Android Services

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Notes are based on:
Android Developers

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Services

Android Services

A Service is an application component that runs in the background, not interacting with the user, for an indefinite period of time.

Services, like other application objects (activities, broadcast listeners...), run in the main thread of their hosting process.

This means that, if your service is going to do any CPU intensive (such as MP3 playback) or blocking (such as networking) operations, it should spawn its own thread in which to do that work.

Each service class must have a corresponding <service> declaration in its package's AndroidManifest.xml.

Taken from: http://developer.android.com/guide/components/services.html
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**Services**

### Android Services

- Services can be started with `startService()` and `bindService()`.

- Each `startService` call invokes the `onStart()` method of the service class, however the service is started only with the *first* call.

- Only one `stopService()` call is needed to stop the service, no matter how many times `startService()` was called.

Taken from: [http://developer.android.com/guide/components/services.html](http://developer.android.com/guide/components/services.html)

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**Service Life Cycle**

Like an activity, a service has lifecycle methods that you can implement to monitor changes in its state. But they are fewer than the activity methods — only three — and they are public, not protected:

1. `void onCreate ()`
2. `void onStart (Intent intent)`
3. `void onDestroy ()`

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![onCreate](onCreate.png)
![onStart](onStart.png)
![onDestroy](onDestroy.png)
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Service Life Cycle

The entire lifetime of a service happens between the time `onCreate()` is called and the time `onDestroy()` returns.

Like an activity, a service does its initial setup in `onCreate()`, and releases all remaining resources in `onDestroy()`.

For example, a music playback service could create the thread where the music will be played in `onCreate()`, and then stop the thread in `onDestroy()`.

Broadcast Receiver Lifecycle

A Broadcast Receiver is an application class that listens for global Intents that are broadcasted to any one who bothers to listen, rather than being sent to a single target application/activity.

The system delivers a broadcast Intent to all interested broadcast receivers, which handle the Intent sequentially.
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Registering a Broadcast Receiver

- You can either *dynamically* register an instance of this class with `registerReceiver()`

- or statically publish an implementation through the `<receiver>` tag in your `AndroidManifest.xml` (see next example).

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Broadcast Receiver Lifecycle

A broadcast receiver has a single callback method:

```java
void onReceive (Context context, Intent broadcastMsg)
```

1. When a broadcast message arrives for the receiver, Android calls its `onReceive()` method and passes it the Intent object containing the message.

2. The broadcast receiver is considered to be *active* only while it is executing its `onReceive()` method.

3. When `onReceive()` returns, it is inactive.
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Services, BroadcastReceivers and the AndroidManifest

The manifest of applications using Android Services must include:

1. A <service> entry for each service used in the application.

2. If the application defines a BroadcastReceiver as an independent class, it must include a <receiver> clause identifying the component.
   - In addition an <intent-filter> entry is needed to declare the actual filter the service and the receiver use.

See example

```xml
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="cis493.demos" android:versionCode="1" android:versionName="1.0.0">
    <uses-sdk android:minSdkVersion="10"/>
    <application android:icon="@drawable/icon" android:label="@string/app_name">
        <activity android:name=".MyServiceDriver2">
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />
                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
        <service android:name="MyService2" />
        <receiver android:name="MyBroadcastReceiver">
            <intent-filter>
                <action android:name="matos.action.GOSERVICE2" />
            </intent-filter>
        </receiver>
    </application>
</manifest>
```
Types of Broadcasts

There are two major classes of broadcasts that can be received:

1. **Normal broadcasts** (sent with `sendBroadcast`) are completely asynchronous. All receivers of the broadcast are run in an *undefined* order, often at the same time.

2. **Ordered broadcasts** (sent with `sendOrderedBroadcast`) are delivered to one receiver at a time. As each receiver executes in turn, it can propagate a result to the next receiver, or it can completely abort the broadcast (`abortBroadcast()`) so that it won't be passed to other receivers.
   - Ordering receivers for execution can be controlled with the `android:priority` attribute of the matching intent-filter;
   - Receivers with the *same priority* will be run in an *arbitrary order*.

