Chapter 12

12. Understanding Android Application and Activity Lifecycles

In earlier chapters we have learned that Android applications run within processes and that they are comprised of multiple components in the form of activities, services and broadcast receivers. The goal of this chapter is to expand on this knowledge by looking at the lifecycle of applications and activities within the Android runtime system.

Regardless of the fanfare about how much memory and computing power resides in the mobile devices of today compared to the desktop systems of yesterday, it is important to keep in mind that these devices are still considered to be "resource constrained" by the standards of modern desktop and laptop based systems, particularly in terms of memory. As such, a key responsibility of the Android system is to ensure that these limited resources are managed effectively and that both the operating system and the applications running on it remain responsive to the user at all times. In order to achieve this, Android is given full control over the lifecycle and state of both the processes in which the applications run, and the individual components that comprise those applications.

An important factor in developing Android applications, therefore, is to gain an understanding of both the application and activity lifecycle management models of Android, and the ways in which an application can react to the state changes that are likely to be imposed upon it during its execution lifetime.

12.1 Android Applications and Resource Management

Each running Android application is viewed by the operating system as a separate process. If the system identifies that resources on the device are reaching capacity it will take steps to terminate processes to free up memory.

When making a determination as to which process to terminate in order to free up memory, the system takes into consideration both the *priority* and *state* of all currently running processes, combining these factors to create what is referred to by Google as an *importance hierarchy*. Processes are then terminated starting with the lowest priority and working up the hierarchy until sufficient resources have been liberated for the system to function.

12.2 Android Process States

Processes host applications and applications are made up of components. Within an Android system, the current state of a process is defined by the highest-ranking active component within the application that it hosts. As outlined in Figure 12-1, a process can be in one of the following five states at any given time:

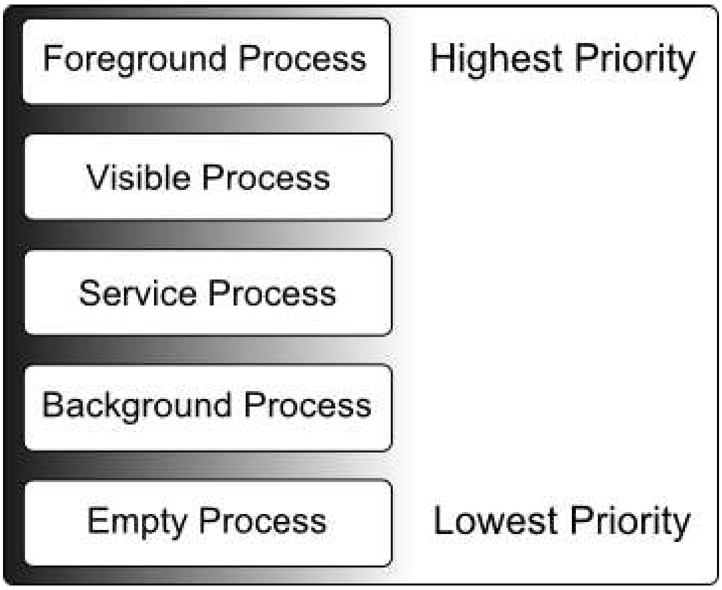

Figure 12-1

12.2.1 Foreground Process

These processes are assigned the highest level of priority. At any one time, there are unlikely to be more than one or two foreground processes active and these are usually the last to be terminated by the system. A process must meet one or more of the following criteria to qualify for foreground status:

- Hosts an activity with which the user is currently interacting.
- Hosts a Service connected to the activity with which the user is interacting.
- Hosts a Service that has indicated, via a call to *startForeground()*, that termination would be disruptive to the user experience.
- Hosts a Service executing either its *onCreate()*, *onResume()* or *onStart()* callbacks.
- Hosts a Broadcast Receiver that is currently executing its *onReceive()* method.

12.2.2 Visible Process

A process containing an activity that is visible to the user but is not the activity with which the user is interacting is classified as a "visible process". This is typically the case when an activity in the process is visible to the user, but another activity, such as a partial screen or dialog, is in the foreground. A process is also eligible for visible status if it hosts a Service that is, itself, bound to a visible or foreground activity.

12.2.3 Service Process

Processes that contain a Service that has already been started and is currently executing.

12.2.4 Background Process

A process that contains one or more activities that are not currently visible to the user, and does not host a Service that qualifies for *Service Process* status. Processes that fall into this category are at high risk of termination in the event that additional memory needs to be freed for higher priority processes. Android maintains a dynamic list of background processes, terminating processes in chronological order such that processes that were the least recently in the foreground are killed first.

12.2.5 Empty Process

Empty processes no longer contain any active applications and are held in memory ready to serve as hosts for newly launched applications. This is somewhat analogous to keeping the doors open and the engine running on a bus in anticipation of passengers arriving. Such processes are, obviously, considered the lowest priority and are the first to be killed to free up resources.

12.3 Inter-Process Dependencies

The situation with regard to determining the highest priority process is slightly more complex than outlined in the preceding section for the simple reason that processes can often be inter-dependent. As such, when making a determination as to the priority of a process, the Android system will also take into consideration whether the process is in some way serving another process of higher priority (for example, a service process acting as the content provider for a foreground process). As a basic rule, the Android documentation states that a process can never be ranked lower than another process that it is currently serving.

12.4 The Activity Lifecycle

As we have previously determined, the state of an Android process is determined largely by the status of the activities and components that make up the application that it hosts. It is important to understand, therefore, that these activities also transition through different states during the execution lifetime of an application. The current state of an activity is determined, in part, by its position in something called the *Activity Stack*.

