
.	com.shimmerresearch.service	CalibratedData	AccelZ: -0.7091562211952324 m/(sec^2)
.	com.shimmerresearch.receiver	Receiver	-0.7091562211952324
.	com.shimmerresearch.service	CalibratedData	AccelX: 0.9815561789881918 m/(sec^2)
.	com.shimmerresearch.service	CalibratedData	AccelY: -2.7442736820586737 m/(sec^2)
.	com.shimmerresearch.service	CalibratedData	AccelZ: -0.7185392996063936 m/(sec^2)
.	com.shimmerresearch.receiver	Receiver	-0.7185392996063936
.	com.shimmerresearch.service	CalibratedData	AccelX: 1.0000198311599897 m/(sec^2)
.	com.shimmerresearch.service	CalibratedData	AccelY: -2.7439462026376575 m/(sec^2)
.	com.shimmerresearch.service	CalibratedData	AccelZ: -0.66732770533299 m/(sec^2)
.	com.shimmerresearch.receiver	Receiver	-0.66732770533299
.	com.shimmerresearch.service	CalibratedData	AccelX: 1.0018624532534512 m/(sec^2)

Figure 19: LogCat of ShimmerBroadcastReceiverExample

5. The service can be stopped by returning to the ShimmerBroadcastServiceExample app and pressing the stop button.

A more elaborate example of the use of services can be found in the folders ShimmerGraphandLogService and MultiShimmerTemplate.

6.7. ShimmerGraphandLogService

The ShimmerGraphandLogService is an example of how to convert an application like Shimmer Graph into a service. Implementation of the service can be found in the ShimmerService.java file. The ShimmerGraph example initializes the Shimmer Object within the Activity as such:-

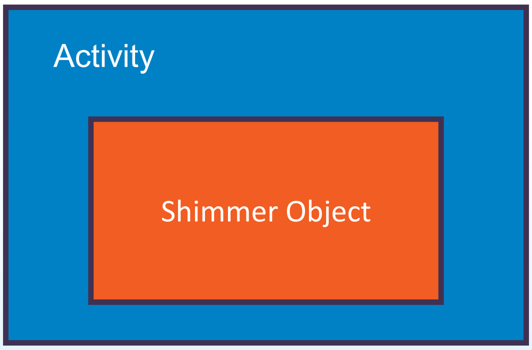


Figure 20: ShimmerGraph

As mentioned in the Section 5, due to the activity lifecycle the activity might be closed thus causing your connection to the Shimmer device to be lost. This example shows how to use a service to cope with long term operations of an Android application such as when you are logging data. Figure 21 shows a representative block diagram of the ShimmerGraphandLogService example.

[14] http://developer.android.com/reference/android/content/BroadcastReceiver.html

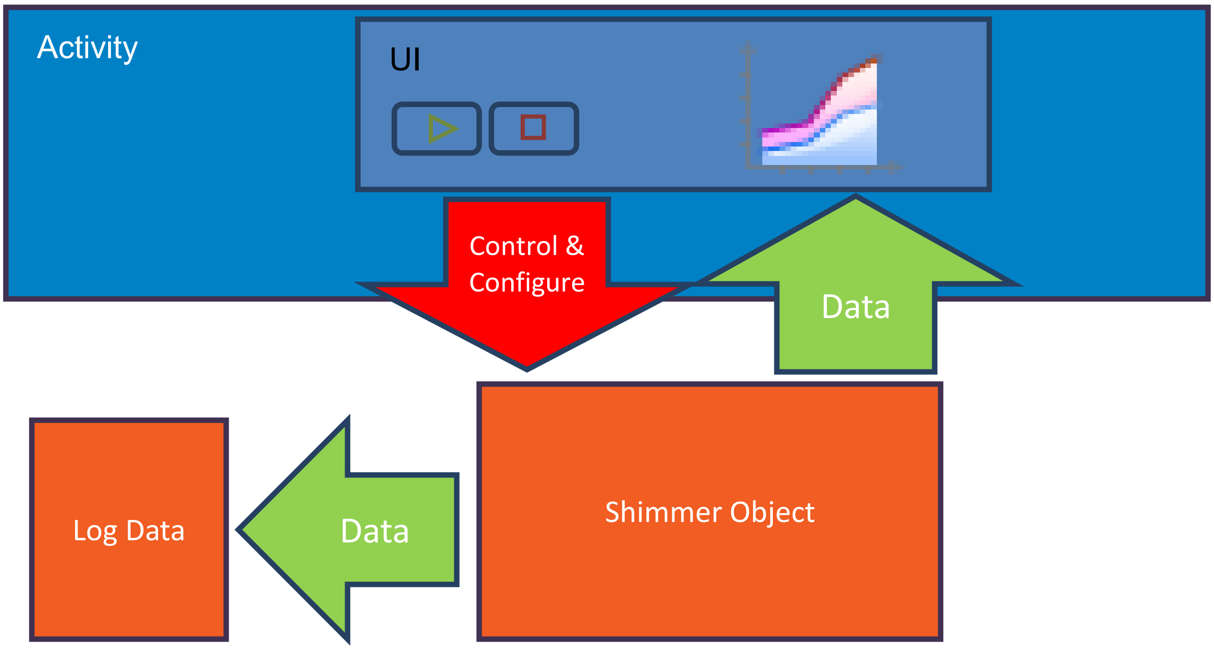


Figure 21: ShimmerGraphandLogService

Compared to Shimmer Graph, this application also has a variety of additional functionalities which are packet reception rate monitoring, battery monitoring, low battery notification and low power magnetometer. As mentioned earlier, in order to use both battery monitoring and low battery notification on the Shimmer device, the battery voltage sensor has to be enabled prior to streaming. The low battery limit can be set via the Commands tab. By default the limit is set to 3.4 Volts. ShimmerGraphandLogService plots the uncalibrated data of the Shimmer. Refer to the *Shimmer 9DoF Calibration User Manual* for more information on this.

When using *Shimmer2* there are six different sampling rates possible for the Magnetometer (0.5 Hz, 1.0 Hz, 2.0 Hz, 5.0 Hz, 10.0 Hz; 5 = 20.0 Hz; 6 = 50.0 Hz). The Magnetometer sampling rate is set to 10Hz when low power magnetometer is enabled, otherwise the sampling rate of the Magnetometer is set as close as possible to the current sampling rate of the Shimmer device. Enabling low power mode for *Shimmer3* works the same with the sampling frequency of the Accelerometer set to 10Hz, the Gyroscope to 31.25Hz and the Magnetometer to 15Hz. Otherwise the sampling rate are set as close as possible to the sampling rate of the *Shimmer3*. Besides low power modes, *Shimmer3* also allows the setting of different Magnetometer/Gyroscope and Accelerometer range.

Data is logged to the root directory of your external storage directory[15]. The current time in milliseconds[16] (at which the file was created) is appended to the filename you have specified. The file can be transferred to your PC via Bluetooth, USB or through the use of an application like DropBox.