Example: Main Steps – The Main Activity

Assume main activity `MyService3Driver` wants to interact with a service called `MyService3`. The main activity is responsible for the following tasks:

1. Start the service called `MyService3`.

```java
Intent intentMyService = new Intent(this, MyService3.class);
ComponentName service = startService(intentMyService);
```

2. Define corresponding receiver’s filter and register local receiver

```java
IntentFilter mainFilter = new IntentFilter("matos.action.GOSERVICE3");
BroadcastReceiver receiver = new MyMainLocalReceiver();
registerReceiver(receiver, mainFilter);
```

3. Implement local receiver and override its main method

```java
public void onReceive(Context localContext, Intent callerIntent)
```
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Example: Main Steps – The Service
The Service uses its `onStart` method to do the following:

1. Create an Intent with the appropriate broadcast filter (any number of receivers could match it).

   ```java
   Intent myFilteredResponse = new Intent("matos.action.GOSERVICE3");
   ```

2. Prepare the extra data (`myServiceData`) to be sent with the intent to the receiver(s)

   ```java
   Object msg = some user data goes here;
   myFilteredResponse.putExtra("myServiceData", msg);
   ```

3. Release the intent to all receivers matching the filter

   ```java
   sendBroadcast(myFilteredResponse);
   ```

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Example: Steps – The Driver (again)
The main activity is responsible for cleanly terminating the service. Do the following

1. Assume `intentMyService` is the original Intent used to start the service. Calling the termination of the service is accomplished by the method

   ```java
   stopService(new Intent(intentMyService));
   ```

2. Use the service’s `onDestroy` method to assure that all of its running threads are terminated and the receiver is unregistered.

   ```java
   unregisterReceiver(receiver);
   ```
Example 1. A very Simple Service

The main application starts a service. The service prints lines on the LogCat until the main activity stops the service. No IPC occurs in the example.

```java
public class TestMyService1 extends Activity implements OnClickListener {
    TextView txtMsg;
    ComponentName service;
    Intent intentMyService1;
    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.main);
        txtMsg = (TextView) findViewById(R.id.txtMsg);
        findViewById(R.id.btnStopService).setOnClickListener(this);
        intentMyService1 = new Intent(this, MyService1.class);
        service = startService(intentMyService1);
        txtMsg.setText("MyService1 started\n (see LogCat)\n");
    }

    @Override
    public void onClick(View v) {
        try {
            stopService(intentMyService1);
            txtMsg.setText("After stopping Service: \n service.getClassName()\n");
        } catch (Exception e) {
            Toast.makeText(this, e.getMessage(), 1).show();
        }
    }
}
```
Example 1. cont.

```java
package cis.matos;
import . . .
public class MyService1 extends Service {
    @Override
    public IBinder onBind(Intent arg0) {
        return null;
    }
    @Override
    public void onCreate() {
        super.onCreate();
    }
    @Override
    public void onStart(Intent intent, int startId) {
        Log.e("<<MyService1-onStart>>", "I am alive-1!");
        Log.e("<<MyService1-onStart>>", "I did something");
    }
    @Override
    public void onDestroy() {
        Log.e("<<MyService1-onDestroy>>", "I am dead-1");
    }
} //MyService1
```

According to the Log

1. Main Activity is started
2. Service is started (onCreate, onStart)
3. Main Activity UI is displayed
4. User stops Service
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Example 1. cont. Manifest

```xml
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="csu.matos"
    android:versionCode="1"
    android:versionName="1.0">
    <uses-sdk
        android:minSdkVersion="8"
        android:targetSdkVersion="15"/>
    <application
        android:icon="@drawable/ic_launcher"
        android:label="@string/app_name"
        android:theme="@style/AppTheme">
        <activity
            android:name=".TestMyService1"
            android:label="@string/title_activity_test_service1">
            <intent-filter>
                <action android:name="android.intent.action.MAIN"/>
                <category android:name="android.intent.category.LAUNCHER"/>
            </intent-filter>
        </activity>
        <service android:name="MyService1"/>
    </application>
</manifest>
```

Example 1. cont. Layout

```xml
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical">
    <EditText
        android:id="@+id/txtMsg"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:inputType="none"
        android:layout_margin="10dp"/>
    <Button
        android:id="@+id/btnStopService"
        android:layout_width="204dp"
        android:layout_height="wrap_content"
        android:layout_gravity="center"
        android:text="Stop Service1"/>
</LinearLayout>
```
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Example 2. A More Interesting Activity-Service Interaction

1. The main activity starts the service and registers a receiver.

2. The service is slow, therefore it runs in a parallel thread its time consuming task.

3. When done with a computing cycle, the service adds a message to an intent.

4. The intent is broadcasted using the filter: matos.action.GOSERVICE3.

5. A BroadcastReceiver (defined inside the main Activity) uses the previous filter and catches the message (displays the contents on the main UI).