12.5 The Activity Stack

For each application that is running on an Android device, the runtime system maintains an *Activity Stack*. When an application is launched, the first of the application's activities to be started is placed onto the stack. When a second activity is started, it is placed on the top of the stack and the previous activity is *pushed* down. The activity at the top of the stack is referred to as the *active (*or *running*) activity. When the active activity exits, it is *popped* off the stack by the runtime and the activity located immediately beneath it in the stack becomes the current active activity. The activity at the top of the stack might, for example, simply exit because the task for which it is responsible has been completed. Alternatively, the user may have selected a "Back" button on the screen to return to the previous activity, causing the current activity to be popped off the stack by the runtime system and therefore destroyed. A visual representation of the Android Activity Stack is illustrated in Figure 12-2.

As shown in the diagram, new activities are pushed on to the top of the stack when they are started. The current active activity is located at the top of the stack until it is either pushed down the stack by a new activity, or popped off the stack when it exits or the user navigates to the previous activity. In the event that resources become constrained, the runtime will kill activities, starting with those at the bottom of the stack.

The Activity Stack is what is referred to in programming terminology as a Last-In-First-Out (LIFO) stack in that the last item to be pushed onto the stack is the first to be popped off.

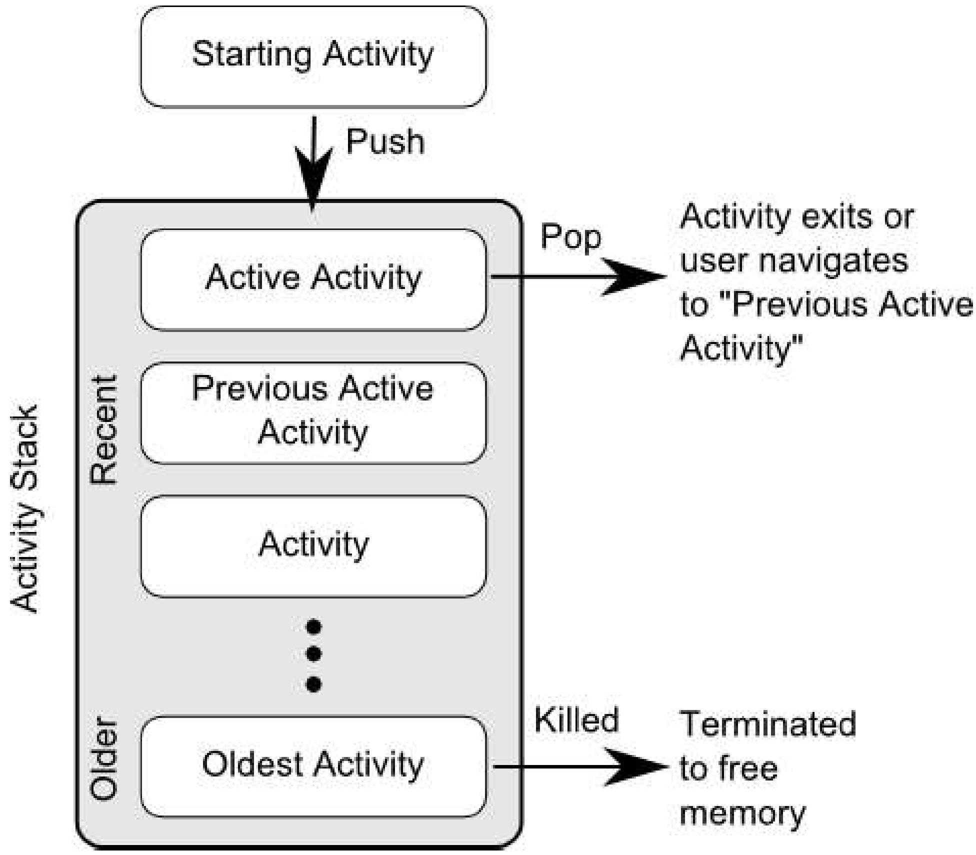

Figure 12-2

12.6 Activity States

An activity can be in one of a number of different states during the course of its execution within an application:

- **Active / Running** – The activity is at the top of the Activity Stack, is the foreground task visible on the device screen, has focus and is currently interacting with the user. This is the least likely activity to be terminated in the event of a resource shortage.
- **Paused** – The activity is visible to the user but does not currently have focus (typically because this activity is partially obscured by the current *active* activity). Paused activities are held in memory, remain attached to the window manager, retain all state information and can quickly be restored to active status when moved to the top of the Activity Stack.
- **Stopped** – The activity is currently not visible to the user (in other words it is totally obscured on the device display by other activities). As with paused activities, it retains all state and member information, but is at higher risk of termination in low memory situations.
- **Killed** – The activity has been terminated by the runtime system in order to free up memory and is no longer present on the Activity Stack. Such activities must be restarted if required by the application.

12.7 Configuration Changes

So far in this chapter, we have looked at two of the causes for the change in state of an Android activity, namely the movement of an activity between the foreground and background, and termination of an activity by the runtime system in order to free up memory. In fact, there is a third scenario in which the state of an activity can dramatically change and this involves a change to the device configuration.

By default, any configuration change that impacts the appearance of an activity (such as rotating the orientation of the device between portrait and landscape, or changing a system font setting) will cause the activity to be destroyed and recreated. The reasoning behind this is that such changes affect resources such as the layout of the user interface and simply destroying and recreating impacted activities is the quickest way for an activity to respond to the configuration change. It is, however, possible to configure an activity so that it is not restarted by the system in response to specific configuration changes.

