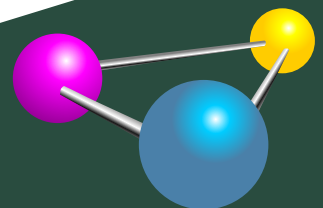


**Version
1.4**

*Updated for
Android 2.1!*

The Busy Coder's Guide to
Advanced
Android™
Development

Mark L. Murphy



COMMONSWARE

The Busy Coder's Guide to Advanced Android Development

by Mark L. Murphy

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by Mark L. Murphy

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Remember that the CommonsWare Web site has errata and resources (e.g., source code) for each of our titles. Just visit the Web page for the book you are interested in and follow the links.

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Some notes for first-generation Kindle users:

- You may wish to drop your font size to level 2 for easier reading

- Source code listings are incorporated as graphics so as to retain the monospace font, though this means the source code listings do not honor changes in Kindle font size

Welcome to the Book!

If you come to this book after having read its companion volume, *The Busy Coder's Guide to Android Development*, thanks for sticking with the series! CommonsWare aims to have the most comprehensive set of Android development resources (outside of the Open Handset Alliance itself), and we appreciate your interest.

If you come to this book having learned about Android from other sources, thanks for joining the CommonsWare community! Android, while aimed at small devices, is a surprisingly vast platform, making it difficult for any given book, training, wiki, or other source to completely cover everything one needs to know. This book will hopefully augment your knowledge of the ins and outs of Android-dom and make it easier for you to create "killer apps" that use the Android platform.

And, most of all, thanks for your interest in this book! I sincerely hope you find it useful and at least occasionally entertaining.

Prerequisites

This book assumes you have experience in Android development, whether from a CommonsWare resource or someplace else. In other words, you should have:

- A working Android development environment, whether it is based on Eclipse, another IDE, or just the command-line tools that accompany the Android SDK
- A strong understanding of how to create activities and the various stock widgets available in Android
- A working knowledge of the Intent system, how it serves as a message bus, and how to use it to launch other activities
- Experience in creating, or at least using, content providers and services

If you picked this book up expecting to learn those topics, you really need another source first, since this book focuses on other topics. While we are fans of *The Busy Coder's Guide to Android Development*, there are plenty of other books available covering the Android basics, blog posts, wikis, and, of course, the main [Android site](#) itself. A list of currently-available Android books can be found on the [Android Programming knol](#).

Some chapters may reference material in previous chapters, though usually with a link back to the preceding section of relevance. Many chapters will reference material in *The Busy Coder's Guide to Android Development*, sometimes via the shorthand *BCG to Android* moniker.

In order to make effective use of this book, you will want to download the source code for it off of [the book's page](#) on the CommonsWare site.

You can find out when new releases of this book are available via:

- The [cw-android](#) Google Group, which is also a great place to ask questions about the book and its examples
- The [commonsguy](#) Twitter feed
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Warescription

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- Sample applications that do not work as advertised, in the environment described in the book
- Factual errors that cannot be open to interpretation

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We appreciate hearing about "softer" issues as well, such as:

- Places where you think we are in error, but where we feel our interpretation is reasonable
- Places where you think we could add sample applications, or expand upon the existing material
- Samples that do not work due to "shifting sands" of the underlying environment (e.g., changed APIs with new releases of an SDK)

However, those "softer" issues do not qualify for the formal bounty program.

Questions about the bug bounty, or problems you wish to report for bounty consideration, should be sent to bounty@commonsware.com.

Source Code

The source code samples shown in this book are available for download from the [CommonsWare Web site](#). All of the Android projects are licensed under the [Apache 2.0 License](#), in case you have the desire to reuse any of it.

If you wish to use the source code from the CommonsWare Web site, bear in mind a few things:

1. The projects are set up to be built by Ant, not by Eclipse. If you wish to use the code with Eclipse, you will need to create a suitable Android Eclipse project and import the code and other assets.
2. You should delete `build.xml`, then run `android update project -p ...` (where `...` is the path to a project of interest) on those projects you wish to use, so the build files are updated for your Android SDK version.

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CommonsWare books generally go through a series of stages.

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Release candidates are editions with version numbers ending in ".9" (0.9, 1.9, etc.). These editions should be complete. Once again, they are made available to those on the Warescription so they get early access to the material and can file bug reports (and receive bounties in return!).

Major editions are those with version numbers ending in ".0" (1.0, 2.0, etc.). These will be first published digitally for the Warescription members, but will shortly thereafter be available in print from booksellers worldwide.

Versions between a major edition and the next release candidate (e.g., 1.1, 1.2) will contain bug fixes plus new material. Each of these editions should also be complete, in that you will not see any "TBD" (to be done) markers or the like. However, these editions may have bugs, and so bug reports are eligible for the bounty program, as with release candidates and major releases.

A book usually will progress fairly rapidly through the pre-release editions to the first release candidate and Version 1.0 – often times, only a few months. Depending on the book's scope, it may go through another cycle of significant improvement (versions 1.1 through 2.0), though this may take several months to a year or more. Eventually, though, the book will go into more of a "maintenance mode", only getting updates to fix bugs and deal

with major ecosystem events – for example, a new release of the Android SDK will necessitate an update to all Android books.

PART I – Advanced UI

WebView, Inside and Out

Android uses the WebKit browser engine as the foundation for both its Browser application and the `WebView` embeddable browsing widget. The Browser application, of course, is something Android users can interact with directly; the `WebView` widget is something you can integrate into your own applications for places where an HTML interface might be useful.

In *BCG to Android*, we saw a simple integration of a `WebView` into an Android activity, with the activity dictating what the browsing widget displayed and how it responded to links.

Here, we will expand on this theme, and show how to more tightly integrate the Java environment of an Android application with the Javascript environment of WebKit.

Friends with Benefits

When you integrate a `WebView` into your activity, you can control what Web pages are displayed, whether they are from a local provider or come from over the Internet, what should happen when a link is clicked, and so forth. And between `WebView`, `WebViewClient`, and `WebSettings`, you can control a fair bit about how the embedded browser behaves. Yet, by default, the browser itself is just a browser, capable of showing Web pages and interacting with Web sites, but otherwise gaining nothing from being hosted by an Android application.

Except for one thing: `addJavascriptInterface()`.

The `addJavascriptInterface()` method on `WebView` allows you to inject a Java object into the `WebView`, exposing its methods, so they can be called by Javascript loaded by the Web content in the `WebView` itself.

Now you have the power to provide access to a wide range of Android features and capabilities to your `WebView`-hosted content. If you can access it from your activity, and if you can wrap it in something convenient for use by Javascript, your Web pages can access it as well.

For example, Google's [Gears](#) project offers a [Geolocation API](#), so Web pages loaded in a Gears-enabled browser can find out where the browser is located. This information could be used for everything from fine-tuning a search to emphasize local content to serving up locale-tailored advertising.

We can do much of the same thing with Android and `addJavascriptInterface()`.

In the `WebView/GeoWeb1` project, you will find a fairly simple layout (`main.xml`):

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    >
    <WebView android:id="@+id/webkit"
        android:layout_width="fill_parent"
        android:layout_height="fill_parent"
    />
</LinearLayout>
```

All this does is host a full-screen `WebView` widget.

Next, take a look at the `GeoWebOne` activity class:

```
public class GeoWebOne extends Activity {
    private static String PROVIDER=LocationManager.GPS_PROVIDER;
```

```
private WebView browser;
private LocationManager myLocationManager=null;

@Override
public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);

    setContentView(R.layout.main);
    browser=(WebView)findViewById(R.id.webkit);

    myLocationManager=(LocationManager) getSystemService(Context.LOCATION_SERVICE
);

    browser.getSettings().setJavaScriptEnabled(true);
    browser.addJavascriptInterface(new Locater(), "locater");
    browser.loadUrl("file:///android_asset/geoweb1.html");
}

@Override
public void onResume() {
    super.onResume();
    myLocationManager.requestLocationUpdates(PROVIDER, 10000,
                                             100.0f,
                                             onLocationChange);
}

@Override
public void onPause() {
    super.onPause();
    myLocationManager.removeUpdates(onLocationChange);
}

LocationListener onLocationChange=new LocationListener() {
    public void onLocationChanged(Location location) {
        // ignore...for now
    }

    public void onProviderDisabled(String provider) {
        // required for interface, not used
    }

    public void onProviderEnabled(String provider) {
        // required for interface, not used
    }

    public void onStatusChanged(String provider, int status,
                                Bundle extras) {
        // required for interface, not used
    }
};

public class Locater {
    public double getLatitude() {
        Location loc=myLocationManager.getLastKnownLocation(PROVIDER);
```

```
    if (loc==null) {
        return(0);
    }

    return(loc.getLatitude());
}

public double getLongitude() {
    Location loc=myLocationManager.getLastKnownLocation(PROVIDER);

    if (loc==null) {
        return(0);
    }

    return(loc.getLongitude());
}
}
```

This looks a bit like some of the `WebView` examples in the *BCG to Android's* chapter on integrating `WebKit`. However, it adds three key bits of code:

1. It sets up the `LocationManager` to provide updates when the device position changes, routing those updates to a do-nothing `LocationListener` callback object
2. It has a `Locater` inner class that provides a convenient API for accessing the current location, in the form of latitude and longitude values
3. It uses `addJavascriptInterface()` to expose a `Locater` instance under the name `locater` to the Web content loaded in the `WebView`

The Web page itself is referenced in the source code as `file:///android_asset/geoweb1.html`, so the `GeoWeb1` project has a corresponding `assets/` directory containing `geoweb1.html`:

```
<html>
<head>
<title>Android GeoWebOne Demo</title>
<script language="javascript">
    function whereami() {
        document.getElementById("lat").innerHTML=locater.getLatitude();
        document.getElementById("lon").innerHTML=locater.getLongitude();
    }
</script>
</head>
```

```
<body>
<p>
You are at: <br/> <span id="lat">(unknown)</span> latitude and <br/>
<span id="lon">(unknown)</span> longitude.
</p>
<p><a onClick="whereami()">Update Location</a></p>
</body>
</html>
```

When you click the "Update Location" link, the page calls a `whereami()` Javascript function, which in turn uses the `locator` object to update the latitude and longitude, initially shown as "(unknown)" on the page.

If you run the application, initially, the page is pretty boring:

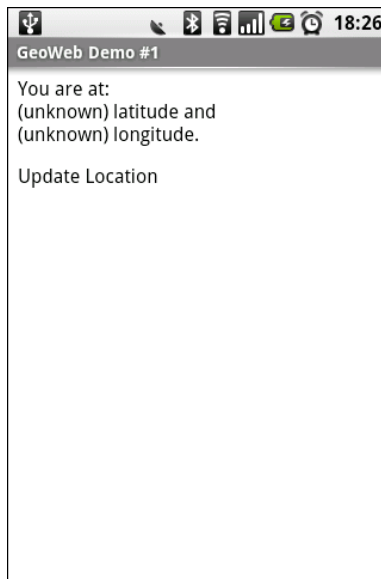


Figure 1. The GeoWebOne sample application, as initially launched

However, if you wait a bit for a GPS fix, and click the "Update Location" link...the page is still pretty boring, but it at least knows where you are:

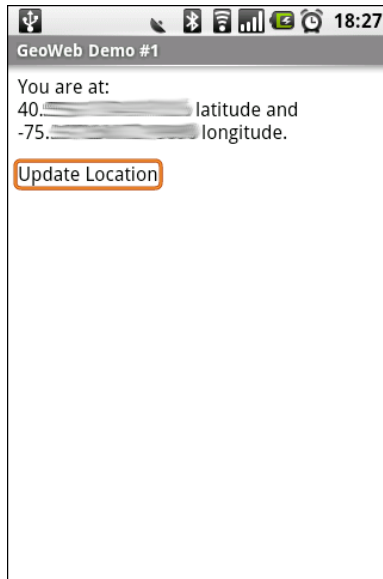


Figure 2. The GeoWebOne sample application, after clicking the Update Location link

Turnabout is Fair Play

Now that we have seen how Javascript can call into Java, it would be nice if Java could somehow call out to Javascript. In our example, it would be helpful if we could expose automatic location updates to the Web page, so it could proactively update the position as the user moves, rather than wait for a click on the "Update Location" link.

Well, as luck would have it, we can do that too. This is a good thing, otherwise, this would be a really weak section of the book.

What is unusual is how you call out to Javascript. One might imagine there would be an `executeJavascript()` counterpart to `addJavascriptInterface()`, where you could supply some Javascript source and have it executed within the context of the currently-loaded Web page.

Oddly enough, that is not how this is accomplished.

Instead, given your snippet of Javascript source to execute, you call `loadUrl()` on your `WebView`, as if you were going to load a Web page, but you put `javascript:` in front of your code and use that as the "address" to load.

If you have ever created a "bookmarklet" for a desktop Web browser, you will recognize this technique as being the Android analogue – the `javascript:` prefix tells the browser to treat the rest of the address as Javascript source, injected into the currently-viewed Web page.

So, armed with this capability, let us modify the previous example to continuously update our position on the Web page.

The layout for this new project (`WebView/GeoWeb2`) is the same as before. The Java source for our activity changes a bit:

```
public class GeoWebTwo extends Activity {
    private static String PROVIDER="gps";
    private WebView browser;
    private LocationManager myLocationManager=null;

    @Override
    public void onCreate(Bundle icle) {
        super.onCreate(icle);
        setContentView(R.layout.main);
        browser=(WebView)findViewById(R.id.webkit);

        myLocationManager=(LocationManager) getSystemService(Context.LOCATION_SERVICE
);

        browser.getSettings().setJavaScriptEnabled(true);
        browser.addJavascriptInterface(new Locater(), "locater");
        browser.loadUrl("file:///android_asset/geoweb2.html");
    }

    @Override
    public void onResume() {
        super.onResume();
        myLocationManager.requestLocationUpdates(PROVIDER, 0,
                                                0,
                                                onLocationChange);
    }

    @Override
    public void onPause() {
        super.onPause();
        myLocationManager.removeUpdates(onLocationChange);
    }
}
```

```
LocationListener onLocationChange=new LocationListener() {
    public void onLocationChanged(Location location) {
        StringBuilder buf=new StringBuilder("javascript:whereami(");

        buf.append(String.valueOf(location.getLatitude()));
        buf.append(",");
        buf.append(String.valueOf(location.getLongitude()));
        buf.append(")");

        browser.loadUrl(buf.toString());
    }

    public void onProviderDisabled(String provider) {
        // required for interface, not used
    }

    public void onProviderEnabled(String provider) {
        // required for interface, not used
    }

    public void onStatusChanged(String provider, int status,
        Bundle extras) {
        // required for interface, not used
    }
};

public class Locater {
    public double getLatitude() {
        Location loc=myLocationManager.getLastKnownLocation(PROVIDER);

        if (loc==null) {
            return(0);
        }

        return(loc.getLatitude());
    }

    public double getLongitude() {
        Location loc=myLocationManager.getLastKnownLocation(PROVIDER);

        if (loc==null) {
            return(0);
        }

        return(loc.getLongitude());
    }
}
```

Before, the `onLocationChanged()` method of our `LocationListener` callback did nothing. Now, it builds up a call to a `whereami()` Javascript function, providing the latitude and longitude as parameters to that call. So, for

example, if our location were 40 degrees latitude and -75 degrees longitude, the call would be `whereami(40,-75)`. Then, it puts `javascript:` in front of it and calls `loadUrl()` on the `WebView`. The result is that a `whereami()` function in the Web page gets called with the new location.

That Web page, of course, also needed a slight revision, to accommodate the option of having the position be passed in:

```
<html>
<head>
<title>Android GeoWebTwo Demo</title>
<script language="javascript">
  function whereami(lat, lon) {
    document.getElementById("lat").innerHTML=lat;
    document.getElementById("lon").innerHTML=lon;
  }
</script>
</head>
<body>
<p>
You are at: <br/> <span id="lat">(unknown)</span> latitude and <br/>
<span id="lon">(unknown)</span> longitude.
</p>
<p><a onClick="whereami(locater.getLatitude(), locater.getLongitude())">
Update Location</a></p>
</body>
</html>
```

The basics are the same, and we can even keep our "Update Location" link, albeit with a slightly different `onClick` attribute.

If you build, install, and run this revised sample on a GPS-equipped Android device, the page will initially display with "(unknown)" for the current position. After a fix is ready, though, the page will automatically update to reflect your actual position. And, as before, you can always click "Update Location" if you wish.

Gearing Up

In these examples, we demonstrate how `WebView` can interact with Java code, code that provides a service a little like one of those from Gears.

Of course, what would be really slick is if we could use Gears itself.

The good news is that Android is close on that front. Gears is actually baked into Android. However, it is only exposed by the Browser application, not via `WebView`. So, an end user of an Android device can leverage Gears-enabled Web pages.

For example, you could load the [Geolocation sample application](#) in your Android device's Browser application. Initially, you will get the standard "can we please use Gears?" security prompt:

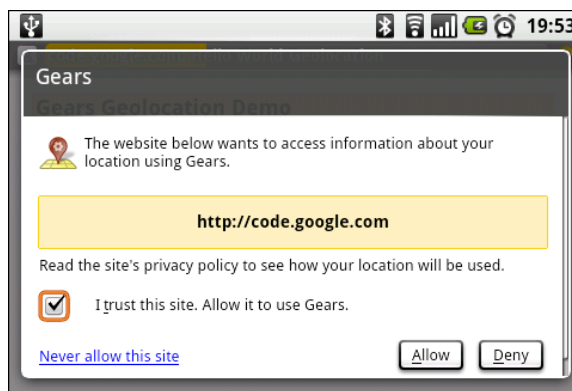


Figure 3. The Gears security prompt

Then, Gears will fire up the GPS interface (if enabled) and will fetch your location:

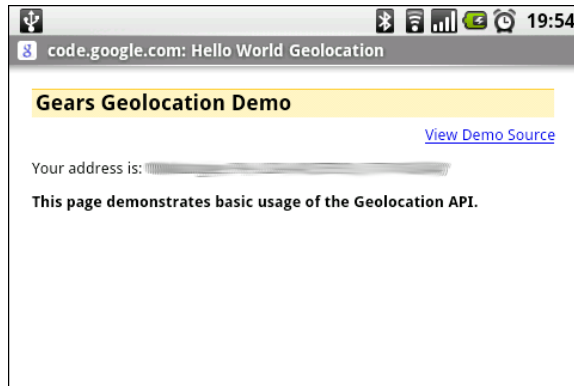


Figure 4. The Gears Geolocation sample application

Back To The Future

The core Android team has indicated that these sorts of capabilities will increase in future editions of the Android operating system. This could include support for more types of plugins, a richer Java-Javascript bridge, and so on.

You can also expect some improvements coming from the overall Android ecosystem. For example, the [PhoneGap](#) project is attempting to build a framework that supports creating Android applications solely out of Web content, using `WebView` as the front-end, supporting a range of Gears-like capabilities and more, such as accelerometer awareness.

Crafting Your Own Views

One of the classic forms of code reuse is the GUI widget. Since the advent of Microsoft Windows – and, to some extent, even earlier – developers have been creating their own widgets to extend an existing widget set. These range from 16-bit Windows "custom controls" to 32-bit Windows OCX components to the innumerable widgets available for Java Swing and SWT, and beyond. Android lets you craft your own widgets as well, such as extending an existing widget with a new UI or new behaviors.

Getting Meta

One common way of creating your own widgets is to aggregate other widgets together into a reusable "meta" widget. Rather than worry about all the details of measuring the widget sizes and drawing its contents, you simply worry about creating the public interface for how one interacts with the widget.

In this section, we will look at the `Views/Meter` sample project. Here, we bundle a `ProgressBar` and two `ImageButton` widgets into a reusable `Meter` widget, allowing one to change a value by clicking "increment" and "decrement" buttons. In most cases, one would probably be better served using the built-in `SeekBar` widget. However, there are times when we only want people to change the value a certain amount at a time, for which the `Meter` is ideally suited. In fact, we will reuse the `Meter` in a [later chapter](#) when we show how to manipulate the various volume levels in Android.

The Widget Layout

The first step towards creating a reusable widget is to lay it out. In some cases, you may prefer to create your widget contents purely in Java, particularly if many copies of the widget will be created and you do not want to inflate them every time. However, otherwise, layout XML is simpler in many cases than the in-Java alternative.

Here is one such Meter layout (`res/layout/meter.xml` in `Views/Meter`):

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="horizontal"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
>
    <ImageButton android:id="@+id/decr"
        android:layout_height="30px"
        android:layout_width="30px"
        android:src="@drawable/decr"
    />
    <ProgressBar android:id="@+id/bar"
        style="?android:attr/progressBarStyleHorizontal"
        android:layout_width="0px"
        android:layout_weight="1"
        android:layout_height="wrap_content"
    />
    <ImageButton android:id="@+id/incr"
        android:layout_height="30px"
        android:layout_width="30px"
        android:src="@drawable/incr"
    />
</LinearLayout>
```