[15] http://developer.android.com/reference/android/os/Environment.html#getExternalStorageDirectory()
[16] http://docs.oracle.com/javase/6/docs/api/java/lang/System.html#currentTimeMillis()

An important thing to note is that while the example application only is limited to the use of a single Shimmer device, the service has been designed to be forward compatible for use with multiple Shimmer devices. Also see the *MultiShimmerPlay* example located in the Unsupported Examples folder.

6.8. Shimmer3DOrientationExample

This example shows how to obtain the 3D orientation of the Shimmer device using the Accelerometer, Gyroscope and Magnetometer. The orientation algorithm used was proposed in the following paper:

Sebastian OH Madgwick, Andrew JL Harrison, and Ravi Vaidyanathan. "*Estimation of imu and marg orientation using a gradient descent algorithm*." Rehabilitation Robotics (ICORR), 2011 IEEE International Conference on. IEEE, 2011.

In order to use this example users need to calibrate their Shimmer devices, using the *Shimmer 9DoF Calibration* application. The Shimmer axis direction used should be the same as what is shown in Figure 22. For further information it is recommended that the user refer to the *Shimmer 9DoF Calibration User Manual* and the corresponding Tutorial Video on YouTube[17].

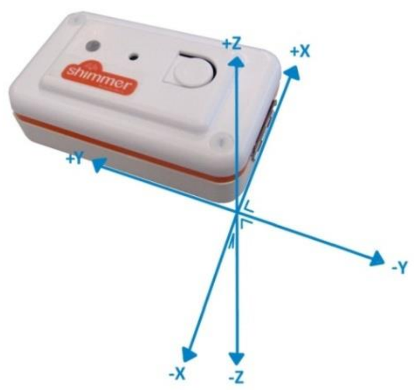


Figure 22: Shimmer Axis Direction

To connect the Shimmer, press the Menu button on the Android device and select Connect. Choose the Shimmer ID from the list of devices and start streaming. Once the device has started streaming position the Android device and Shimmer device as shown in the figure where both the *y*-axis of the Android and Shimmer device are parallel and are pointing in the same direction. Once the cube representation of the Shimmer device has become static press the set button. Once pressed you should now see the orange side of the cube as shown in Figure 23.

[17] https://www.youtube.com/watch?v=aI2WDecTtfs

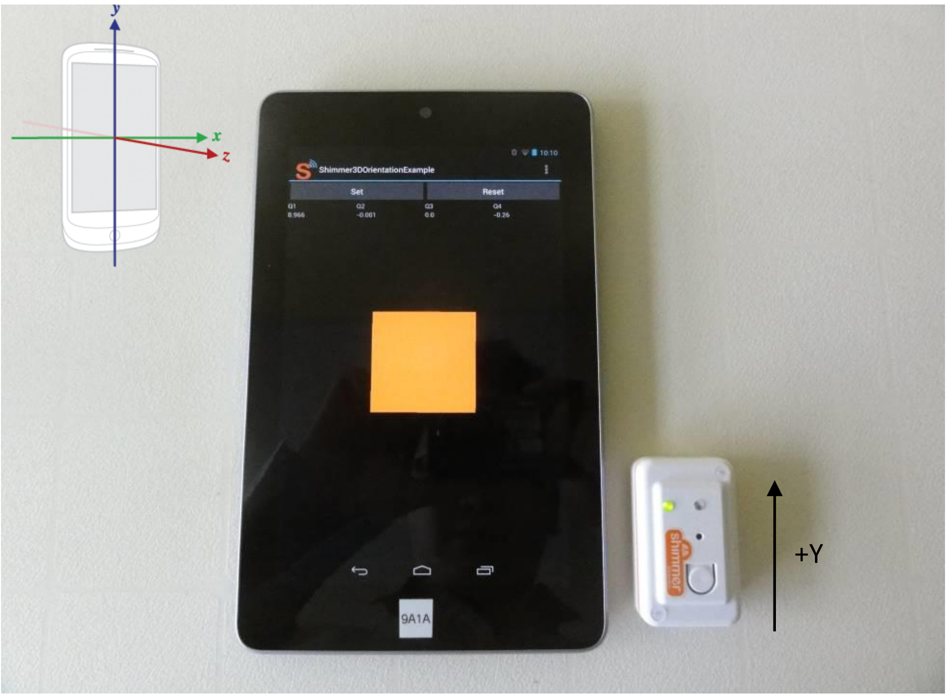


Figure 23: Front Representation of the Shimmer device

Turning the Shimmer device along the *y*-axis to the position shown in Figure 24 will result in the cube showing the green side.

Within this example functionality to enable Gyro On-The-Fly Calibration is provided. When enabled the offset vector of the gyroscope is recalculated whenever the Shimmer device is stationary. Implementation details of this can be found in the Shimmer.java file.

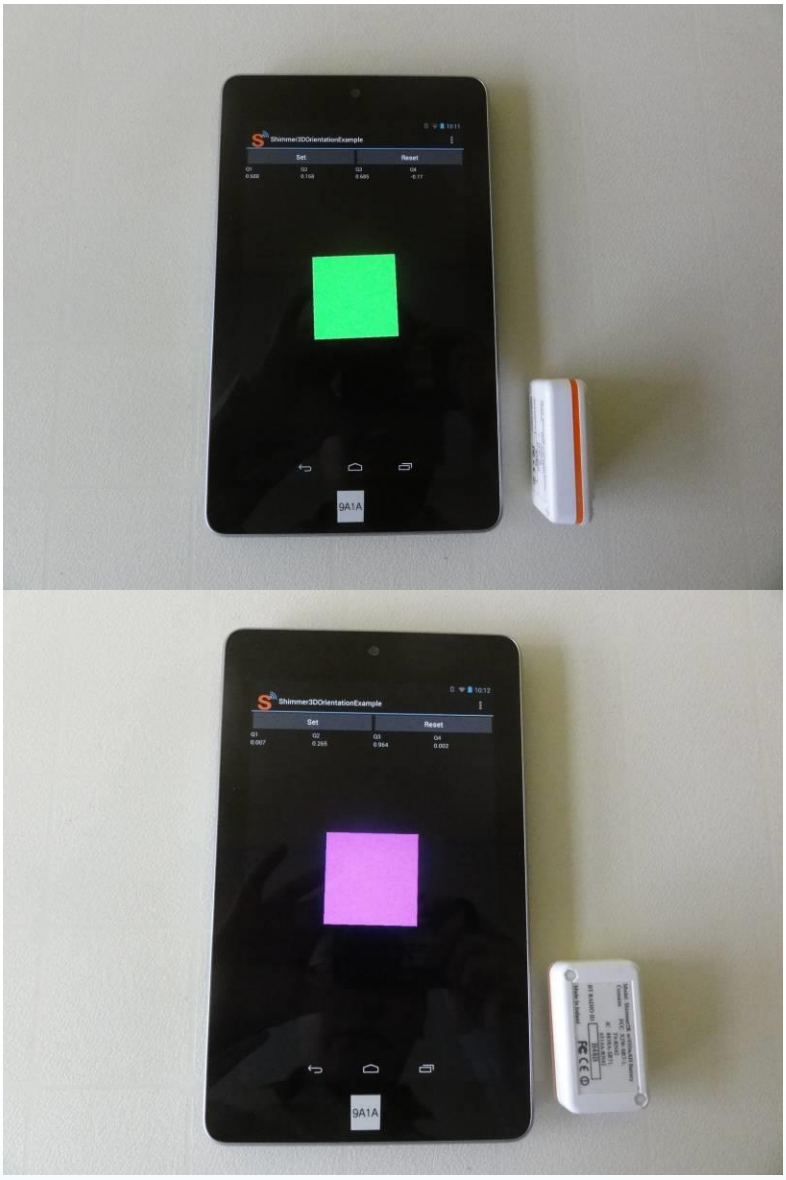


Figure 24: Side and Back 3D Representation of the Shimmer device

6.9. MultiShimmerTemplate

The purpose of this example is to allow users to focus more on developing the application rather than having to worry about controlling and configuring their Shimmer devices. This example is made up 3 different options in the navigation drawer menu: Devices, Plot and Blank.