12.8 Handling State Change

If nothing else, it should be clear from this chapter that an application and, by definition, the components contained therein will transition through many states during the course of its lifespan. Of particular importance is the fact that these state changes (up to and including complete termination) are imposed upon the application by the Android runtime subject to the actions of the user and the availability of resources on the device.

In practice, however, these state changes are not imposed entirely without notice and an application will, in most circumstances, be notified by the runtime system of the changes and given the opportunity to react accordingly. This will typically involve saving or restoring both internal data structures and user interface state, thereby allowing the user to switch seamlessly between applications and providing at least the appearance of multiple, concurrently running applications.

Android provides two ways to handle the changes to the lifecycle states of the objects within in app. One approach involves responding to state change method calls from the operating system and is covered in detail in the next chapter entitled *"Handling Android Activity State Changes"*.

A new approach, and one that is recommended by Google, involves the lifecycle classes included with the Jetpack Android Architecture components, introduced in *"Modern Android App Architecture with Jetpack"* and explained in more detail in the chapter entitled *"Working with Android Lifecycle-Aware Components"*.

12.9 Summary

Mobile devices are typically considered to be resource constrained, particularly in terms of on-board memory capacity. Consequently, a prime responsibility of the Android operating system is to ensure that applications, and the operating system in general, remain responsive to the user.

Applications are hosted on Android within processes. Each application, in turn, is made up of components in the form of activities and Services.

The Android runtime system has the power to terminate both processes and individual activities in order to free up memory. Process state is taken into consideration by the runtime system when deciding whether a process is a suitable candidate for termination. The state of a process is largely dependent upon the status of the activities hosted by that process.

The key message of this chapter is that an application moves through a variety of states during its execution lifespan and has very little control over its destiny within the Android runtime environment. Those processes and activities that are not directly interacting with the user run a higher risk of termination by the runtime system. An essential element of Android application development, therefore, involves the ability of an application to respond to state change notifications from the operating system.

Chapter 13

13. Handling Android Activity State Changes

Based on the information outlined in the chapter entitled *"Understanding Android Application and Activity Lifecycles"* it is now evident that the activities and fragments that make up an application pass through a variety of different states during the course of the application's lifespan. The change from one state to the other is imposed by the Android runtime system and is, therefore, largely beyond the control of the activity itself. That does not, however, mean that the app cannot react to those changes and take appropriate actions.

The primary objective of this chapter is to provide a high-level overview of the ways in which an activity may be notified of a state change and to outline the areas where it is advisable to save or restore state information. Having covered this information, the chapter will then touch briefly on the subject of *activity lifetimes*.

13.1 New vs. Old Lifecycle Techniques

Up until recently, there was a standard way to build lifecycle awareness into an app. This is the approach covered in this chapter and involves implementing a set of methods (one for each lifecycle state) within an activity or fragment instance that get called by the operating system when the lifecycle status of that object changes. This approach has remained unchanged since the early years of the Android operating system and, while still a viable option today, it does have some limitations which will be explained later in this chapter.

With the introduction of the lifecycle classes with the Jetpack Android Architecture Components, a better approach to lifecycle handling is now available. This modern approach to lifecycle management (together with the Jetpack components and architecture guidelines) will be covered in detail in later chapters. It is still important, however, to understand the traditional lifecycle methods for a couple of reasons. First, as an Android developer you will not be completely insulated from the traditional lifecycle methods and will still make use of some of them. More importantly, understanding the older way of handling lifecycles will provide a good knowledge foundation on which to begin learning the new approach later in the book.

13.2 The Activity and Fragment Classes

With few exceptions, activities and fragments in an application are created as subclasses of the Android AppCompatActivity class and Fragment classes respectively.

Consider, for example, the *AndroidSample* project created in *"Creating an Example Android App in Android Studio"*. Load this project into the Android Studio environment and locate the *MainActivity.java* file (located in *app -> java -> com.<your domain>.androidsample*). Having located the file, double-click on it to load it into the editor where it should read as follows:

```
package com.ebookfrenzy.androidsample;

import androidx.appcompat.app.AppCompatActivity;

import android.os.Bundle;
import android.view.View;
import android.widget.EditText;
```

```
import android.widget.TextView;

public class MainActivity extends AppCompatActivity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
    }

    public void convertCurrency(View view) {

        EditText dollarText = findViewById(R.id.dollarText);
        TextView textView = findViewById(R.id.textView);

        if (!dollarText.getText().toString().equals("")) {

            Float dollarValue = Float.valueOf(dollarText.getText().toString());
            Float euroValue = dollarValue * 0.85F;
            textView.setText(euroValue.toString());
        } else {
            textView.setText(R.string.no_value_string);
        }
    }
}
```

When the project was created, we instructed Android Studio also to create an initial activity named *MainActivity*. As is evident from the above code, the MainActivity class is a subclass of the AppCompatActivity class.