All we do is line them up in a row, giving the `ProgressBar` any excess space (via `android:layout_width = "0px"` and `android:layout_weight = "1"`). We are using a pair of 16x16 pixel images from the [Nuvola](#) icon set for the increment and decrement button faces.

The Attribute Declarations

Widgets usually have attributes that you can set in the XML file, such as the `android:src` attribute we specified on the `ImageButton` widgets in the layout

above. You can create your own custom attributes that can be used in your custom widget, by creating a `res/values/attrs.xml` file to specify them.

For example, here is the attributes file for Meter:

```
<resources>
  <declare-styleable name="Meter">
    <attr name="max" format="integer" />
    <attr name="incr" format="integer" />
    <attr name="decr" format="integer" />
  </declare-styleable>
</resources>
```

The `declare-styleable` element describes what attributes are available on the widget class specified in the `name` attribute – in our case, we will call the widget `Meter`. Inside `declare-styleable` you can have one or more `attr` elements, each indicating the name of an attribute (e.g., `incr`) and what data type the attribute has (e.g., `integer`). The data type will help with compile-time validation and in getting any supplied values for this attribute parsed into the appropriate type at runtime.

Here, we indicate there are three attributes: `max` (indicating the highest value the `Meter` will go to), `incr` (indicating how much the value should increase when the increment button is clicked), and `decr` (indicating how much the value should decrease when the decrement button is clicked).

The Widget Implementation

There are many ways to go about actually implementing a widget. This section outlines one option: using a container class (specifically `LinearLayout`) and inflating the contents of your widget layout into the container.

The Constructor

To be usable inside of layout XML, you need to implement a constructor that takes two parameters:

1. A Context object, typically representing the Activity that is inflating your widget
2. An AttributeSet, representing the bundle of attributes included in the element in the layout being inflated that references your widget

In this constructor, after chaining to your superclass, you can do some basic configuration of your widget. Bear in mind, though, that you are not in position to configure the widgets that make up your aggregate widget – you need to wait until `onFinishInflate()` before you can do anything with those.

One thing you definitely want to do in the constructor, though, is use that AttributeSet to get the values of whatever attributes you defined in your `attrs.xml` file. For example, here is the constructor for Meter:

```
public Meter(final Context ctxt, AttributeSet attrs) {
    super(ctxt, attrs);

    this.setOrientation(HORIZONTAL);

    TypedArray a=ctxt.obtainStyledAttributes(attrs,
                                             R.styleable.Meter,
                                             0, 0);

    max=a.getInt(R.styleable.Meter_max, 100);
    incrAmount=a.getInt(R.styleable.Meter_incr, 1);
    decrAmount=-1*a.getInt(R.styleable.Meter_decr, 1);

    a.recycle();
}
```

The `obtainStyledAttributes()` on Context allows us to convert the AttributeSet into useful values:

- It resolves references to other resources, such as strings
- It handles any styles that might be declared via the style attribute in the layout element that references your widget
- It finds the resources you declared via `attrs.xml` and makes them available to you

In the code shown above, we get our TypedArray via `obtainStyledAttributes()`, then call `getInt()` three times to get our values

out of the `TypedArray`. The `TypedArray` is keyed by `R.styleable` identifiers, so we use the three generated for us by the build tools for `max`, `incr`, and `decr`.

Note that you should call `recycle()` on the `TypedArray` when done – this makes this `TypedArray` available for immediate reuse, rather than forcing it to be garbage-collected.

Finishing Inflation

Your widget will also typically override `onFinishInflate()`. At this point, you can turn around and add your own contents, via Java code or, as shown below, by inflating a layout XML resource into yourself as a container:

```
@Override
protected void onFinishInflate() {
    super.onFinishInflate();

    ((Activity)getContext()).getLayoutInflater().inflate(R.layout.meter, this);

    bar=(ProgressBar)findViewById(R.id.bar);
    bar.setMax(max);

    ImageButton btn=(ImageButton)findViewById(R.id.incr);

    btn.setOnClickListener(new View.OnClickListener() {
        public void onClick(View v) {
            bar.incrementProgressBy(incrAmount);

            if (onIncr!=null) {
                onIncr.onClick(Meter.this);
            }
        }
    });

    btn=(ImageButton)findViewById(R.id.decr);

    btn.setOnClickListener(new View.OnClickListener() {
        public void onClick(View v) {
            bar.incrementProgressBy(decrAmount);

            if (onDecr!=null) {
                onDecr.onClick(Meter.this);
            }
        }
    });
}
```

Of course, once you have constructed or inflated your contents, you can configure them, particularly using the attributes you declared in `attrs.xml` and retrieved in your constructor.

Event Handlers and Other Methods

If you wish to expose events to the outside world – such as `Meter` exposing when the increment or decrement buttons are clicked – you need to do a few things:

- Choose or create an appropriate listener class or classes (e.g., `View.OnClickListener`)
- Hold onto instances of those classes as data members of the widget class
- Offer setters (and, optionally, getters) to define those listener objects
- Call those listeners when appropriate

For example, `Meter` holds onto a pair of `View.OnClickListener` instances:

```
private View.OnClickListener onIncr=null;
private View.OnClickListener onDecr=null;
```

It lets users of `Meter` define those listeners via getters:

```
public void setOnIncrListener(View.OnClickListener onIncr) {
    this.onIncr=onIncr;
}

public void setOnDecrListener(View.OnClickListener onDecr) {
    this.onDecr=onDecr;
}
```

And, as shown in the previous section, it passes along the button clicks to the listeners:

```
ImageButton btn=(ImageButton)findViewById(R.id.incr);
btn.setOnClickListener(new View.OnClickListener() {
```

```
public void onClick(View v) {
    bar.incrementProgressBy(incrAmount);

    if (onIncr!=null) {
        onIncr.onClick(Meter.this);
    }
}
});

btn=(ImageButton)findViewById(R.id.decr);

btn.setOnClickListener(new View.OnClickListener() {
    public void onClick(View v) {
        bar.incrementProgressBy(decrAmount);

        if (onDecr!=null) {
            onDecr.onClick(Meter.this);
        }
    }
});
```

Note that we change the value passed in the `onClick()` method – our listener receives the `ImageButton`, but we pass the `Meter` widget on the outbound `onClick()` call. This is so we do not leak internal implementation of our widget. The users of `Meter` should neither know nor care that we have `ImageButton` widgets as part of the `Meter` internals.

Your widget may well require other methods as well, for widget-specific configuration or functionality, though `Meter` does not.

Using the Widget

Given all of that, using the `Meter` widget is not significantly different than using any other widget provided in the system...with a few minor exceptions.