6. At some point the main activity stops the service and finishes executing.

Example 2. Layout

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical">
    <ScrollView>
        <ScrollView>
            <TextView
                android:id="@+id/txtMsg"
                android:layout_width="match_parent"
                android:layout_height="wrap_content"
                android:inputType="none"/>
        </ScrollView>
    </ScrollView>
    <Button
        android:id="@+id/btnStopService"
        android:layout_width="151dip"
        android:layout_height="wrap_content"
        android:layout_gravity="center"
        android:text="Stop Service"/>
</LinearLayout>
```
Example 2. Manifest

```xml
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
package="cis493.demos"
android:versionCode="1"
android:versionName="1.0.0">
<uses-sdk android:minSdkVersion="10" />
</manifest>
```

public class MyServiceDriver3 extends Activity implements OnClickListener {
  TextView txtMsg;
  ComponentName service;
  Intent intentMyService3;
  BroadcastReceiver receiver;

  @Override
  public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.main);
    txtMsg = (TextView) findViewById(R.id.txtMsg);
    intentMyService3 = new Intent(this, MyService3.class);
    service = startService(intentMyService3);
    txtMsg.setText("My Service3 started - (see LogCat)");
    findViewById(R.id.btnStopService).setOnClickListener(this);
    // register & define filter for local listener
    IntentFilter mainFilter = new IntentFilter("matos.action.GOSERVICE3");
    receiver = new MyMainLocalReceiver();
    registerReceiver(receiver, mainFilter);
  }
}
public void onClick(View v) {
    // assume: v.getId() == R.id.btnStopService
    try {
        stopService(intentMyService3);
        txtMsg.setText("After stoping Service: \n" + service.getClassName());
    } catch (Exception e) {
        e.printStackTrace();
    }
}

@Override
protected void onDestroy() {
    super.onDestroy();
    try {
        stopService(intentMyService3);
        unregisterReceiver(receiver);
    } catch (Exception e) {
        Log.e("MAIN3-DESTROY>>>", e.getMessage());
    }
    Log.e("MAIN3-DESTROY>>>", "Adios");
}

public class MyMainLocalReceiver extends BroadcastReceiver {
    @Override
    public void onReceive(Context localContext, Intent callerIntent) {
        String serviceData = callerIntent.getStringExtra("service3Data");
        Log.e("MAIN>>>", "Data received from Service3: " + serviceData);
        String now = "\nService3Data: > " + serviceData;
        txtMsg.append(now);
    }
}
public class MyService3 extends Service {
    boolean isRunning = true;

    @Override
    public IBinder onBind(Intent arg0) {
        return null;
    }

    @Override
    public void onCreate() {
        super.onCreate();
    }

    @Override
    public void onStart(Intent intent, int startId) {
        Log.e("<<MyService3-onStart>>", "I am alive-3!");
        Thread serviceThread = new Thread ( new Runnable () {
            public void run () {
                for (int i = 0; i < 120 && isRunning; i++) {
                    try {
                        // fake that you are very busy here
                        Thread.sleep(1000);
                        Intent intentDataForMyClient = new Intent("matos.action.GOSERVICE3");
                        String msg = "data-item-" + i;
                        intentDataForMyClient.putExtra("service3Data", msg);
                        sendBroadcast(intentDataForMyClient);
                    } catch (Exception e) {
                        e.printStackTrace();
                    }
                } // for
            } // run
        });
        serviceThread.start();
    } // onStart

    @Override
    public void onDestroy() {
        super.onDestroy();
        Log.e("<<MyService3-onDestroy>>", "I am Dead-3");
        isRunning = false;
    } // onDestroy
} // MyService3
Example 3. An App Connected to Multiple Services

In this application the Main Activity starts three services:

1. **MyService4**: A music player whose input is an mp3 resource file stored in `res/raw`.
2. **MyService5Async**: A service producing Fibonacci numbers in the 20-50 range. The task of number generation is implemented inside an `AsyncTask`. The efficiency of this Fibonacci implementation is $O(2^n)$ [intentionally slow!]
3. **MyService6**: The service returns GPS coordinates. Two methods are used to obtain the current location (a) a quick Network-provider based reading (coarse location), and (b) a more precise but slower Satellite reading (fine location).

The Main Application defines and registers a `BroadcastReceiver` capable of attending messages matching any of the three filters used by the broadcasting services above. Received results are displayed on the user’s screen.
Example 3. An App Connected to Multiple Services

**MainActivity: TestMyService4.java**