A review of the reference documentation for the AppCompatActivity class would reveal that it is itself a subclass of the Activity class. This can be verified within the Android Studio editor using the *Hierarchy* tool window. With the *MainActivity.java* file loaded into the editor, click on AppCompatActivity in the *class* declaration line and press the *Ctrl-H* keyboard shortcut. The hierarchy tool window will subsequently appear displaying the class hierarchy for the selected class. As illustrated in Figure 13-1, AppCompatActivity is clearly subclassed from the FragmentActivity class which is itself ultimately a subclass of the Activity class:

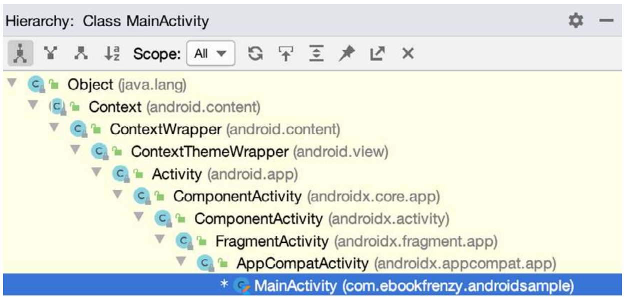

Figure 13-1

The Activity and Fragment classes contain a range of methods that are intended to be called by the Android runtime to notify the object when its state is changing. For the purposes of this chapter, we will refer to these as the *lifecycle methods*. An activity or fragment class simply needs to *override* these methods and implement the necessary functionality within them in order to react accordingly to state changes.

One such method is named *onCreate()* and, turning once again to the above code fragment, we can see that this method has already been overridden and implemented for us in the *MainActivity* class. In a later section we will explore in detail both *onCreate()* and the other relevant lifecycle methods of the Activity and Fragment classes.

13.3 Dynamic State vs. Persistent State

A key objective of lifecycle management is ensuring that the state of the activity is saved and restored at appropriate times. When talking about *state* in this context we mean the data that is currently being held within the activity and the appearance of the user interface. The activity might, for example, maintain a data model in memory that needs to be saved to a database, content provider or file. Such state information, because it persists from one invocation of the application to another, is referred to as the *persistent state*.

The appearance of the user interface (such as text entered into a text field but not yet committed to the application's internal data model) is referred to as the *dynamic state*, since it is typically only retained during a single invocation of the application (and also referred to as *user interface state* or *instance state*).

Understanding the differences between these two states is important because both the ways they are saved, and the reasons for doing so, differ.

The purpose of saving the persistent state is to avoid the loss of data that may result from an activity being killed by the runtime system while in the background. The dynamic state, on the other hand, is saved and restored for reasons that are slightly more complex.

Consider, for example, that an application contains an activity (which we will refer to as *Activity A*) containing a text field and some radio buttons. During the course of using the application, the user enters some text into the text field and makes a selection from the radio buttons. Before performing an action to save these changes, however, the user then switches to another activity causing *Activity A* to be pushed down the Activity Stack and placed into the background. After some time, the runtime system ascertains that memory is low and consequently kills *Activity A* to free up resources. As far as the user is concerned, however, *Activity A* was simply placed into the background and is ready to be moved to the foreground at any time. On returning *Activity A* to the foreground the user would, quite reasonably, expect the entered text and radio button selections to have been retained. In this scenario, however, a new instance of *Activity A* will have been created and, if the dynamic state was not saved and restored, the previous user input lost.

The main purpose of saving dynamic state, therefore, is to give the perception of seamless switching between foreground and background activities, regardless of the fact that activities may actually have been killed and restarted without the user's knowledge.

The mechanisms for saving persistent and dynamic state will become clearer in the following sections of this chapter.

13.4 The Android Lifecycle Methods

As previously explained, the Activity and Fragment classes contain a number of lifecycle methods which act as event handlers when the state of an instance changes. The primary methods supported by the Android Activity and Fragment class are as follows:

- **onCreate(Bundle savedInstanceState)** – The method that is called when the activity is first created and the ideal location for most initialization tasks to be performed. The method is passed an argument in the form of a *Bundle* object that may contain dynamic state information (typically relating to the state of the user interface) from a prior invocation of the activity.

- **onRestart()** – Called when the activity is about to restart after having previously been stopped by the runtime system.

- **onStart()** – Always called immediately after the call to the *onCreate()* or *onRestart()* methods, this method indicates to the activity that it is about to become visible to the user. This call will be followed by a call to *onResume()* if the activity moves to the top of the activity stack, or *onStop()* in the event that it is pushed down the stack by another activity.

- **onResume()** – Indicates that the activity is now at the top of the activity stack and is the activity with which the user is currently interacting.

- **onPause()** – Indicates that a previous activity is about to become the foreground activity. This call will be followed by a call to either the *onResume()* or *onStop()* method depending on whether the activity moves back to the foreground or becomes invisible to the user. Steps may be taken within this method to store *persistent state* information not yet saved by the app. To avoid delays in switching between activities, time consuming operations such as storing data to a database or performing network operations should be avoided within this method. This method should also ensure that any CPU intensive tasks such as animation are stopped.

- **onStop()** – The activity is now no longer visible to the user. The two possible scenarios that may follow this call are a call to *onRestart()* in the event that the activity moves to the foreground again, or *onDestroy()* if the activity is being terminated.

- **onDestroy()** – The activity is about to be destroyed, either voluntarily because the activity has completed its tasks and has called the *finish()* method or because the runtime is terminating it either to release memory or due to a configuration change (such as the orientation of the device changing). It is important to note that a call will not always be made to *onDestroy()* when an activity is terminated.

- **onConfigurationChanged()** – Called when a configuration change occurs for which the activity has indicated it is not to be restarted. The method is passed a Configuration object outlining the new device configuration and it is then the responsibility of the activity to react to the change.

The following lifecycle methods only apply to the Fragment class:

- **onAttach()** - Called when the fragment is assigned to an activity.

- **onCreateView()** - Called to create and return the fragment's user interface layout view hierarchy.

- **onActivityCreated()** - The *onCreate()* method of the activity with which the fragment is associated has completed execution.