In the layout, since your custom widget is not in the `android.widget` Java package, you need to fully-qualify the class name for the widget, as seen in the `main.xml` layout for the `Views/Meter` project:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res/com.commonware.android.widget"
```

```
android:orientation="horizontal"
android:layout_width="fill_parent"
android:layout_height="wrap_content"
android:paddingTop="5px"
>
<TextView
  android:layout_width="wrap_content"
  android:layout_height="wrap_content"
  android:text="Meter:"
/>
<com.commonsware.android.widget.Meter
  android:id="@+id/meter"
  android:layout_width="fill_parent"
  android:layout_height="wrap_content"
  app:max="100"
  app:incr="1"
  app:decr="5"
/>
</LinearLayout>
```

You will also note that we have a new namespace (`xmlns:app = "http://schemas.android.com/apk/res/com.commonsware.android.widget"`), and that our custom attributes from above are in that namespace (e.g., `app:max`). The custom namespace is because our attributes are not official Android ones and so will not be recognized by the build tools in the `android:` namespace, so we have to create our own. The value of the namespace needs to be `http://schemas.android.com/apk/res/` plus the name of the package containing the styleable attributes (`com.commonsware.android.widget`).

With just the stock generated activity, we get the following UI:

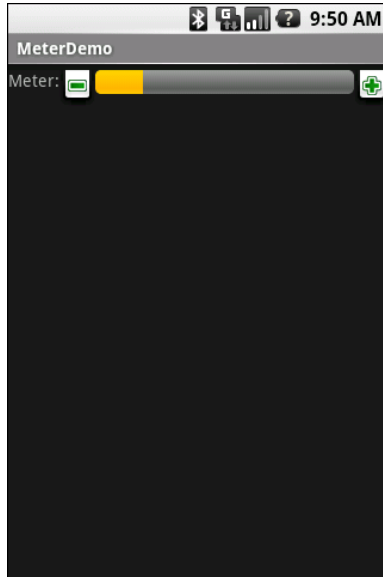


Figure 5. The MeterDemo application

Note that there is a significant shortcut we are taking here: our `Meter` implementation and its consumer (`MeterDemo`) are in the same Java package. We will expose this shortcut in a [later chapter](#) when we use the `Meter` widget in another project.

Change of State

Sometimes, we do not need to change the functionality of an existing widget, but we simply want to change how it looks. Maybe you want an oddly-shaped `Button`, or a `CheckBox` that is much larger, or something. In these cases, you may be able to tailor instances of the existing widget as you see fit, rather than have to roll a separate widget yourself.

Changing Button Backgrounds

Suppose you want a `Button` that looks like the second button shown below:

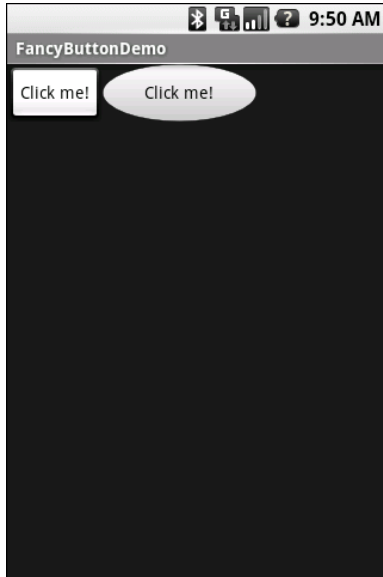


Figure 6. The FancyButton application, showing a normal oval-shaped button

Moreover, it needs to not just sit there, but also be focusable:

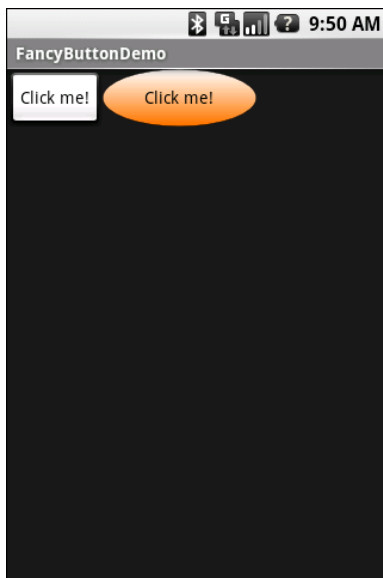


Figure 7. The FancyButton application, showing a focused oval-shaped button

...and it needs to be clickable:

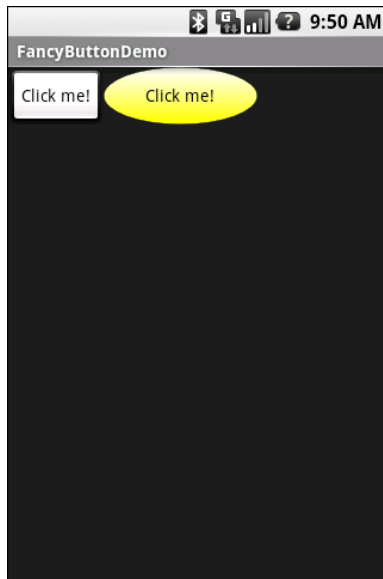


Figure 8. The FancyButton application, showing a pressed oval-shaped button

If you did not want the look of the Button to change, you could get by just with a simple `android:background` attribute on the Button, providing an oval PNG. However, if you want the Button to change looks based on state, you need to create another flavor of custom Drawable – the selector.

A selector Drawable is an XML file, akin to [shapes with gradients](#). However, rather than specifying a shape, it specifies a set of other Drawable resources and the circumstances under which they should be applied, as described via a series of states for the widget using the Drawable.

For example, from Views/FancyButton, here is `res/drawable/fancybutton.xml`, implementing a selector Drawable:

```
<?xml version="1.0" encoding="utf-8"?>
<selector xmlns:android="http://schemas.android.com/apk/res/android">
  <item
    android:state_focused="true"
    android:state_pressed="false"
    android:drawable="@drawable/btn_oval_selected"/>
```

```
/>
<item
  android:state_focused="true"
  android:state_pressed="true"
  android:drawable="@drawable/btn_oval_pressed"
/>
<item
  android:state_focused="false"
  android:state_pressed="true"
  android:drawable="@drawable/btn_oval_pressed"
/>
<item
  android:drawable="@drawable/btn_oval_normal"
/>
</selector>
```

There are four states being described in this selector:

1. Where the button is focused (`android:state_focused = "true"`) but not pressed (`android:state_pressed = "false"`)
2. Where the button is both focused and pressed
3. Where the button is not focused but is pressed
4. The default, where the button is neither focused nor pressed

In these four states, we specify three `Drawable` resources, for normal, focused, and pressed (the latter being used regardless of focus).

If we specify this selector `Drawable` resource as the `android:background` of a `Button`, Android will use the appropriate PNG based on the status of the `Button` itself:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="horizontal"
  android:layout_width="fill_parent"
  android:layout_height="wrap_content"
  >
  <Button
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:text="Click me!"
  />
  <Button
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
```

```
    android:text="Click me!"
    android:background="@drawable/fancybutton"
  />
</LinearLayout>
```

Changing CheckBox States

The same basic concept can be used to change the images used by a CheckBox.

In this case, the fact that Android is open source helps, as we can extract files and resources from Android and adjust them to create our own editions, without worrying about license hassles.

For example, here is a selector Drawable for a fancy CheckBox, showing a dizzying array of possible states:

```
<?xml version="1.0" encoding="utf-8"?>
<selector xmlns:android="http://schemas.android.com/apk/res/android">

    <!-- Enabled states -->

    <item android:state_checked="true" android:state_window_focused="false"
        android:state_enabled="true"
        android:drawable="@drawable/btn_check_on" />
    <item android:state_checked="false" android:state_window_focused="false"
        android:state_enabled="true"
        android:drawable="@drawable/btn_check_off" />

    <item android:state_checked="true" android:state_pressed="true"
        android:state_enabled="true"
        android:drawable="@drawable/btn_check_on_pressed" />
    <item android:state_checked="false" android:state_pressed="true"
        android:state_enabled="true"
        android:drawable="@drawable/btn_check_off_pressed" />

    <item android:state_checked="true" android:state_focused="true"
        android:state_enabled="true"
        android:drawable="@drawable/btn_check_on_selected" />
    <item android:state_checked="false" android:state_focused="true"
        android:state_enabled="true"
        android:drawable="@drawable/btn_check_off_selected" />

    <item android:state_checked="false"
        android:state_enabled="true"
        android:drawable="@drawable/btn_check_off" />
    <item android:state_checked="true"
```

```
        android:state_enabled="true"
        android:drawable="@drawable/btn_check_on" />

<!-- Disabled states -->

<item android:state_checked="true" android:state_window_focused="false"
      android:drawable="@drawable/btn_check_on_disable" />
<item android:state_checked="false" android:state_window_focused="false"
      android:drawable="@drawable/btn_check_off_disable" />

<item android:state_checked="true" android:state_focused="true"
      android:drawable="@drawable/btn_check_on_disable_focused" />
<item android:state_checked="false" android:state_focused="true"
      android:drawable="@drawable/btn_check_off_disable_focused" />

<item android:state_checked="false"
      android:drawable="@drawable/btn_check_off_disable" />
<item android:state_checked="true"
      android:drawable="@drawable/btn_check_on_disable" />
</selector>
```

Each of the referenced PNG images can be extracted from the `android.jar` file in your Android SDK, or obtained from various online resources. In the case of `Views/FancyCheck`, we zoomed each of the images to 200% of original size, to make a set of large (albeit fuzzy) checkbox images.