```java
package csu.matos;

import ...

public class TestService4 extends Activity implements OnClickListener {
    TextView txtMsg;
    EditText etTts;
    Intent intentCallService4;
    Intent intentCallService5;
    Intent intentCallService6;
    BroadcastReceiver receiver;

    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.
    findViewById(R.id.
        findViewById(R.id.
        findViewById(R.id.
        findViewById(R.id.
    }

    @Override
    public void onClick(View view) {
        switch (view.getId()) {
            case R.id.btnStart4:
                intentCallService4 = new Intent(TestService4.this, MyService4.class);
                startService(intentCallService4);
                break;
            case R.id.btnStop4:
                stopService(intentCallService4);
                break;
            case R.id.btnStart5:
                intentCallService5 = new Intent(TestService4.this, MyService5.class);
                startService(intentCallService5);
                break;
            case R.id.btnStop5:
                stopService(intentCallService5);
                break;
            case R.id.btnStart6:
                intentCallService6 = new Intent(TestService4.this, MyService6.class);
                startService(intentCallService6);
                break;
            case R.id.btnStop6:
                stopService(intentCallService6);
                break;
        }
    }
}
```

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Example 3. MainActivity: TestMyService4.java

Log.e("MAIN", "Main started");

// get ready to invoke execution of background services
intentCallService4 = new Intent(this, MyService4.class);
intentCallService5 = new Intent(this, MyService5Async.class);
intentCallService6 = new Intent(this, MyService6.class);

// register local listener & define triggering filter
IntentFilter filter5 = new IntentFilter("matos.action.GOSERVICE5");
IntentFilter filter6 = new IntentFilter("matos.action.GPSFIX");
receiver = new MyEmbeddedBroadcastReceiver();
registerReceiver(receiver, filter5);
registerReceiver(receiver, filter6);

} // onCreate

@override
public void onClick(View v) {
    if (v.getId() == R.id.btnStart4) {
        log.e("MAIN", "onClick: starting service4");
        startService(intentCallService4);
    } else if (v.getId() == R.id.btnStop4) {
        log.e("MAIN", "onClick: stopping service4");
        stopService(intentCallService4);
    } else if (v.getId() == R.id.btnStart5) {
        log.e("MAIN", "onClick: starting service5");
        startService(intentCallService5);
    } else if (v.getId() == R.id.btnStop5) {
        log.e("MAIN", "onClick: stopping service5");
        stopService(intentCallService5);
    } else if (v.getId() == R.id.btnStart6) {
        log.e("MAIN", "onClick: starting service6");
        startService(intentCallService6);
    } else if (v.getId() == R.id.btnStop6) {
        log.e("MAIN", "onClick: stopping service6");
        stopService(intentCallService6);
    }
} // onClick
Example 3. MainActivity: TestMyService4.java

```java
public class MyEmbeddedBroadcastReceiver extends BroadcastReceiver {
    @Override
    public void onReceive(Context context, Intent intent) {
        Log.e("MAIN\>>>", "ACTION: " + intent.getAction());
        if (intent.getAction().equals("matos.action.GOSERVICE5")) {
            String service5Data = intent.getStringExtra("MyService5DataItem");
            Log.e("MAIN\>>>", "Data received from Service5: " + service5Data);
            txtMsg.append("Service5Data: > " + service5Data);
        } else if (intent.getAction().equals("matos.action.GPSFIX")) {
            double latitude = intent.getDoubleExtra("latitude", -1);
            double longitude = intent.getDoubleExtra("longitude", -1);
            String provider = intent.getStringExtra("provider");
            String service6Data = provider + " lat: " + Double.toString(latitude) + " lon: " + Double.toString(longitude);
            Log.e("MAIN\>>>", "Data received from Service6: " + service6Data);
            txtMsg.append("Service6Data: > " + service6Data);
        }
    }
}
```
### Services

**Example 3. MyService4 – A Music Player**

```java
@override
public void onDestroy() {
    Toast.makeText(this, "MyService4 Stopped", Toast.LENGTH_LONG).show();
    Log.e("MyService4", "onDestroy");
    player.stop();
    player.release();
    player = null;
}