- **onViewStatusRestored()** - The fragment's saved view hierarchy has been restored.

In addition to the lifecycle methods outlined above, there are two methods intended specifically for saving and restoring the *dynamic state* of an activity:

- **onRestoreInstanceState(Bundle savedInstanceState)** – This method is called immediately after a call to the *onStart()* method in the event that the activity is restarting from a previous invocation in which state was saved. As with *onCreate()*, this method is passed a Bundle object containing the previous state data. This method is typically used in situations where it makes more sense to restore a previous state after the initialization of the activity has been performed in *onCreate()* and *onStart()*.

- **onSaveInstanceState(Bundle outState)** – Called before an activity is destroyed so that the current *dynamic state* (usually relating to the user interface) can be saved. The method is passed the Bundle object into which the state should be saved and which is subsequently passed through to the *onCreate()* and *onRestoreInstanceState()* methods when the activity is restarted. Note that this method is only called in situations where the runtime ascertains that dynamic state needs to be saved.

When overriding the above methods, it is important to remember that, with the exception of *onRestoreInstanceState()* and *onSaveInstanceState()*, the method implementation must include a call to the corresponding method in the super class. For example, the following method overrides the *onRestart()* method but also includes a call to the super class instance of the method:

```
protected void onRestart() {
        super.onRestart();
        Log.i(TAG, "onRestart");
}
```

Failure to make this super class call in method overrides will result in the runtime throwing an exception during execution. While calls to the super class in the *onRestoreInstanceState()* and *onSaveInstanceState()* methods are optional (they can, for example, be omitted when implementing custom save and restoration behavior) there are considerable benefits to using them, a subject that will be covered in the chapter entitled *"Saving and Restoring the State of an Android Activity"*.

13.5 Lifetimes

The final topic to be covered involves an outline of the *entire*, *visible* and *foreground* lifetimes through which an activity or fragment will transition during execution:

- **Entire Lifetime** –The term "entire lifetime" is used to describe everything that takes place between the initial call to the *onCreate()* method and the call to *onDestroy()* prior to the object terminating.
- **Visible Lifetime** – Covers the periods of execution between the call to *onStart()* and *onStop()*. During this period the activity or fragment is visible to the user though may not be the object with which the user is currently interacting.
- **Foreground Lifetime** – Refers to the periods of execution between calls to the *onResume()* and *onPause()* methods.

It is important to note that an activity or fragment may pass through the *foreground* and *visible* lifetimes multiple times during the course of the *entire* lifetime.

The concepts of lifetimes and lifecycle methods are illustrated in Figure 13-2:

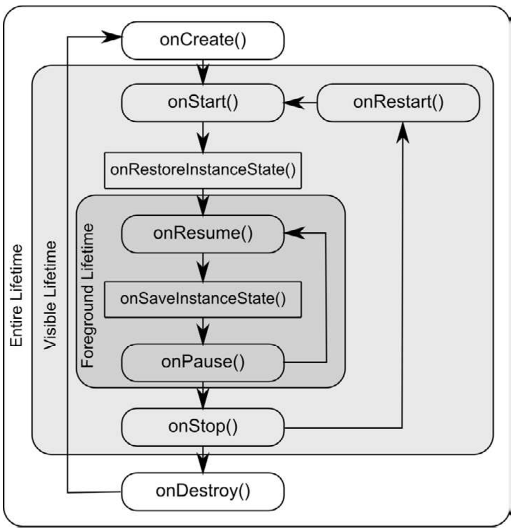

Figure 13-2

13.6 Foldable Devices and Multi-Resume

As discussed previously, an activity is considered to be in the resumed state when it has moved to the foreground and is the activity with which the user is currently interacting. On standard devices an app can have one activity in the resumed state at any one time and all other activities are likely to be in the paused or stopped state.

For some time now, Android has included multi-window support, allowing multiple activities to appear simultaneously in either split-screen or freeform configurations. Although originally used primarily on large screen tablet devices, this feature is likely to become more popular with the introduction of foldable devices.

On devices running Android 10 and on which multi-window support is enabled (as will be the case for most foldables), it will be possible for multiple app activities to be in the resumed state at the same time (a concept referred to as *multi-resume*) allowing those visible activities to continue functioning (for example streaming content or updating visual data) even when another activity currently has focus. Although multiple activities can be in the resumed state, only one of these activities will be considered to the *topmost resumed activity* (in other words, the activity with which the user most recently interacted).

An activity can receive notification that it has gained or lost the topmost resumed status by implementing the *onTopResumedActivityChanged()* callback method.

13.7 Disabling Configuration Change Restarts

As previously outlined, an activity may indicate that it is not to be restarted in the event of certain configuration changes. This is achieved by adding an *android:configChanges* directive to the activity element within the project manifest file. The following manifest file excerpt, for example, indicates that the activity should not be restarted in the event of configuration changes relating to orientation or device-wide font size:

```
<activity android:name=".MainActivity"
          android:configChanges="orientation|fontScale"
          android:label="@string/app_name">
```

13.8 Lifecycle Method Limitations

As discussed at the start of this chapter, lifecycle methods have been in use for many years and, until recently, were the only mechanism available for handling lifecycle state changes for activities and fragments. There are, however, shortcomings to this approach.

One issue with the lifecycle methods is that they do not provide an easy way for an activity or fragment to find out its current lifecycle state at any given point during app execution. Instead the object would need to track the state internally, or wait for the next lifecycle method call.