Figure 9. An example of a zoomed CheckBox image

In our layout, we can specify that we want to use our `res/drawable/fancycheck.xml` selector Drawable as our background:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    >
    <CheckBox
```

```
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="I'm normal!"
    />
    <CheckBox
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text=""
        android:button="@drawable/fancycheck"
        android:background="@drawable/btn_check_label_background"
    />
</LinearLayout>
```

This gives us a look like this:

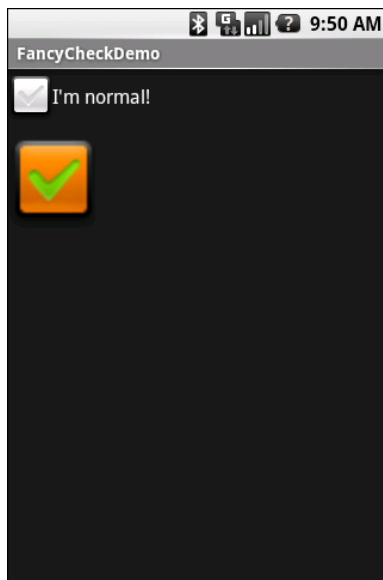


Figure 10. The FancyCheck application, showing a focused and checked CheckBox

Note that our CheckBox text is blank. The reason is that CheckBox is expecting the graphics to be 38px wide. Since ours are substantially larger, the CheckBox images overlap the text. Fixing this would require substantial work. It is simplest to fill the CheckBox text with some whitespace, then use a separate TextView for our CheckBox caption.

Creating Drawables

Drawable resources come in all shapes and sizes, and not just in terms of pixel dimensions. While many Drawable resources will be PNG or JPEG files, you can easily create other resources that supply other sorts of Drawable objects to your application. In this chapter, we will examine a few of these that may prove useful as you try to make your application look its best.

First, we look at using shape XML files to create **gradient** effects that can be resized to accommodate different contents. We then examine **StateListDrawable** and how it can be used for button backgrounds, tab icons, map icons, and the like. We wrap by looking at **nine-patch bitmaps**, for places where a shape file will not work but that the image still needs to be resized, such as a Button background.

Traversing Along a Gradient

Gradients have long been used to add "something a little extra" to a user interface, whether it is Microsoft adding them to Office's title bars in the late 1990's or the seemingly endless number of gradient buttons adorning "Web 2.0" sites.

And now, you can have gradients in your Android applications as well.

The easiest way to create a gradient is to use an XML file to describe the gradient. By placing the file in `res/drawable/`, it can be referenced as a

Drawable resource, no different than any other such resource, like a PNG file.

For example, here is a gradient Drawable resource, `active_row.xml`, from the Drawable/Gradient sample project:

```
<shape xmlns:android="http://schemas.android.com/apk/res/android"
android:shape="rectangle">
  <gradient
    android:startColor="#44FFFF00"
    android:endColor="#FFFFFF00"
    android:angle="270"
  />
  <padding
    android:top="2px"
    android:bottom="2px"
  />
  <corners android:radius="6px" />
</shape>
```

A gradient is applied to the more general-purpose `<shape>` element, in this case, a rectangle. The gradient is defined as having a start and end color – in this case, the gradient is an increasing amount of yellow, with only the alpha channel varying to control how much the background blends in. The color is applied in a direction determined by the number of degrees specified by the `android:angle` attribute, with 270 representing "down" (start color at the top, end color at the bottom).

As with any other XML-defined shape, you can control various aspects of the way the shape is drawn. In this case, we put some padding around the drawable and round off the corners of the rectangle.

To use this Drawable in Java code, you can reference it as `R.drawable.active_row`. One possible use of a gradient is in custom ListView row selection, as shown in Drawable/GradientDemo:

```
package com.commonware.android.drawable;

import android.app.ListActivity;
import android.content.Context;
import android.os.Bundle;
import android.content.res.ColorStateList;
import android.view.View;
```

```
import android.view.ViewGroup;
import android.widget.AdapterView;
import android.widget.AdapterView.OnItemClickListener;
import android.widget.AdapterView.OnItemSelectedListener;
import android.widget.ArrayAdapter;
import android.widget.ListView;
import android.widget.TextView;

public class GradientDemo extends ListActivity {
    private static ColorStateList allWhite=ColorStateList.valueOf(0xFFFFFFFF);
    private static String[] items={"lorem", "ipsum", "dolor",
        "sit", "amet", "consectetuer",
        "adipiscing", "elit", "morbi",
        "vel", "ligula", "vitae",
        "arcu", "aliquet", "mollis",
        "etiam", "vel", "erat",
        "placerat", "ante",
        "porttitor", "sodales",
        "pellentesque", "augue",
        "purus"};

    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.main);
        setListAdapter(new GradientAdapter(this));
        getListView().setOnItemSelectedListener(listener);
    }

    class GradientAdapter extends ArrayAdapter {
        GradientAdapter(Context ctx, R.layout.row, items);

        @Override
        public View getView(int position, View convertView,
            ViewGroup parent) {
            GradientWrapper wrapper=null;

            if (convertView==null) {
                convertView=getLayoutInflater().inflate(R.layout.row,
                    parent, false);

                wrapper=new GradientWrapper(convertView);
                convertView.setTag(wrapper);
            }
            else {
                wrapper=(GradientWrapper)convertView.getTag();
            }

            wrapper.getLabel().setText(items[position]);

            return(convertView);
        }
    }

    class GradientWrapper {
```

```
View row=null;
TextView label=null;

GradientWrapper(View row) {
    this.row=row;
}

TextView getLabel() {
    if (label==null) {
        label=(TextView)row.findViewById(R.id.label);
    }

    return(label);
}
}

AdapterView.OnItemSelectedListener listener=new
AdapterView.OnItemSelectedListener() {
    View lastRow=null;

    public void onItemSelected(AdapterView<?> parent,
                               View view, int position,
                               long id) {
        if (lastRow!=null) {
            lastRow.setBackgroundColor(0x00000000);
        }

        view.setBackgroundResource(R.drawable.active_row);
        lastRow=view;
    }

    public void onNothingSelected(AdapterView<?> parent) {
        if (lastRow!=null) {
            lastRow.setBackgroundColor(0x00000000);
            lastRow=null;
        }
    }
}
};
}
```

In an [earlier chapter](#), we showed how you can get control and customize how a selected row appears in a `ListView`. This time, we apply the gradient rounded rectangle as the background of the row. We could have accomplished this via appropriate choices for `android:listSelector` and `android:drawSelectorOnTop` as well.

The result is a selection bar implementing the gradient:

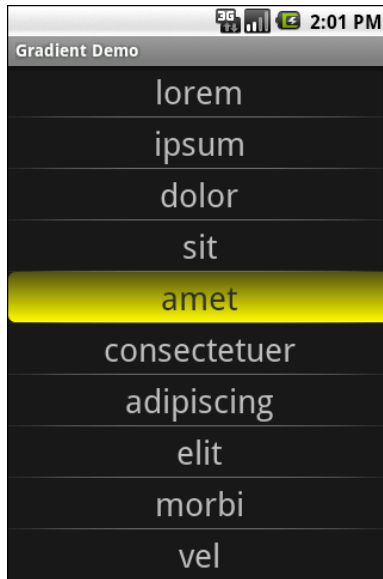


Figure 11. The GradientDemo sample application

Note that because the list background is black, the yellow is mixed with black on the top end of the gradient. If the list background were white, the top end of the gradient would be yellow mixed with white, as determined by the alpha channel specified on the gradient's top color.

State Law

Gradients and other shapes are not the only types of `Drawable` resource you can define using XML. One, the `StateListDrawable`, is key if you want to have different images when widgets are in different states.

Take for example the humble `Button`. Somewhere along the line, you have probably tried setting the background of the `Button` to a different color, perhaps via the `android:background` attribute in layout XML. If you have not tried this before, give it a shot now.

When you replace the `Button` background with a color, the `Button` becomes...well...flat. There is no defined border. There is no visual response

when you click the Button. There is no orange highlight if you select the button with the D-pad or trackball.

This is because what makes a Button visually be a Button is its background. Your new background is a flat color, which will be used no matter what is going on with the Button itself. The original background, however, was a `StateListDrawable`, one that looks something like this:

```
<?xml version="1.0" encoding="utf-8"?>
<!-- Copyright (C) 2008 The Android Open Source Project

Licensed under the Apache License, Version 2.0 (the "License");
you may not use this file except in compliance with the License.
You may obtain a copy of the License at

http://www.apache.org/licenses/LICENSE-2.0

Unless required by applicable law or agreed to in writing, software
distributed under the License is distributed on an "AS IS" BASIS,
WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
See the License for the specific language governing permissions and
limitations under the License.
-->