Devices

The Devices item provides the functionality of adding new devices. Once the Shimmer has been added, several options regarding the state of the Shimmer are provided. The configuration option will be only available when the Shimmer is in a connected state.

Plot

The plot panel allows users to plot signals. It also shows the heart rate when the option is selected.

Blank

The blank fragment is to help users get started creating their own fragments.

Heart Rate option

The heart rate panel allows users to calculate heart rate data from either the PPG or ECG sensor. PPG users should note that the following sensors, GSR and PPG (Internal ADC A1, A12, A13 or A14), need to be enabled when using this feature. In addition Int Exp Power has to be enabled as well. For ECG uses, set enabled sensors to ECG. Once set re-load the configuration dialog and select Heart Rate. Next pick the ECG channel which will be used to calculate the heart rate. Heart rate calculation requires a 10 second training phase, of which no data will be plotted. Due to Android Processing limitations we recommend setting the sampling rate to 128Hz. Note that we do not provide any support in terms of the ECG/PPG to HR algorithm in itself and only the jar file is provided.

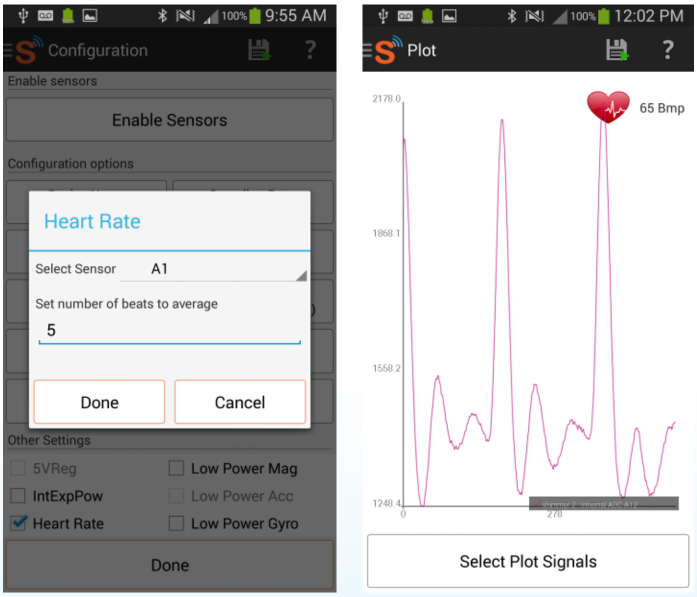


Figure 25: Heart Rate. a: HR configuration b: HR visualization

NOTE: The PPG Signal takes a couple of seconds before it reaches a steady state where the pulse can clearly be seen.

Write Data To File option

The floppy disk icon placed in the action bar offers the possibility to write the data from all devices to a file (one file for each device). The files will be saved in the MultiShimmerTemplate folder.

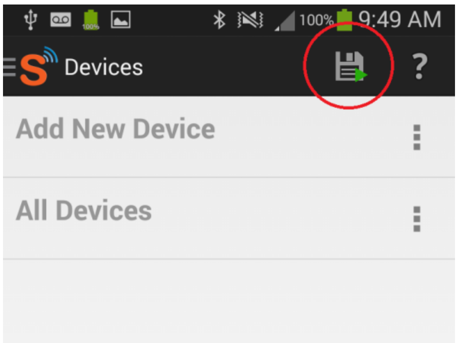


Figure 26: Write Data To File icon

6.10. ShimmerAdvancedExGExample

This example shows how to use the Advanced ExG features. Users should note that this app is only compatible with Shimmer 3 devices with BtStream v0.3, LogAndStream v0.1, SDLog v.07 or higher versions of these firmwares. In order to try the ExG configuration a Shimmer 3 must be connected. Then the *Shimmer ExG Configuration* menu option must be selected.

This app also aims to test the ExG configuration. The *Load ExG Values* menu option displays the ExG configuration for both chips. For testing the configuration the device must be streaming data. Please refer to the Advance ExG manual for further information.

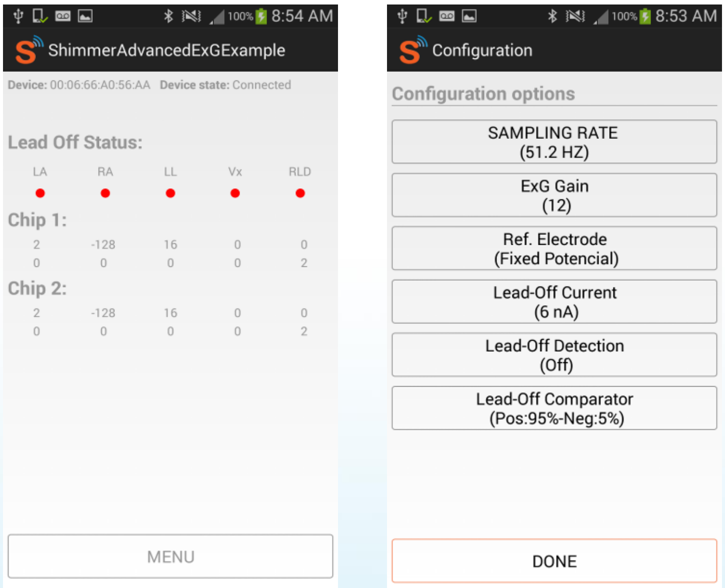


Figure 26: ShimmeAdvancedExGExample. a: Main screen b:ExG Advanced configuration screen

6.11. ShimmerLogAndStreamExample

This example shows how to use the LogAndStream firmware. Users should note that this app is only compatible with Shimmer 3 devices running LogAndStream firmware. The app is based around several buttons which familiarise the user with the main LogAndStream features. After connecting to a device, it is possible to stream data or stream and log data at the same time. The app also offers the possibility of reading the device status; the status is used to check whether the device is docked/undocked and sensing. To know more about all the firmware features, please refer to the LogAndStream User Manual.