Also, the methods do not provide a simple way for one object to observe the lifecycle state changes of other objects within an app. This is a serious consideration since many other objects within an app can potentially be impacted by a lifecycle state change in a given activity or fragment.

The lifecycle methods are also only available on subclasses of the Fragment and Activity classes. It is not possible, therefore, to build custom classes that are truly lifecycle aware.

Finally, the lifecycle methods result in most of the lifecycle handling code being written within the activity or fragment which can lead to complex and error prone code. Ideally, much of this code should reside in the other classes that are impacted by the state change. An app that streams video, for example, might include a class designed specifically to manage the incoming stream. If the app needs to pause the stream when the main activity is stopped, the code to do so should reside in the streaming class, not the main activity.

All of these problems and more are resolved by using *lifecycle-aware* components, a topic which will be covered starting with the chapter entitled *"Modern Android App Architecture with Jetpack"*.

13.9 Summary

All activities are derived from the Android *Activity* class which, in turn, contains a number of lifecycle methods that are designed to be called by the runtime system when the state of an activity changes. Similarly, the Fragment class contains a number of comparable methods. By overriding these methods, activities and fragments can respond to state changes and, where necessary, take steps to save and restore the current state of both the activity and the application. Lifecycle state can be thought of as taking two forms. The persistent state refers to data that needs to be stored between application invocations (for example to a file or database). Dynamic state, on the other hand, relates instead to the current appearance of the user interface.

Although lifecycle methods have a number of limitations that can be avoided by making use of lifecycle-aware components, an understanding of these methods is important in order to fully understand the new approaches to lifecycle management covered later in this book.

In this chapter, we have highlighted the lifecycle methods available to activities and covered the concept of activity lifetimes. In the next chapter, entitled *"Android Activity State Changes by Example"*, we will implement an example application that puts much of this theory into practice.

Chapter 14

14. Android Activity State Changes by Example

The previous chapters have discussed in some detail the different states and lifecycles of the activities that comprise an Android application. In this chapter, we will put the theory of handling activity state changes into practice through the creation of an example application. The purpose of this example application is to provide a real world demonstration of an activity as it passes through a variety of different states within the Android runtime. In the next chapter, entitled *"Saving and Restoring the State of an Android Activity"*, the example project constructed in this chapter will be extended to demonstrate the saving and restoration of dynamic activity state.

14.1 Creating the State Change Example Project

The first step in this exercise is to create the new project. Begin by launching Android Studio and, if necessary, closing any currently open projects using the *File -> Close Project* menu option so that the Welcome screen appears.

Select the *Start a new Android Studio project* quick start option from the welcome screen and, within the resulting new project dialog, choose the Empty Activity template before clicking on the Next button.

Enter StateChange into the Name field and specify *com.ebookfrenzy.statechange* as the package name. Before clicking on the Finish button, change the Minimum API level setting to API 26: Android 8.0 (Oreo) and the Language menu to Java. Upon completion of the project creation process, the *StateChange* project should be listed in the Project tool window located along the left-hand edge of the Android Studio main window.

The next action to take involves the design of the user interface for the activity. This is stored in a file named *activity_main.xml* which should already be loaded into the Layout Editor tool. If it is not, navigate to it in the project tool window where it can be found in the *app -> res -> layout* folder. Once located, double-clicking on the file will load it into the Android Studio Layout Editor tool.

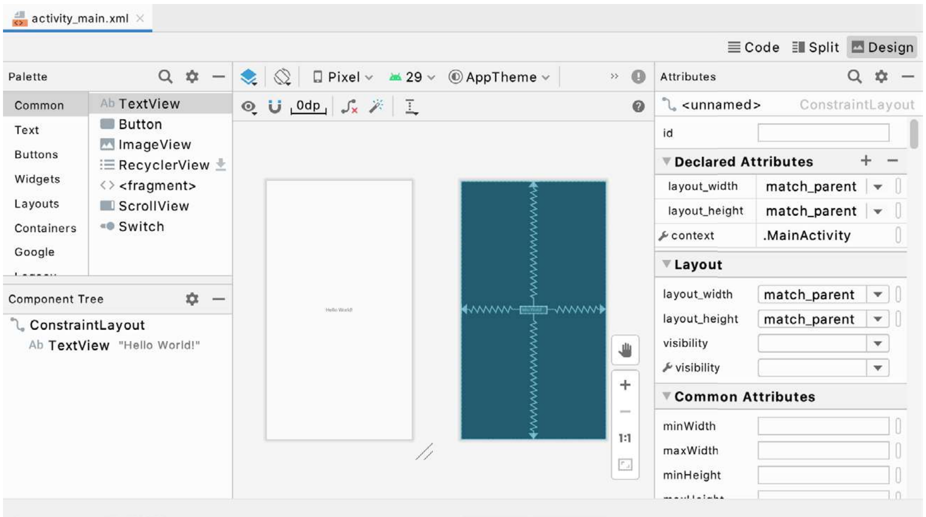

Figure 14-1

14.2 Designing the User Interface

With the user interface layout loaded into the Layout Editor tool, it is now time to design the user interface for the example application. Instead of the "Hello world!" TextView currently present in the user interface design, the activity actually requires an EditText view. Select the TextView object in the Layout Editor canvas and press the Delete key on the keyboard to remove it from the design.

From the Palette located on the left side of the Layout Editor, select the *Text* category and, from the list of text components, click and drag a *Plain Text* component over to the visual representation of the device screen. Move the component to the center of the display so that the center guidelines appear and drop it into place so that the layout resembles that of Figure 14-2.