@override
public void onStart(Intent intent, int startid) {
    if (player.isPlaying())
        Toast.makeText(this, "MyService4 Already Started " + startid,
                        Toast.LENGTH_LONG).show();
    else
        Toast.makeText(this, "MyService4 Started " + startid,
                        Toast.LENGTH_LONG).show();
    Log.e("MyService4", "onStart");
    player.start();
}
```

**Example 3. MyService5Async – A Slow Fibonacci Number Gen.**

```java
package csu.matos;
import ...;

public class MyService5Async extends Service {
    boolean isRunning = true;

    private Handler handler = new Handler() {
        @Override
        public void handleMessage(Message msg) {
            super.handleMessage(msg);
            Log.e("MyService5Async-Handler", "Handler got from MyService5Async: " + (String)msg.obj);
        }
    };

    @Override
    public IBinder onBind(Intent arg0) {
        return null;
    }

    @Override
    public void onCreate() {
        super.onCreate();
    }
```
Example 3. MyService5Async – A Slow Fibonacci Number Gen.

```java
@Override
public void onStart(Intent intent, int startId) {
    Log.e("<<MyService5Async-onStart>>", "I am alive-5Async!");
    // we place the slow work of the service in an AsynTask
    // so the response we send our caller who run
    // a "startService(...)" method gets a quick OK from us.
    new ComputeFibonacciRecursivelyTask().execute(20, 50);
}

// this recursive evaluation of Fibonacci numbers is exponential O(2^n)
// for large n values it should be very time-consuming!
public Integer fibonacci(Integer n){
    if ( n==0 || n==1 )
        return 1;
    else
        return fibonacci(n-1) + fibonacci(n-2);
}

@Override
public void onDestroy() {
    //super.onDestroy();
    Log.e("<<MyService5Async-onDestroy>>", "I am dead-5-Async");
    isRunning = false;
}
```

```java
public class ComputeFibonacciRecursivelyTask extends AsyncTask<Integer, Integer, Integer> {
    @Override
    protected Integer doInBackground(Integer... params) {
        for (int i=params[0]; i<params[1]; i++){
            Integer fibn = fibonacci(i);
            publishProgress(i, fibn);
        }
        return null;
    }

    @Override
    protected void onProgressUpdate(Integer... values) {
        super.onProgressUpdate(values);
        Intent intentFilter5 = new Intent("matos.action.GOSERVICE5");
        String data = "dataItem5-fibonacciAsyncTask" + values[0] + ": " + values[1];
        intentFilter5.putExtra("MyService5DataItem", data);
        sendBroadcast(intentFilter5);
        // (next id not really needed!!! - we did the broadcasting already)
        Message msg = handler.obtainMessage(5, data);
        handler.sendMessage(msg);
    }
}
```
Example 3. MyService6 – A GPS Service broadcasting locations.

```java
package csu.matos;

import ...

public class MyService6 extends Service {
    String GPS_FILTER = "matos.action.GPSFIX";
    Thread serviceThread;
    LocationManager lm;
    GPSListener myLocationListener;

    @Override
    public IBinder onBind(Intent arg0) {
        return null;
    }

    @Override
    public void onCreate() {
        super.onCreate();
    }

    @Override
    public void onStart(Intent intent, int startId) {
        Log.e("<<MyGpsService-onStart>>", "I am alive-GPS!");
        serviceThread = new Thread(new Runnable() {
            public void run() {
                getGPSFix_Version1(); // uses NETWORK provider
                getGPSFix_Version2(); // uses GPS chip provider
                // run
            }
        });
        serviceThread.start();
    }
}
```
Example 3. MyService6 – A GPS Service broadcasting locations.

```java
public void getGPSFix_Version1() {
    // Get the location manager
    LocationManager locationManager = (LocationManager)
        getSystemService(Context.LOCATION_SERVICE);
    // work with best provider
    Criteria criteria = new Criteria();
    String provider = locationManager.getBestProvider(criteria, false);
    Location location = locationManager.getLastKnownLocation(provider);
    if (location != null) {
        // capture location data sent by current provider
        double latitude = location.getLatitude();
        double longitude = location.getLongitude();

        // assemble data bundle to be broadcasted
        Intent myFilteredResponse = new Intent(GPS_FILTER);
        myFilteredResponse.putExtra("latitude", latitude);
        myFilteredResponse.putExtra("longitude", longitude);
        myFilteredResponse.putExtra("provider", provider);
        Log.e(">>GPS_Service<<", provider + " =>Lat:" + latitude
            + " lon:" + longitude);
        // send the location data out
        sendBroadcast(myFilteredResponse);
    }
}
```

Example 3. MyService6 – A GPS Service broadcasting locations.