7. ShimmerPCInstrumentDriver

The *ShimmerPCInstrumentDriver* is a folder holding the *ShimmerPC* class which extends the *ShimmerBluetooth* class. The SPP connection is handled by the open source JSSC library[18]. Changing the serial port library, is a straight forward process, just by extending the *ShimmerBluetooth* class, and implementing the abstract methods such as read and write.

An example below is shown of the ShimmerCapture example, using the *ShimmerPC* class. Users will require pairing the Shimmer devices to their PCs manually, as well as retrieving the appropriate COM Ports to use. For further information please refer to the *Shimmer User Manual*.

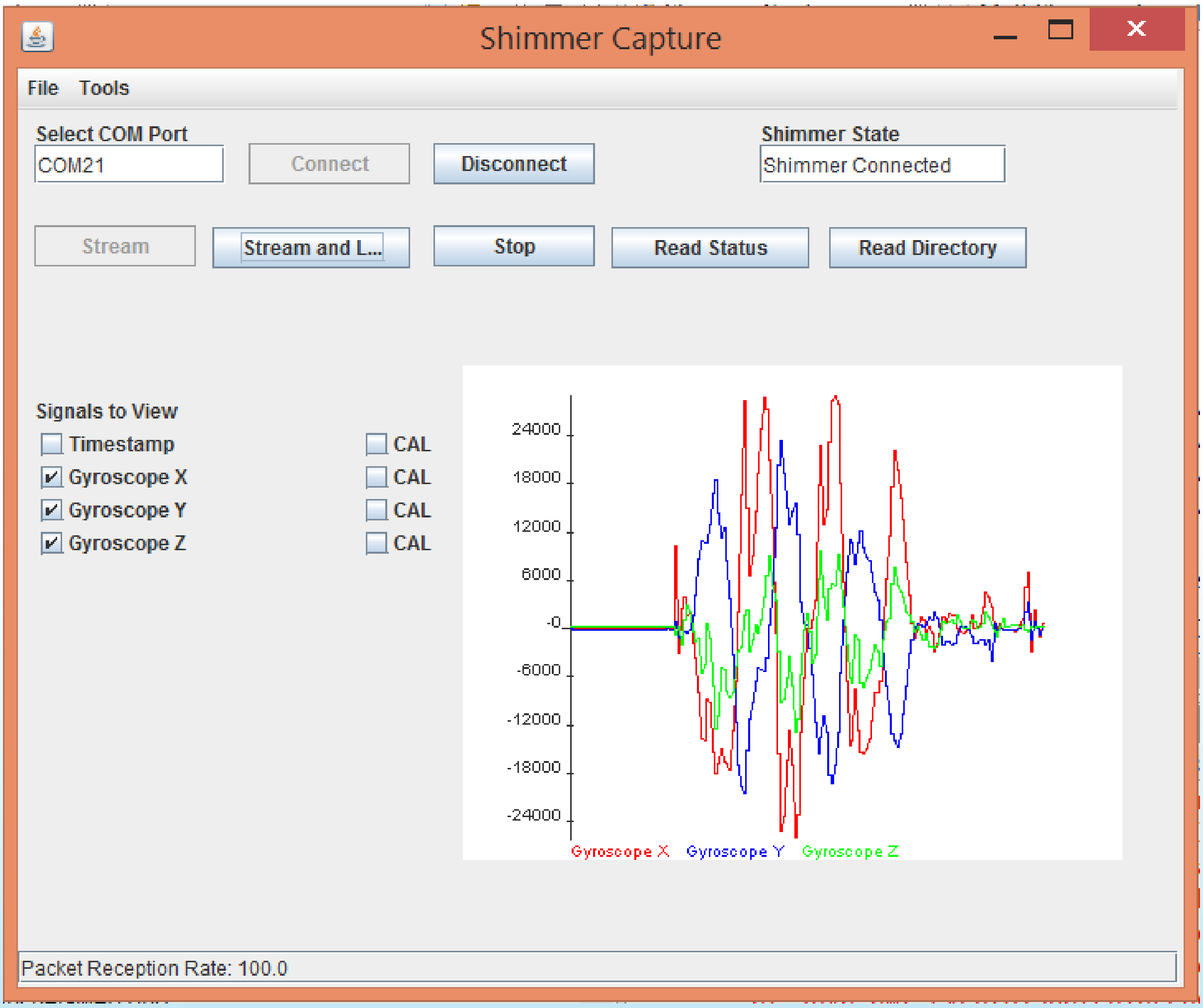


Figure 25: ShimmerCapture

[18] https://code.google.com/p/java-simple-serial-connector/

Once the Shimmer is connected and ready for streaming the start button will be enabled, as will the Configuration and EXG panels which can be found under 'Tools' in the menu bar. These panels can only be accessed when the Shimmer is connected and not streaming. The Shimmer State field in the main panel displays whether the Shimmer is connected or disconnected. Note that in the main panel the buttons Stream and Log, Read Status, and Read Directory is only applicable for Shimmer devices using LogAndStream Firmware.

The *ShimmerPCInstrumentDriver* interacts with *ShimmerCapture* through call back methods. This is done by having ShimmerCapture extend the BasicProcessWithCallBack. In order to receive messages from ShimmerPC use the setWaitForData() method as shown in the example. You will now receive messages in the processMsgFromCallback method.

Two variables are sent to the UI; the first is an identifier and the second is the data/object to be transmitted to the UI. The identifier is an integer and can be used to tell the UI what type of message is being sent, such as a state change or data packet transfer. The code below shows the API sending a state change notification message to the UI, with the current Shimmer state and the BluetoothAddress.

```
CallbackObject callBackObject = new CallbackObject(mState, getBluetoothAddress());
sendCallBackMsg(MSG_IDENTIFIER_STATE_CHANGE, callBackObject);
```

ShimmerCapture receives this callBackMethod and uses the indicator to determine how to process the data via processMsgFromCallback. The code snippet below demonstrates how the UI uses the callBackMethod.

```
protected void processMsgFromCallback(ShimmerMsg shimmerMSG) {
        int ind = shimmerMSG.mIdentifier;
        Object object = (Object) shimmerMSG.mB;
        if (ind == ShimmerPC.MSG_IDENTIFIER_STATE_CHANGE) {
                CallbackObject callbackObject = (CallbackObject)object;
                int state = callbackObject.mIndicator;
                ....
```

In the configuration panel (Figure 26), the sensors to be enabled can be selected and other Shimmer settings can be changed. The sensors selected in the configuration panel will be enabled by the method writeEnabledSensors() in the ShimmerDriver. The method getListOfEnabledSensorSignals() is then used to display the list of signals in the main panel, as shown in Figure 25. The maximum number of signals that can be displayed here is twelve. The signals selected from this list will be displayed on the graph when streaming.

The configuration panel also allows users to calculate heart rate data from either the PPG or ECG sensor.

When using ECG to HR, note that the exg settings need to be set to ECG. It is recommended a High Pass Filter of 0.5Hz and an appropriate Band Stop Filter (*set to the AC frequency of the region*) be used.

The Channel LA_RA is used to calculate the heart rate. This example only supports Shimmer3 devices, though the ECGtoHR algorithm works with Shimmer2r ECG units as well.