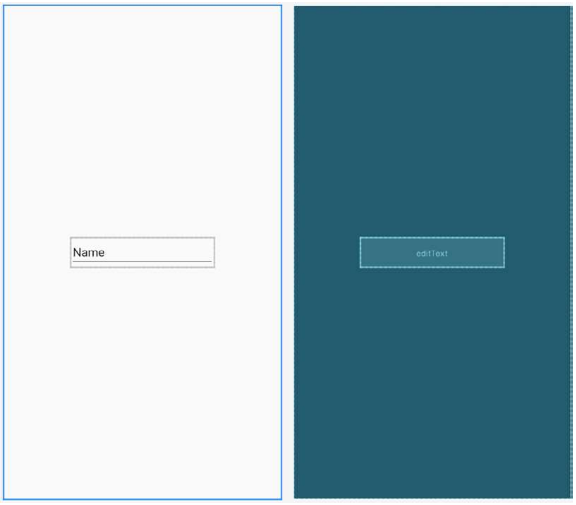

Figure 14-2

When using the EditText widget it is necessary to specify an *input type* for the view. This simply defines the type of text or data that will be entered by the user. For example, if the input type is set to *Phone*, the user will be restricted to entering numerical digits into the view. Alternatively, if the input type is set to *TextCapCharacters*, the input will default to upper case characters. Input type settings may also be combined.

For the purposes of this example, we will set the input type to support general text input. To do so, select the EditText widget in the layout and locate the *inputType* entry within the Attributes tool window. Click on the flag icon to the left of the current setting to open the list of options and, within the list, switch off *textPersonName* and enable *text* before clicking on the Apply button. Remaining in the Attributes tool window, change the id of the view to *editText*.

By default the EditText is displaying text which reads "Name". Remaining within the Attributes panel, delete this from the *text* property field so that the view is blank within the layout.

14.3 Overriding the Activity Lifecycle Methods

At this point, the project contains a single activity named *MainActivity*, which is derived from the Android *AppCompatActivity* class. The source code for this activity is contained within the *MainActivity.java* file which should already be open in an editor session and represented by a tab in the editor tab bar. In the event that the file is no longer open, navigate to it in the Project tool window panel (*app -> java -> com.ebookfrenzy.statechange -> MainActivity*) and double-click on it to load the file into the editor. Once loaded the code should read as follows:

```
package com.ebookfrenzy.statechange;

import androidx.appcompat.app.AppCompatActivity;
```

```
import android.os.Bundle;

public class MainActivity extends AppCompatActivity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
    }
}
```

So far the only lifecycle method overridden by the activity is the *onCreate()* method which has been implemented to call the super class instance of the method before setting up the user interface for the activity. We will now modify this method so that it outputs a diagnostic message in the Android Studio Logcat panel each time it executes. For this, we will use the *Log* class, which requires that we import *android.util.Log* and declare a tag that will enable us to filter these messages in the log output:

```
package com.ebookfrenzy.statechange;
.
.
import android.util.Log;

public class MainActivity extends AppCompatActivity {

    private static final String TAG = "StateChange";

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);

        Log.i(TAG, "onCreate");
    }
}
```

The next task is to override some more methods, with each one containing a corresponding log call. These override methods may be added manually or generated using the *Alt-Insert* keyboard shortcut as outlined in the chapter entitled *"The Basics of the Android Studio Code Editor"*. Note that the Log calls will still need to be added manually if the methods are being auto-generated:

```
@Override
protected void onStart() {
    super.onStart();
    Log.i(TAG, "onStart");
}

@Override
protected void onResume() {
```

```
    super.onResume();
    Log.i(TAG, "onResume");
}

@Override
protected void onPause() {
    super.onPause();
    Log.i(TAG, "onPause");
}

@Override
protected void onStop() {
    super.onStop();
    Log.i(TAG, "onStop");
}

@Override
protected void onRestart() {
    super.onRestart();
    Log.i(TAG, "onRestart");
}

@Override
protected void onDestroy() {
    super.onDestroy();
    Log.i(TAG, "onDestroy");
}

@Override
protected void onSaveInstanceState(Bundle outState) {
    super.onSaveInstanceState(outState);
    Log.i(TAG, "onSaveInstanceState");
}

@Override
protected void onRestoreInstanceState(Bundle savedInstanceState) {
    super.onRestoreInstanceState(savedInstanceState);
    Log.i(TAG, "onRestoreInstanceState");
}
```

14.4 Filtering the Logcat Panel

The purpose of the code added to the overridden methods in *MainActivity.java* is to output logging information to the *Logcat* tool window. This output can be configured to display all events relating to the device or emulator session, or restricted to those events that relate to the currently selected app. The output can also be further restricted to only those log events that match a specified filter.

Display the Logcat tool window and click on the filter menu (marked as B in Figure 14-3) to review the available options. When this menu is set to *Show only selected application*, only those messages relating to the app selected in the menu marked as A will be displayed in the Logcat panel. Choosing *No Filters*, on the other hand, will display all the messages generated by the device or emulator.

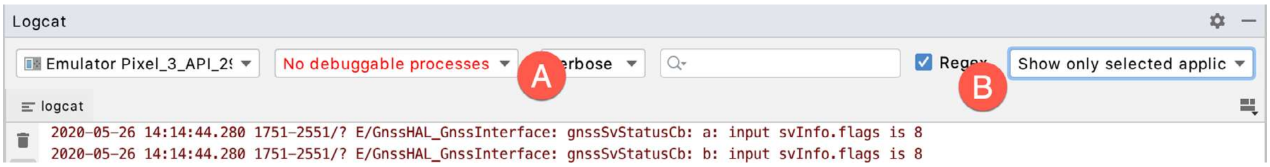

Figure 14-3

Before running the application, it is worth demonstrating the creation of a filter which, when selected, will further restrict the log output to ensure that only those log messages containing the tag declared in our activity are displayed.