<selector xmlns:android="http://schemas.android.com/apk/res/android">
  <item android:state_window_focused="false" android:state_enabled="true"
    android:drawable="@drawable/btn_default_normal" />
  <item android:state_window_focused="false" android:state_enabled="false"
    android:drawable="@drawable/btn_default_normal_disable" />
  <item android:state_pressed="true"
    android:drawable="@drawable/btn_default_pressed" />
  <item android:state_focused="true" android:state_enabled="true"
    android:drawable="@drawable/btn_default_selected" />
  <item android:state_enabled="true"
    android:drawable="@drawable/btn_default_normal" />
  <item android:state_focused="true"
    android:drawable="@drawable/btn_default_normal_disable_focused" />
  <item
    android:drawable="@drawable/btn_default_normal_disable" />
</selector>
```

The XML has a `<selector>` root element, indicating this is a `StateListDrawable`. The `<item>` elements inside the root describe what Drawable resource should be used if the `StateListDrawable` is being used in some state. For example, if the "window" (think activity or dialog) does not have the focus (`android:state_window_focused="false"`) and the Button is enabled (`android:state_enabled="true"`), then we use the

`@drawable/btn_default_normal` Drawable resource. That resource, as it turns out, is a nine-patch PNG file, described [later in this chapter](#).

Android applies each rule in turn, top-down, to find the Drawable to use for a given state of the `StateListDrawable`. The last rule has no `android:state_*` attributes, meaning it is the overall default image to use if none of the other rules match.

So, if you want to change the background of a `Button`, you need to:

1. Copy the above resource, found in your Android SDK as `res/drawable/btn_default.xml`, into your project
2. Copy each of the `Button` state nine-patch images into your project
3. Modify whichever of those nine-patch images you want, to affect the visual change you seek
4. If need be, tweak the states and images defined in the `StateListDrawable` XML you copied
5. Reference the local `StateListDrawable` as the background for your `Button`

You can also use this technique for tab icons – the currently-selected tab will use the image defined as `android:state_selected="true"`, while the other tabs will use images with `android:state_selected="false"`.

We will see `StateListDrawable` used [later in this book](#), in the chapter on maps, showing you how you can have different icons in an overlay for normal and selected states of an overlay item.

A Stitch In Time Saves Nine

As you read through the Android documentation, you no doubt ran into references to "nine-patch" or "9-patch" and wondered what Android had to do with [quilting](#). Rest assured, you will not need to take up needlework to be an effective Android developer.

If, however, you are looking to create backgrounds for resizable widgets, like a `Button`, you will probably need to work with nine-patch images.

As the Android documentation states, a nine-patch is "a PNG image in which you define stretchable sections that Android will resize to fit the object at display time to accommodate variable sized sections, such as text strings". By using a specially-created PNG file, Android can avoid trying to use vector-based formats (e.g., SVG) and their associated overhead when trying to create a background at runtime. Yet, at the same time, Android can still resize the background to handle whatever you want to put inside of it, such as the text of a `Button`.

In this section, we will cover some of the basics of nine-patch graphics, including how to customize and apply them to your own Android layouts.

The Name and the Border

Nine-patch graphics are PNG files whose names end in `.9.png`. This means they can be edited using normal graphics tools, but Android knows to apply nine-patch rules to their use.

What makes a nine-patch graphic different than an ordinary PNG is a one-pixel-wide border surrounding the image. When drawn, Android will remove that border, showing only the stretched rendition of what lies inside the border. The border is used as a control channel, providing instructions to Android for how to deal with stretching the image to fit its contents.

Padding and the Box

Along the right and bottom sides, you can draw one-pixel-wide black lines to indicate the "padding box". Android will stretch the image such that the contents of the widget will fit inside that padding box.

For example, suppose we are using a nine-patch as the background of a button. When you set the text to appear in the button (e.g., "Hello, world!"), Android will compute the size of that text, in terms of width and height in pixels. Then, it will stretch the nine-patch image such that the text will reside inside the padding box. What lies outside the padding box forms the border of the button, typically a rounded rectangle of some form.

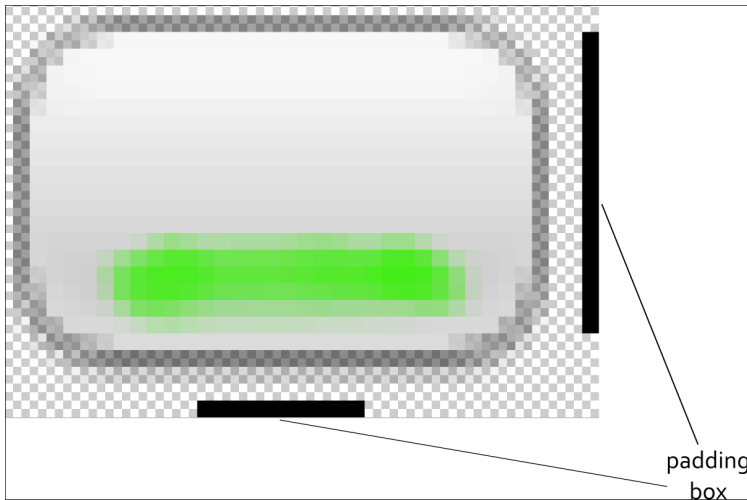


Figure 12. The padding box, as shown by a set of control lines to the right and bottom of the stretchable image

Stretch Zones

To tell Android where on the image to actually do the stretching, draw one-pixel-wide black lines on the top and left sides of the image. Android will scale the graphic only in those areas – areas outside the stretch zones are not stretched.

Perhaps the most common pattern is the center-stretch, where the middle portions of the image on both axes are considered stretchable, but the edges are not:

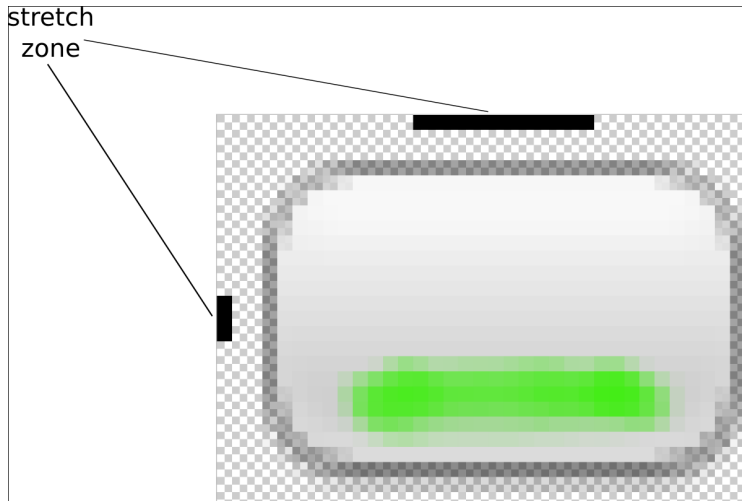


Figure 13. The stretch zones, as shown by a set of control lines to the right and bottom of the stretchable image

Here, the stretch zones will be stretched just enough for the contents to fit in the padding box. The edges of the graphic are left unstretched.

Some additional rules to bear in mind:

- If you have multiple discrete stretch zones along an axis (e.g., two zones separated by whitespace), Android will stretch both of them but keep them in their current proportions. So, if the first zone is twice as wide as the second zone in the original graphic, the first zone will be twice as wide as the second zone in the stretched graphic.
- If you leave out the control lines for the padding box, it is assumed that the padding box and the stretch zones are one and the same.

Tooling

To experiment with nine-patch images, you may wish to use the `draw9patch` program, found in the `tools/` directory of your SDK installation:

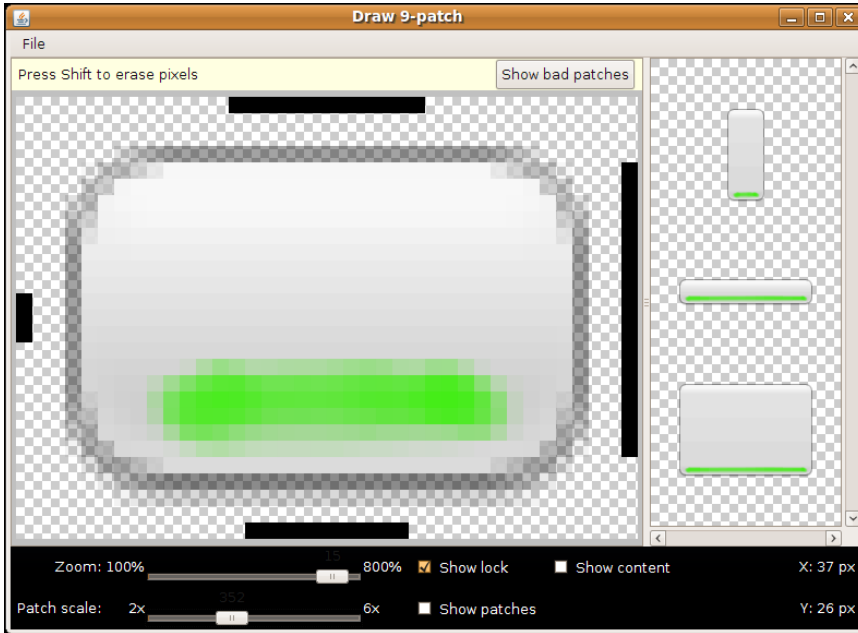


Figure 14. The draw9patch tool

While a regular graphics editor would allow you to draw any color on any pixel, `draw9patch` limits you to drawing or erasing pixels in the control area. If you attempt to draw inside the main image area itself, you will be blocked.

On the right, you will see samples of the image in various stretched sizes, so you can see the impact as you change the stretchable zones and padding box.

While this is convenient for working with the nine-patch nature of the image, you will still need some other graphics editor to create or modify the body of the image itself. For example, the image shown above, from the `Drawable/NinePatch` project, is a modified version of a nine-patch graphic from the SDK's `ApiDemos`, where the GIMP was used to add the neon green stripe across the bottom portion of the image.

Using Nine-Patch Images

Nine-patch images are most commonly used as backgrounds, as illustrated by the following layout:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    >
    <TableLayout
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:stretchColumns="1"
        >
        <TableRow
            android:layout_width="fill_parent"
            android:layout_height="wrap_content"
            >
            <TextView
                android:layout_width="wrap_content"
                android:layout_height="wrap_content"
                android:layout_gravity="center_vertical"
                android:text="Horizontal:"
            />
            <SeekBar android:id="@+id/horizontal"
                android:layout_width="fill_parent"
                android:layout_height="wrap_content"
            />
        </TableRow>
        <TableRow
            android:layout_width="fill_parent"
            android:layout_height="wrap_content"
            >
            <TextView
                android:layout_width="wrap_content"
                android:layout_height="wrap_content"
                android:layout_gravity="center_vertical"
                android:text="Vertical:"
            />
            <SeekBar android:id="@+id/vertical"
                android:layout_width="fill_parent"
                android:layout_height="wrap_content"
            />
        </TableRow>
    </TableLayout>
</LinearLayout>
```

Creating Drawables

```
<Button android:id="@+id/resize"
        android:layout_width="48px"
        android:layout_height="48px"
        android:text="Hi!"
        android:background="@drawable/button"
    />
</LinearLayout>
</LinearLayout>
```

Here, we have two `SeekBar` widgets, labeled for the horizontal and vertical axes, plus a `Button` set up with our nine-patch graphic as its background (`android:background = "@drawable/button"`).