Users should note that the following sensors, GSR and PPG (Internal ADC A13), need to be enabled when using this. In addition Int Exp Power has to be enabled as well. Heart rate calculation require a 10 second training phase, of which no data will be plotted.

Note that we do not provide any support in terms of the PPG to HR algorithm and ECG to HR algorithm in itself and only the *ShimmerBiophysicalProcessingLibrary.jar* file is provided.

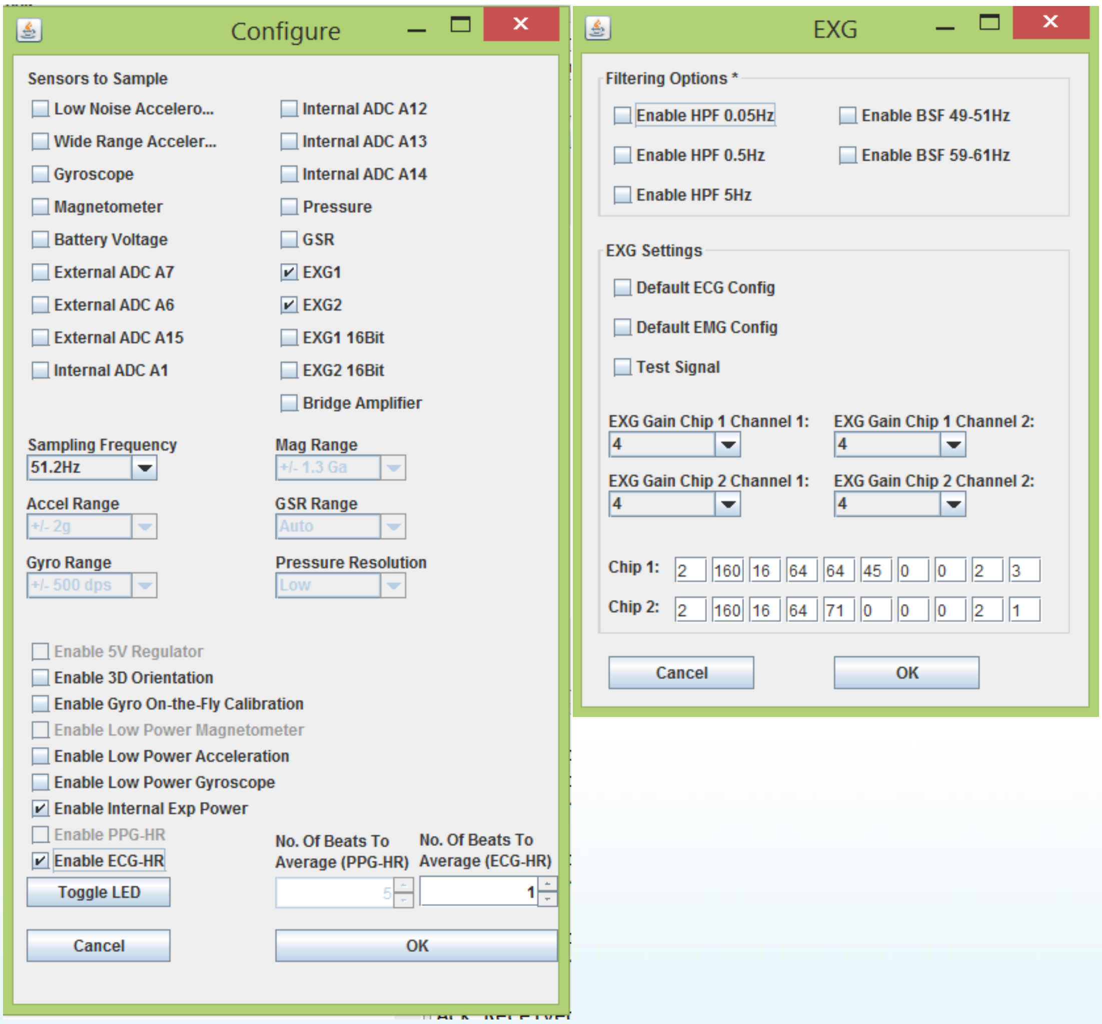


Figure 26: Configuration Panel and EXG Panel

EXG (ECG/EMG).

For *Shimmer3*, an EXG Configuration panel is enabled, shown in Figure 26. Configuring the EXG settings is a two-step process; the sensors need to be enabled in the configuration panel and the EXG settings can be changed in the EXG panel. If EXG1 and EXG2 (24-Bit) are enabled, EXG1 16Bit and EXG2 16Bit are disabled, and vice-versa. To monitor ECG, EXG1 and EXG 2 (24-Bit or 16-Bit) need to be enabled and to monitor EMG, only EXG1 needs to be enabled. At the bottom of the EXG panel are fields for each EXG chip which display the selected configurations. These settings are stored in a ten byte register. The function of each byte is explained in Table 1 below. Default ECG configurations, default EMG configurations and a test signal can be selected. These options will automatically update the bytes stored in the register. If default ECG or EMG configurations are chosen, the names of the signals displayed in the main panel will change accordingly, as shown in Figure 27. The configuration options chosen in this panel will not be written to the Shimmer until the OK button is selected.

Byte Position	Name	Description
Byte 1	CONFIG1: Configuration Register 1	This register configures each ADC channel sample rate.
Byte 2	CONFIG2: Configuration Register 2	This register configures the test signal, clock, reference, and LOFF buffer.
Byte 3	LOFF: Lead-Off Control Register	This register configures the lead-off detection operation.
Byte 4	CH1SET: Channel 1 Settings	This register configures the power mode, PGA gain and multiplexer settings channels.
Byte 5	CH2SET: Channel 2 Settings	This register configures the power mode, PGA gain and multiplexer settings channels.
Byte 6	RLD_SENS: Right Leg Drive Sense Selection	This register configures the selection of the positive and negative signals from each channel for the right leg drive derivation.
Byte 7	LOFF_SENS: Lead-Off Sense Selection	This register selects the positive and negative side from each channel for lead-off detection.
Byte 8	LOFF_STAT: Lead-Off Status	The register stores the status of whether the positive or negative electrode on each channel is on or off.
Byte 9	RESP1: Respiration Control Register 1	This register controls the respiration functionality.
Byte 10	RESP2: Respiration Control Register 2	This register controls the respiration and calibration functionality.