From the filter menu (B), select the *Edit Filter Configuration* menu option. In the *Create New Logcat Filter* dialog (Figure 14-4), name the filter *Lifecycle* and, in the *Log Tag* field, enter the Tag value declared in *MainActivity.java* (in the above code example this was *StateChange*).

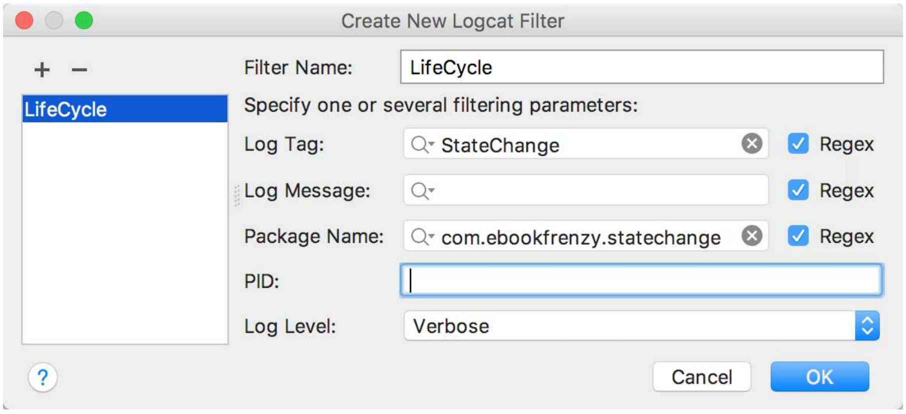

Figure 14-4

Enter the package identifier in the *Package Name* field and, when the changes are complete, click on the *OK* button to create the filter and dismiss the dialog. Instead of listing *No Filters,* the newly created filter should now be selected in the Logcat tool window.

14.5 Running the Application

For optimal results, the application should be run on a physical Android device or emulator. With the device configured and connected to the development computer, click on the run button represented by a green triangle located in the Android Studio toolbar as shown in Figure 14-5 below, select the *Run -> Run…* menu option or use the Shift+F10 keyboard shortcut:

Figure 14-5

Select the physical Android device from the *Choose Device* dialog if it appears (assuming that you have not already configured it to be the default target). After Android Studio has built the application and installed it on the device it should start up and be running in the foreground.

A review of the Logcat panel should indicate which methods have so far been triggered (taking care to ensure that the *Lifecycle* filter created in the preceding section is selected to filter out log events that are not currently of interest to us):

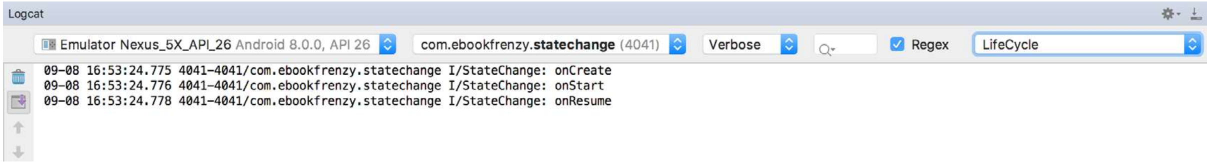

Figure 14-6

14.6 Experimenting with the Activity

With the diagnostics working, it is now time to exercise the application with a view to gaining an understanding of the activity lifecycle state changes. To begin with, consider the initial sequence of log events in the Logcat panel:

```
onCreate
onStart
onResume
```

Clearly, the initial state changes are exactly as outlined in *"Understanding Android Application and Activity Lifecycles"*. Note, however, that a call was not made to *onRestoreInstanceState()* since the Android runtime detected that there was no state to restore in this situation.

Tap on the Home icon in the bottom status bar on the device display and note the sequence of method calls reported in the log as follows:

```
onPause
onStop
onSaveInstanceState
```

In this case, the runtime has noticed that the activity is no longer in the foreground, is not visible to the user and has stopped the activity, but not without providing an opportunity for the activity to save the dynamic state. Depending on whether the runtime ultimately destroyed the activity or simply restarted it, the activity will either be notified it has been restarted via a call to *onRestart()* or will go through the creation sequence again when the user returns to the activity.

As outlined in *"Understanding Android Application and Activity Lifecycles"*, the destruction and recreation of an activity can be triggered by making a configuration change to the device, such as rotating from portrait to landscape. To see this in action, simply rotate the device while the *StateChange* application is in the foreground. When using the emulator, device rotation may be simulated using the rotation button located in the emulator toolbar. The resulting sequence of method calls in the log should read as follows:

```
onPause
onStop
onSaveInstanceState
onDestroy
onCreate
onStart
onRestoreInstanceState
onResume
```

Clearly, the runtime system has given the activity an opportunity to save state before being destroyed and restarted.

14.7 Summary

The old adage that a picture is worth a thousand words holds just as true for examples when learning a new programming paradigm. In this chapter, we have created an example Android application for the purpose of demonstrating the different lifecycle states through which an activity is likely to pass. In the course of developing the project in this chapter, we also looked at a mechanism for generating diagnostic logging information from within an activity.

In the next chapter, we will extend the *StateChange* example project to demonstrate how to save and restore an activity's dynamic state.