The `NinePatchDemo` activity then uses the two `SeekBar` widgets to let the user control how large the button should be drawn on-screen, starting from an initial size of 48px square:

```
package com.commonware.android.drawable;

import android.app.Activity;
import android.os.Bundle;
import android.view.View;
import android.view.ViewGroup;
import android.widget.LinearLayout;
import android.widget.SeekBar;

public class NinePatchDemo extends Activity {
    SeekBar horizontal=null;
    SeekBar vertical=null;
    View thingToResize=null;

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

        thingToResize=findViewById(R.id.resize);

        horizontal=(SeekBar)findViewById(R.id.horizontal);
        vertical=(SeekBar)findViewById(R.id.vertical);

        horizontal.setMax(272); // 320 less 48 starting size
        vertical.setMax(272); // keep it square @ max

        horizontal.setOnSeekBarChangeListener(h);
        vertical.setOnSeekBarChangeListener(v);
    }

    SeekBar.OnSeekBarChangeListener h=new SeekBar.OnSeekBarChangeListener() {
        public void onProgressChanged(SeekBar seekBar,
```

Creating Drawables

```
        int progress,
        boolean fromTouch) {
    ViewGroup.LayoutParams old=thingToResize.getLayoutParams();
    ViewGroup.LayoutParams current=new LinearLayout.LayoutParams(48+progress,
                                                                    old.height);

    thingToResize.setLayoutParams(current);
}

public void onStartTrackingTouch(SeekBar seekBar) {
    // unused
}

public void onStopTrackingTouch(SeekBar seekBar) {
    // unused
}
};

SeekBar.OnSeekBarChangeListener v=new SeekBar.OnSeekBarChangeListener() {
    public void onProgressChanged(SeekBar seekBar,
        int progress,
        boolean fromTouch) {
        ViewGroup.LayoutParams old=thingToResize.getLayoutParams();
        ViewGroup.LayoutParams current=new LinearLayout.LayoutParams(old.width,
                                                                    48+progress);

        thingToResize.setLayoutParams(current);
    }

    public void onStartTrackingTouch(SeekBar seekBar) {
        // unused
    }

    public void onStopTrackingTouch(SeekBar seekBar) {
        // unused
    }
}
};
}
```

The result is an application that can be used much like the right pane of draw9patch, to see how the nine-patch graphic looks on an actual device or emulator in various sizes:

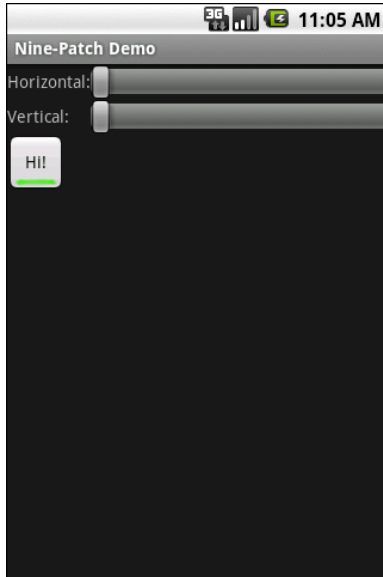


Figure 15. The NinePatch sample project, in its initial state

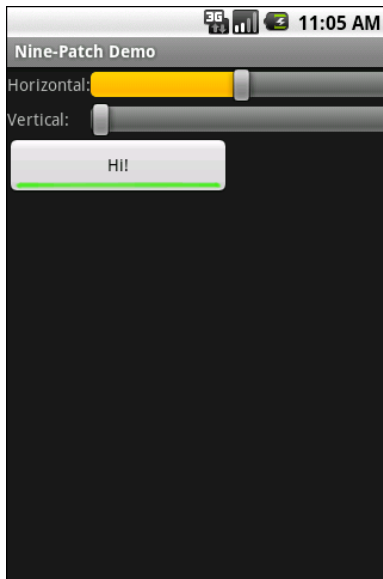


Figure 16. The NinePatch sample project, after making it bigger horizontally

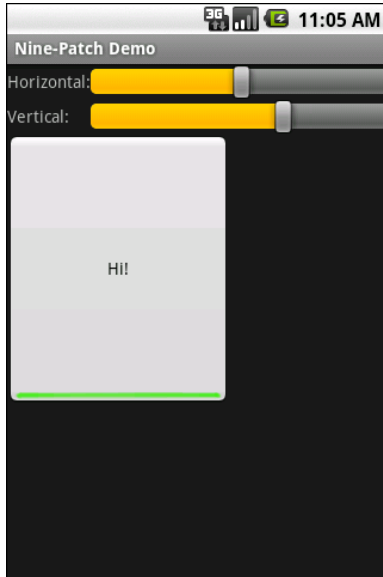


Figure 17. The NinePatch sample application, after making it bigger in both dimensions

More Fun With ListViews

One of the most important widgets in your toolbelt is the `ListView`. Some activities are purely a `ListView`, to allow the user to sift through a few choices...or perhaps a few thousand. We already saw in *The Busy Coder's Guide to Android Development* how to create "fancy `ListViews`", where you have complete control over the list rows themselves. In this chapter, we will cover some additional techniques you can use to make your `ListView` widgets be pleasant for your users to work with.

Giant Economy-Size Dividers

You may have noticed that the preference UI has what behaves a lot like a `ListView`, but with a curious characteristic: not everything is selectable:

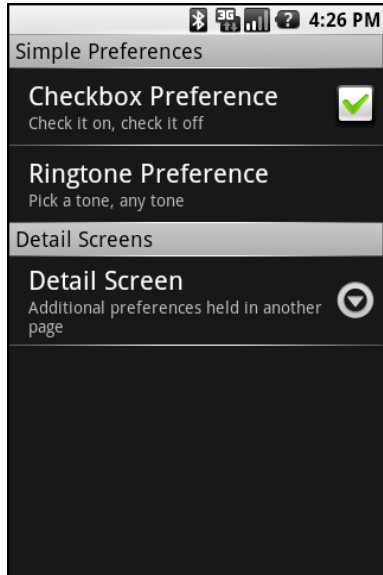


Figure 18. A PreferenceScreen UI

You may have thought that this required some custom widget, or some fancy on-the-fly `View` handling, to achieve this effect.

If so, you would have been wrong.

It turns out that any `ListView` can exhibit this behavior. In this section, we will see how this is achieved and a reusable framework for creating such a `ListView`.

Choosing What Is Selectable

There are two methods in the `Adapter` hierarchy that let you control what is and is not selectable in a `ListView`:

- `areAllItemsSelectable()` should return `true` for ordinary `ListView` widgets and `false` for `ListView` widgets where some items in the `Adapter` are selectable and others are not
- `isEnabled()`, given a position, should return `true` if the item at that position should be selectable and `false` otherwise

Given these two, it is "merely" a matter of overriding your chosen Adapter class and implementing these two methods as appropriate to get the visual effect you desire.

As one might expect, this is not quite as easy as it may sound.

For example, suppose you have a database of books, and you want to present a list of book titles for the user to choose from. Furthermore, suppose you have arranged for the books to be in alphabetical order within each major book style (Fiction, Non-Fiction, etc.), courtesy of a well-crafted `ORDER BY` clause on your query. And suppose you want to have headings, like on the preferences screen, for those book styles.

If you simply take the `Cursor` from that query and hand it to a `SimpleCursorAdapter`, the two methods cited above will be implemented as the default, saying every row is selectable. And, since every row is a book, that is what you want...for the books.

To get the headings in place, your Adapter needs to mix the headings in with the books (so they all appear in the proper sequence), return a custom `View` for each (so headings look different than the books), and implement the two methods that control whether the headings or books are selectable. There is no easy way to do this from a simple query.

Instead, you need to be a bit more creative, and wrap your `SimpleCursorAdapter` in something that can intelligently inject the section headings.

Introducing MergeAdapter

CommonWare – the publishers of this book – have released a number of open source reusable Android libraries, collectively called the CommonsWare Android Components (CWAC, pronounced "quack"). Several of these will come into play for adding headings to a list, primarily `MergeAdapter`.

`MergeAdapter` takes a collection of `ListAdapter` objects and other `View` widgets and consolidates them into a single master `ListAdapter` that can be poured into a `ListView`. You supply the contents – `MergeAdapter` handles the `ListAdapter` interface to make them all appear to be a single contiguous list.

In the case of `ListView` with section headings, we can use `MergeAdapter` to alternate between headings (each a `View`) and the rows inside each heading (e.g., a `CursorAdapter` wrapping content culled from a database).

We will see how `MergeAdapter` works in greater detail in an upcoming edition of this book. Here, we will see how you can apply a `MergeAdapter` to achieve the desired `ListView` look and feel.

Lists via Merges

The pattern to use `MergeAdapter` for sectioned lists is fairly simple:

- Create one `Adapter` for each section. For example, in the book scenario described above, you might have one `SimpleCursorAdapter` for each book style (one for Fiction, one for Non-Fiction, etc.).
- Create heading `Views` for each heading (e.g., a custom-styled `TextView`)
- Create a `MergeAdapter` and sequentially add each heading and content `Adapter` in turn
- Put the container `Adapter` in the `ListView`, and everything flows from there

You will see this implemented in the `ListView/Sections` sample project, which is another riff on the "list of *lorem ipsum* words" sample you see scattered throughout the *Busy Coder* books.