Table 1: EXG Register Contents

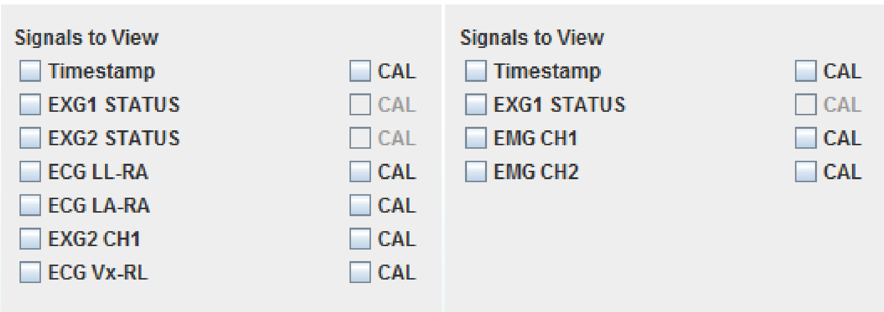


Figure 27: Default ECG and EMG Configuration - Signal Names

Within the EXG panel, there are filtering options. There are three high-pass filters with corner frequencies 0.05Hz, 0.5Hz and 5Hz and band-stop filters with stop bands of 49-51Hz and 59-61Hz. The purpose of the high-pass filters is to eliminate low frequency interference such as motion artefacts, and the purpose of the band-stop filters is to eliminate mains interference. Only calibrated EXG signals are filtered and not RAW. If filtering is enabled the filtered calibrated signal will be logged and not the calibrated unfiltered signal. This filtered signal is used to calculate Heart Rate when ECGtoHR algorithm is enabled.

8. Usage Considerations

8.1. Differences between *Shimmer2r* and *Shimmer3*

When using the *Shimmer Android API*, readers should take note of some fundamental differences between *Shimmer2r* and *Shimmer3*. The first is that the following two commands are only available for *Shimmer2r* hardware:-

SET_5V_REGULATOR_COMMAND *(when using an Expansion Board with Shimmer2r)*

SET_PMUX_COMMAND *(when monitoring battery voltage)*

In terms of accelerometers, the *Shimmer3* has more than a single Accelerometer. The Analog accelerometer (KXRB5-2042) has a fixed 2g range while the other has a range of either 2g, 4g , 8g and 16g (LSM303DLHC). Users interested in 2g range, are advised to use the analog accelerometer which has less noise.

Also readers should note that the data rate of the gyroscope (MPU9150), accelerometer (LSM303DLHC) and magnetometer (LSM303DLHC) are now configurable. To facilitate this, a low power mode has been added for the gyroscope and magnetometer sensors as well. When not in low power mode, the data rate of the sensors are set such as to match the sampling rate of the Shimmer device as close as possible (but always higher) For further detail it is recommended that the ShimmerGraphandLogService is studied.

The *Shimmer3* also includes a Pressure sensor (BMP180). The pressure sensor's resolution is configurable (ultra low power, standard, high resolution and ultra high resolution). Users should take note of the Max Conversion time when selecting the sampling rate and the resolution mode, further details can be found in the BMP180 data sheet. Currently only the *ShimmerGraphAndLogService* provides an example usage of the pressure sensor.

There is also an external sensor option when using the *GSR+ Expansion Board*. Among other things this can be used to interface a PPG (Photoplethysmography) sensor to a *Shimmer3* device. To use PPG, the following must be enabled

- Int ADC A13/PPG - *The output of the sensor connected to the GSR+ board is measured by the internal ADC A13*
- Internal Exp Power (*to power the external sensor e.g. PPG*)

PPG data output will be under the category 'Internal ADC A13'. For further functionality of the *GSR+ Expansion Board* users are encouraged to read the *GSR+ Expansion Board User Guide.*

An example application using the *Shimmer Java/Android API* for EXG (ECG/EMG) can be found in *MultiShimmerTemplate*. The EXG board consist of two ADS1292R chips of which further details can be found in the *ExG User Guide for ECG* / *ExG User Guide for EMG*.

In summary in order to use it for ECG both EXG1 and EXG2 (24bit/16bit) has to be enabled, and the EXG chip needs to be set to default ECG configuration.

```
mShimmer.writeEnabledSensors(ShimmerPCBT.SENSOR_EXG1_24BIT|ShimmerPCBT.SENSOR_EXG1_24BIT);
```

```
mShimmer.enableDefaultECGConfiguration();
```

To use it for EMG, set the default configuration using:

```
mShimmer.enableDefaultEMGConfiguration();
```

And to enable the internal test signal (+/-1mv square wave):

```
Shimmer.enableEXGTestSignal();
```

USERS SHOULD NOT enable the ECG/EMG for the *Shimmer3*!

```
mShimmer.writeEnabledSensors(ShimmerPCBT.SENSOR_ECG);
```

```
mShimmer.writeEnabledSensors(ShimmerPCBT.SENSOR_EMG);
```

Users should note that *writeEnabledSensors(byte[])* will be deprecated in the future, due to EXG1/EXG2 (*Shimmer3*) and EMG/ECG (*Shimmer2r*) having the same sensor bitmap value. To avoid confusion this will be replaced by *writeEnabledSensors(String[])* in the future.

8.2. Battery Monitoring

From Android Beta 0.7 onwards battery monitoring can be done by using the *writeenabledsensors* command. Battery monitoring is done via the ADC used by ExpBoard A0 and ExpBoardaA7, thus while monitoring the battery you will be unable to use those ports. There is also a low battery warning functionality built in, which will cause the green LED of the Shimmer device to turn yellow when the voltage has dropped below a specified value. This value can be specified via the command *setBattLimitWarning.* Users should note that battery monitoring is only supported on Shimmer devices which have the *BtStream* firmware installed on it. In order to use both battery monitoring and low battery notification on the Shimmer device, the battery voltage sensor has to be enabled prior to streaming. The low battery limit can be set via the Commands tab. By default the limit is set to 3.4 Volts. For an example application which uses the low battery indicator please refer to ShimmerGraphandLogService.

Users using *Shimmer2r/2/1* should note that enabling battery monitoring will cause crosstalk between the accelerometer/gyroscope sensor channels (*z*-axis) and one of the voltage measurements (VSenseBatt). This can influence the battery reading by 5-6% on average and up to 10% in extreme cases. This occurs because the battery resistor divider which is approximately 300kOhm leading to the ADC channel is not buffered by a voltage buffer. It is recommended where possible that the said kinematic sensors be disabled when measuring the battery voltage. When simultaneous streaming of both Accelerometer/Gyroscope and Battery Voltage is required the following are methods which might help mitigate the effects of crosstalk

12 SW averaging (100 to 1000 counts) to the battery measurement as accel. signals are quasi-periodic assuming the user isn't in an elevator or vehicle
13 VSenseBatt - n * Zaccel = VSenseBatt_correct where the scaling factor (n) would need to be determined experimentally

14 Measuring battery voltage only when the device is in a static position

8.3. Bluetooth Connectivity

The reader should be aware that on occasion it might be difficult to make a successful connection to the Shimmer unit due to the Bluetooth paging mechanism. This is explained below.

Paging Inquiry

- The page (and inquiry) window on the RN42 defaults to 320ms (out of a 2.56s). So the RN42 is only "listening" for a connection 12.5% of the time
- When a Bluetooth slave successfully connects or pairs with a BT master they synchronize their frequency hopping pattern. Using a FHS (frequency hopping synchronization) packet if a master has not connected to a slave over a long period of time then the frequency hopping pattern can get severely out of sync (and based on clock drift inside the RN42, this would explain why certain Shimmers seem worse than others). Combine this the 12.5% duty cycle of the page window then it can result in needing multiple attempts to make a connection, but once the connection is made the frequency hopping pattern re-syncs.