```java
public void getGPSFix_Version2() {
    try {
        Looper.prepare();
        // try to get your GPS location using the
        // LOCATION.SERVICE provider
        lm = (LocationManager) getSystemService(Context.LOCATION_SERVICE);

        // This listener will catch and disseminate location updates
        myLocationListener = new GPSListener();
        // define update frequency for GPS readings
        long minTime = 2000; // 2 seconds
        float minDistance = 5; // 5 meter
        // request GPS updates
        lm.requestLocationUpdates(LocationManager.GPS_PROVIDER, minTime,
            minDistance, myLocationListener);
        Looper.loop();
    } catch (Exception e) {
        e.printStackTrace();
    }
}
```
### Example 3. MyService6 – A GPS Service broadcasting locations.

```java
@override
public void onDestroy() {
    super.onDestroy();
    Log.e("<<MyGpsService-onDestroy>>, "I am dead-GPS");
    try {
        lm.removeUpdates(myLocationListener);
        isRunning = false;
    } catch (Exception e) {
        Toast.makeText(getApplicationContext(), e.getMessage(), 1).show();
    }
}  // onDestroy
```

```java
private class GPSListener implements LocationListener {
    public void onLocationChanged(Location location) {
        // capture location data sent by current provider
        double latitude = location.getLatitude();
        double longitude = location.getLongitude();
        // assemble data bundle to be broadcasted
        Intent myFilteredResponse = new Intent(GPS_FILTER);
        myFilteredResponse.putExtra("latitude", latitude);
        myFilteredResponse.putExtra("longitude", longitude);
        myFilteredResponse.putExtra("provider", location.getProvider());
        Log.e(">>GPS_Service<<", "Lat:" + latitude + " Lon:" + longitude);
        // send the location data out
        sendBroadcast(myFilteredResponse);
    }

    public void onProviderDisabled(String provider) {
    }

    public void onProviderEnabled(String provider) {
    }

    public void onStatusChanged(String provider, int status, Bundle extras) {
    }
}  // GPSListener class
```
Example 3. Manifest

```xml
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="csu.matos"
    android:versionName="1.0">
    <uses-sdk
        android:minSdkVersion="8"
        android:targetSdkVersion="15" />
    <uses-permission android:name="android.permission.ACCESS_COARSE_LOCATION" />
    <uses-permission android:name="android.permission.ACCESS_FINE_LOCATION" />
    <application
        android:icon="@drawable/ic_launcher"
        android:label="@string/app_name"
        android:theme="@style/AppTheme">
        <service android:name=".MyService4" />
        <service android:name=".MyService5Async" />
        <service android:name=".MyService6" />
        <activity
            android:name=".TestService4"
            android:label="@string/title_activity_test_service4"
            android:screenOrientation="portrait">
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />
                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
        <service android:name=".MyService4" />
        <service android:name=".MyService5Async" />
        <service android:name=".MyService6" />
    </application>
</manifest>
```

Example 3. Layout

```xml
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="match_parent"
    android:layout_height="match_parent">
    <LinearLayout
        android:layout_width="match_parent"
        android:layout_height="match_parent"
        android:orientation="vertical">
        <Button
            android:id="@+id/btnStart4"
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
            android:ems="15"
            android:text="Start Service4 (Music Player)" />
        <Button
            android:id="@+id/btnStop4"
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
            android:ems="15"
            android:text="Stop Service4 (Music Player)" />
    </LinearLayout>
</LinearLayout>
```
Example 3. Layout

```xml
<ScrollView
    android:layout_width="match_parent"
    android:layout_height="wrap_content">
    <TextView
        android:id="@+id/txtMsg"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:layout_margin="5dp" />
</ScrollView>
</LinearLayout>
</LinearLayout>
```

Example 3. Layout

```xml
<ScrollView
    android:layout_width="match_parent"
    android:layout_height="wrap_content">
    <TextView
        android:id="@+id/txtMsg"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:layout_margin="5dp" />
</ScrollView>
</LinearLayout>
```