8.4. Backward Compatibility

Developers using an older version of the *Shimmer Java/Android API* (Rev 1.3 and below) can update their drivers by importing the ShimmerDriver and ShimmerAndroidDriver into their eclipse workspace, as explained in section 3 . Due to some restructuring users will have to ensure where applicable, that the following are imported :-

```
import com.shimmerresearch.android.*;
import com.shimmerresearch.driver.*;
```

As the Shimmer class has been relocated to the package com.shimmerresearch.android.

Alternatively you can copy the packages over manually to your project as well.

8.5. Developers notes

Adding Delay

Users should note that when executing commands such as readaccelrange(), it does not mean when the function returns that the command has been executed. It just means that the instruction has been put on the instruction stack for execution. The implication is that there is no guarantee that if the following is executed, that the getaccelrange will return the values read from the Shimmer, as it might not have been executed yet.

shimmer.readaccelrange();

shimmer.getaccelrange();

For the time being the fix for this is to include a delay, as such, to allow time for the instruction to execute and for the Shimmer device to response.

```
shimmer.readaccelrange();

try {

        Thread.sleep(500);

} catch (InterruptedException e) {

        e.printStackTrace();

}

shimmer.getaccelrange();
```

DataProcessing Interface

The data processing interface is provided to provide more flexibility and usability of the code. This interface is implemented within the ShimmerBluetooth class and is executed after the BuildMSG() method. It allow users to easily plug in their own algorithms and codes into the *Shimmer Java/Android API* without having to directly modify the API. The method ProcessData is called whenever the Shimmer class receives and interprets (*converts bytes into raw and calibrated sensor data ~ ObjectCluster format)* a data packet. The method InitializeProcessData is called whenever a start streaming command is sent to the Shimmer device. This can be used to initialize an algorithm (e.g. *if it needs to be reset every time the Shimmer device starts streaming*).

```
Shimmer shimmer = new Shimmer(..);

MyOwnAlgorithm mMyAlgorithm;

shimmer.setDataProcessing(new DataProcessing(){


        @Override

        public ObjectCluster ProcessData(ObjectCluster ojc) {

                ojc = mMyAlgorithm(ojc);

                return ojc;

        }

        @Override

        public InitializeProcessData() {

                mMyAlgorithm = new MyOwnAlgorithm();

        }

});
```

From a development standpoint of extending the class the interface can be used as such

```
public class ShimmerAdvance extends Shimmer implements DataProcessing{
	MyOwnAlgorithm mMyAlgorithm;
	…
	public ShimmerAdvance(){
		setDataProcessing(this);
	}
	@Override
	public ObjectCluster ProcessData(ObjectCluster ojc) {
		ojc = mMyAlgorithm(ojc);
		return ojc;
	}
	@Override
	public ObjectCluster InitializationforDataProcessing(ObjectCluster ojc) {
		mMyAlgorithm = new MyOwnAlgorithm();
	}
}
```

BlueCove

Within the *JavaShimmerConnect* project there is now a working application called *ShimmerConnectBCove* which uses the *BlueCove* library http://bluecove.org/. This addition will allow users to connect to their Shimmer device through the specifying of the Bluetooth address. The bluetooth address of the device should be specified as follows btspp://000666669686:1 , where 000666669686 is the Bluetooth address. In addition *BlueCove* also has other useful Bluetooth functions such as Bluetooth Scanning which users might want to explore. Users should note that the Linux library is licensed under a GPL license. For further details please refer to the *BlueCove* website.

Troubleshoot

Sometimes my device fails to connect to the Android device?

Please try the following:-

- Ensure the Shimmer device is fully charged
- Switch off your Shimmer device and the Bluetooth radio on your Android device, and then restart them.
- Unpair your Shimmer device and then pair them again

When I try to run the application on Eclipse I see the following error

```
[2012-06-15 13:28:28 - Shimmer] Installing Shimmer.apk...
[2012-06-15 13:28:30 - Shimmer] Re-installation failed due to different
application signatures.
[2012-06-15 13:28:30 - Shimmer] You must perform a full uninstall of the
application. WARNING: This will remove the application data!
[2012-06-15 13:28:30 - Shimmer] Please execute 'adb uninstall
shimmer.shimmergraph' in a shell.
[2012-06-15 13:28:30 - Shimmer] Launch canceled!
```

Launch the windows command prompt. Locate the folder platform-tools. Depending on where you have installed the SDK the directory will look something like this:-

C:\Program Files (x86)\Android\android-sdk\platform-tools>

Next execute the command which was requested, which in this case is 'adb uninstall shimmer.shimmergraph'. Alternatively uninstall the application first from the Android device.

When I try to run the application on Eclipse I see the following error

```
[2012-06-21 09:25:25 - ShimmerExample] ERROR: Application requires API version 10.
Device API version is 8 (Android 2.2).
[2012-06-21 09:25:25 - ShimmerExample] Launch canceled!
```

`Edit AndroidManifest.xml`

`Change` *`x`* `to the appropriate value which matches your device`

```
<uses-sdk android:minSdkVersion="x" />
```

My device fails to pair with the Android device

First ensure that you have *BtStream* installed on your Shimmer device.

If that still fails, change the line:-

tmp = device.createRfcommSocketToServiceRecord(mSPP_UUID);

within the Shimmer class file to :-

tmp = device.createInsecureRfcommSocketToServiceRecord(mSPP_UUID);

Read http://code.google.com/p/android/issues/detail?id=15919 for explanation.

I see the error Conversion to Dalvik format failed with error x.

Ensure you do not have JAR files on your buildpath that include the same package and classes[19].

How can I retrieve the class files from the jar file

Download an extraction application such as WinRaR and extract the jar file.

I see the following error

```
[2013-12-04 14:16:57 - Dex Loader] Unable to execute dex: Multiple dex files define
Lcom/google/common/annotations/Beta;
```

- Right click on the Project Name
- Select Java Build Path, go to the tab Order and Export
- Unchecked your .jar library

I see the following error

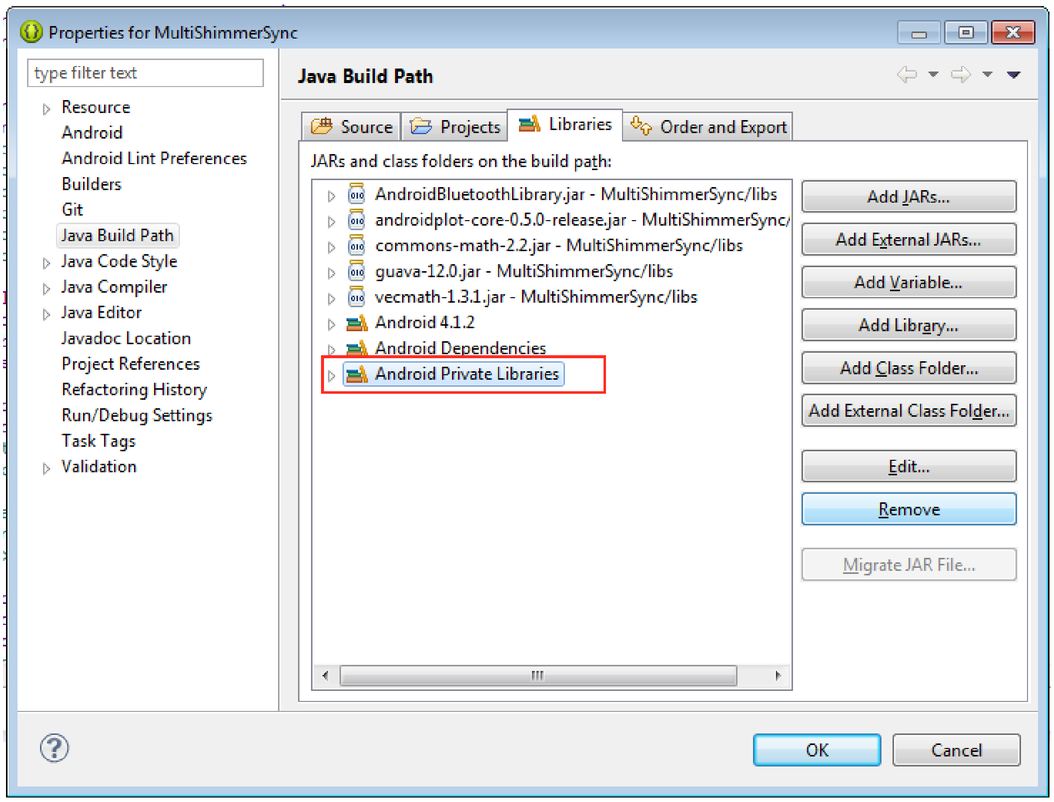
```
[2013-12-05 15:41:10 - MultiShimmerSync] Found 2 versions of android-support-
v4.jar in the dependency list,
[2013-12-05 15:41:10 - MultiShimmerSync] but not all the versions are identical
(check is based on SHA-1 only at this time).
[2013-12-05 15:41:10 - MultiShimmerSync] All versions of the libraries must be the
same at this time.
[2013-12-05 15:41:10 - MultiShimmerSync] Versions found are:
[2013-12-05 15:41:10 - MultiShimmerSync] Path: C:\Users\JC
Lim\GIT\Git\MultiShimmerSync\libs\android-support-v4.jar
[2013-12-05 15:41:10 - MultiShimmerSync]      Length: 349252
[2013-12-05 15:41:10 - MultiShimmerSync]      SHA-1:
612846c9857077a039b533718f72db3bc041d389
[2013-12-05 15:41:10 - MultiShimmerSync] Path: C:\Users\JC
Lim\GIT\Git\ShimmerAndroidInstrumentDriver\libs\android-support-v4.jar
[2013-12-05 15:41:10 - MultiShimmerSync]      Length: 621451
[2013-12-05 15:41:10 - MultiShimmerSync]      SHA-1:
5896b0a4e377ac4242eb2bc785220c1c4fc052f4
[2013-12-05 15:41:10 - MultiShimmerSync] Jar mismatch! Fix your dependencies
```

Got to Properties ->Java Build Path -> Libraries and remove :-

Android Private Libraries

After that Clean your project.

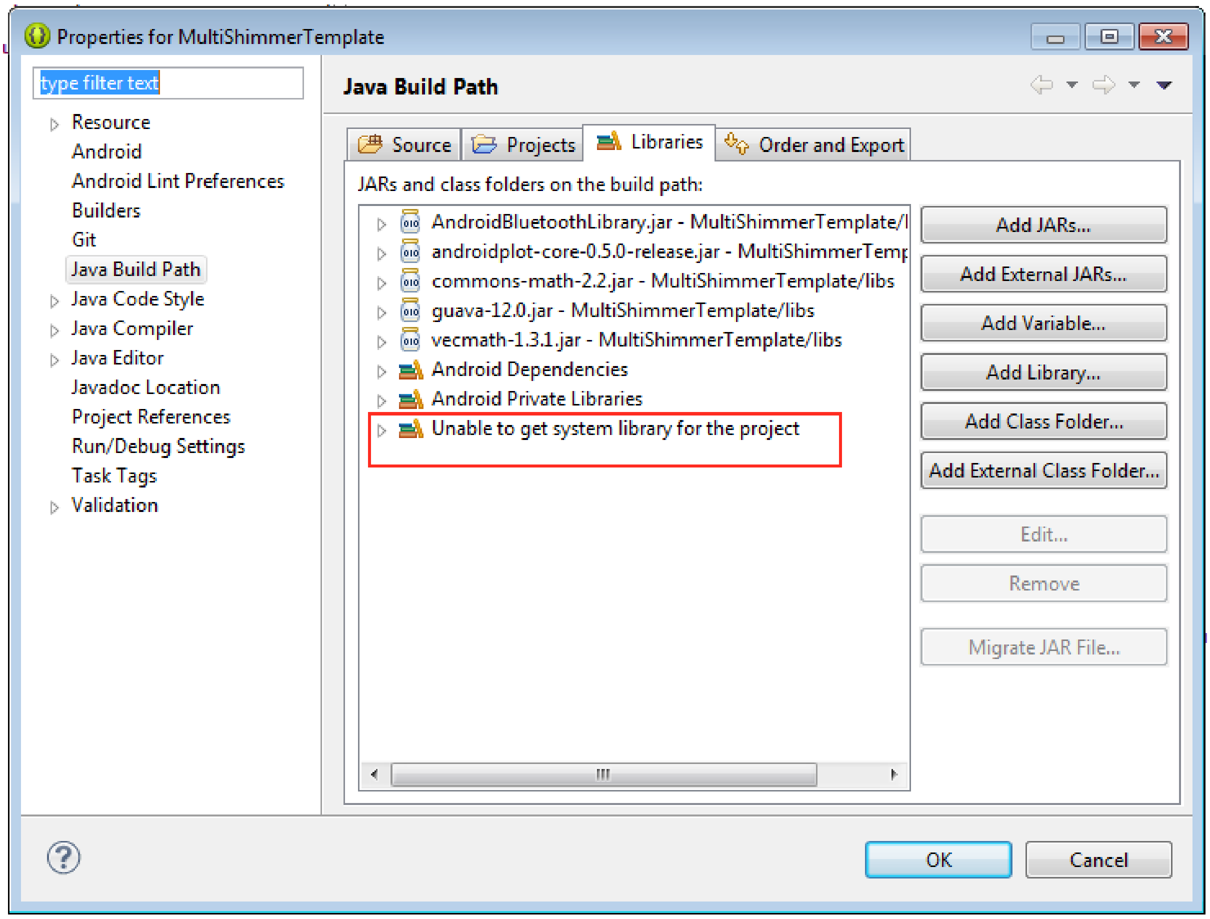
[19] http://stackoverflow.com/questions/2680827/conversion-to-dalvik-format-failed-with-error-1-on-external-jar



Eclipse related errors

Its not uncommon to rectify eclipse related errors, by cleaning your project folder, and even restarting eclipse

I See the following error



Remove it and use Android Tools --> Fix Project Properties

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