The layout for the screen is just a `ListView`, because the activity – `SectionedDemo` – is just a `ListActivity`:

```
<?xml version="1.0" encoding="utf-8"?>
<ListView
```

```
xmlns:android="http://schemas.android.com/apk/res/android"
android:id="@android:id/list"
android:layout_width="fill_parent"
android:layout_height="fill_parent"
android:drawSelectorOnTop="true"
/>
```

Our activity's `onCreate()` method wraps our list of nonsense words in an `ArrayAdapter` three times, first with the original list and twice on randomly shuffled editions of the list. It pops each of those into the `MergeAdapter` after a related heading, inflated from a custom layout:

```
package com.commonware.android.listview;

import android.app.ListActivity;
import android.content.Context;
import android.os.Bundle;
import android.view.View;
import android.view.ViewGroup;
import android.widget.AdapterView;
import android.widget.AdapterView.OnItemClickListener;
import android.widget.ArrayAdapter;
import android.widget.ListView;
import android.widget.TextView;
import java.util.Arrays;
import java.util.Collections;
import java.util.List;

public class SectionedDemo extends ListActivity {
    private static String[] items={"lorem", "ipsum", "dolor",
                                   "sit", "amet", "consectetuer",
                                   "adipiscing", "elit", "morbi",
                                   "vel", "ligula", "vitae",
                                   "arcu", "aliquet", "mollis",
                                   "etiam", "vel", "erat",
                                   "placerat", "ante",
                                   "porttitor", "sodales",
                                   "pellentesque", "augue",
                                   "purus"};

    @Override
    public void onCreate(Bundle icle) {
        super.onCreate(icle);
        setContentView(R.layout.main);

        adapter.addSection("Original",
                           new ArrayAdapter<String>(this,
                                                    android.R.layout.simple_list_item_1,
                                                    items));

        List<String> list=Arrays.asList(items);
```

```
Collections.shuffle(list);

adapter.addSection("Shuffled",
    new ArrayAdapter<String>(this,
        android.R.layout.simple_list_item_1,
        list));

list=Arrays.asList(items);

Collections.shuffle(list);

adapter.addSection("Re-shuffled",
    new ArrayAdapter<String>(this,
        android.R.layout.simple_list_item_1,
        list));

setListAdapter(adapter);
}

SectionedAdapter adapter=new SectionedAdapter() {
    protected View getHeaderView(String caption, int index,
        View convertView,
        ViewGroup parent) {
        TextView result=(TextView)convertView;

        if (convertView==null) {
            result=(TextView)getLayoutInflater()
                .inflate(R.layout.header,
                    null);
        }

        result.setText(caption);

        return(result);
    }
};
}
```

he result is much as you might expect:

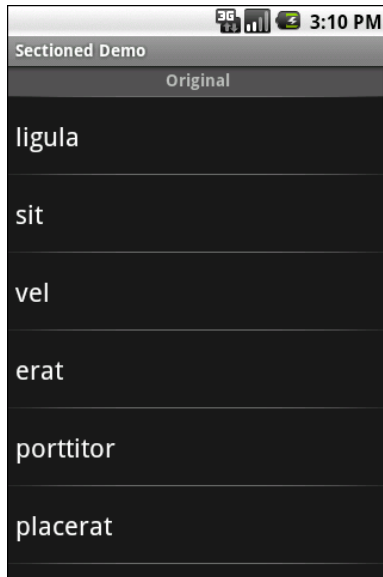


Figure 19. A ListView using a MergeAdapter, showing one header and part of a list

Here, the headers are simple bits of text with an appropriate style applied. Your section headers, of course, can be as complex as you like.

From Head To Toe

Perhaps you do not need section headers scattered throughout your list. If you only need extra "fake rows" at the beginning or end of your list, you can use header and footer views.

ListView supports `addHeaderView()` and `addFooterView()` methods that allow you to add view objects to the beginning and end of the list, respectively. These view objects otherwise behave like regular rows, in that they are part of the scrolled area and will scroll off the screen if the list is long enough. If you want fixed headers or footers, rather than put them in the ListView itself, put them outside the ListView, perhaps using a `LinearLayout`.

To demonstrate header and footer views, take a peek at `ListView/HeaderFooter`, particularly the `HeaderFooterDemo` class:

```
package com.commonware.android.listview;

import android.app.ListActivity;
import android.content.Context;
import android.os.Bundle;
import android.os.Handler;
import android.os.SystemClock;
import android.view.View;
import android.view.ViewGroup;
import android.widget.AdapterView;
import android.widget.AdapterView.Adapter;
import android.widget.AdapterView.OnItemClickListener;
import android.widget.ArrayAdapter;
import android.widget.Button;
import android.widget.ListView;
import android.widget.TextView;
import java.util.Arrays;
import java.util.Collections;
import java.util.List;
import java.util.concurrent.atomic.AtomicBoolean;

public class HeaderFooterDemo extends ListActivity {
    private static String[] items={"lorem", "ipsum", "dolor",
        "sit", "amet", "consectetuer",
        "adipiscing", "elit", "morbi",
        "vel", "ligula", "vitae",
        "arcu", "aliquet", "mollis",
        "etiam", "vel", "erat",
        "placerat", "ante",
        "porttitor", "sodales",
        "pellentesque", "augue",
        "purus"};

    private long startTime=SystemClock uptimeMillis();
    private Handler handler=new Handler();
    private AtomicBoolean areWeDeadYet=new AtomicBoolean(false);

    @Override
    public void onCreate(Bundle icle) {
        super.onCreate(icle);
        setContentView(R.layout.main);
        getListView().addHeaderView(buildHeader());
        getListView().addFooterView(buildFooter());
        setListAdapter(new ArrayAdapter<String>(this,
            android.R.layout.simple_list_item_1,
            items));
    }

    @Override
    public void onDestroy() {
        super.onDestroy();

        areWeDeadYet.set(true);
    }

    private View buildHeader() {
        Button btn=new Button(this);
```

```
btn.setText("Randomize!");
btn.setOnClickListener(new View.OnClickListener() {
    public void onClick(View v) {
        List<String> list=Arrays.asList(items);

        Collections.shuffle(list);

        setListAdapter(new ArrayAdapter<String>(HeaderFooterDemo.this,
            android.R.layout.simple_list_item_1,
            list));
    }
});

return(btn);
}

private View buildFooter() {
    TextView txt=new TextView(this);

    updateFooter(txt);

    return(txt);
}

private void updateFooter(final TextView txt) {
    long runtime=(SystemClock uptimeMillis()-startTime)/1000;

    txt.setText(String.valueOf(runtime)+" seconds since activity launched");

    if (!areWeDeadYet.get()) {
        handler.postDelayed(new Runnable() {
            public void run() {

                updateFooter(txt);
            }
        }, 1000);
    }
}
}
```

Here, we add a header view built via `buildHeader()`, returning a `Button` that, when clicked, will shuffle the contents of the list. We also add a footer view built via `buildFooter()`, returning a `TextView` that shows how long the activity has been running, updated every second. The list itself is the ever-popular list of *lorem ipsum* words.

When initially displayed, the header is visible but the footer is not, because the list is too long:

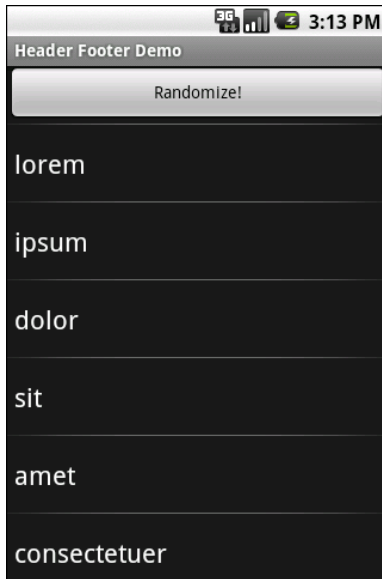


Figure 20. A ListView with a header view shown

If you scroll downward, the header will slide off the top, and eventually the footer will scroll into view:



Figure 21. A ListView with a footer view shown

Control Your Selection

The stock Android UI for a selected `ListView` row is fairly simplistic: it highlights the row in orange...and nothing more. You can control the `Drawable` used for selection via the `android:listSelector` and `android:drawSelectorOnTop` attributes on the `ListView` element in your layout. However, even those simply apply some generic look to the selected row.

It may be you want to do something more elaborate for a selected row, such as changing the row around to expose more information. Maybe you have thumbnail photos but only display the photo on the selected row. Or perhaps you want to show some sort of secondary line of text, like a person's instant messenger status, only on the selected row. Or, there may be times you want a more subtle indication of the selected item than having the whole row show up in some neon color. The stock Android UI for highlighting a selection will not do any of this for you.

That just means you have to do it yourself. The good news is, it is not very difficult.

Create a Unified Row View

The simplest way to accomplish this is for each row view to have all of the widgets you want for the selected-row perspective, but with the "extra stuff" flagged as invisible at the outset. That way, rows initially look "normal" when put into the list – all you need to do is toggle the invisible widgets to visible when a row gets selected and toggle them back to invisible when a row is de-selected.

For example, in the `ListView/Selector` project, you will find a `row.xml` layout representing a row in a list:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="horizontal"
```

```
android:layout_width="fill_parent"
android:layout_height="fill_parent" >
<View
    android:id="@+id/bar"
    android:background="#FFFFFF00"
    android:layout_width="5px"
    android:layout_height="fill_parent"
    android:visibility="invisible"
/>
<TextView
    android:id="@+id/label"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:textSize="10pt"
    android:paddingTop="2px"
    android:paddingBottom="2px"
    android:paddingLeft="5px"
/>
</LinearLayout>
```

There is a `TextView` representing the bulk of the row. Before it, though, on the left, is a plain view named `bar`. The background of the view is set to yellow (`android:background = "#FFFFFF00"`) and the width to `5px`. More importantly, it is set to be invisible (`android:visibility = "invisible"`). Hence, when the row is put into a `ListView`, the yellow bar is not seen...until we make the bar visible.

Configure the List, Get Control on Selection

Next, we need to set up a `ListView` and arrange to be notified when rows are selected and de-selected. That is merely a matter of calling `setOnItemSelectedListener()` for the `ListView`, providing a listener to be notified on a selection change. You can see that in the context of a `ListActivity` in our `SelectorDemo` class:

```
package com.commonware.android.listview;

import android.app.ListActivity;
import android.content.Context;
import android.os.Bundle;
import android.content.res.ColorStateList;
import android.view.View;
import android.view.ViewGroup;
import android.widget.AdapterView;
import android.widget.AdapterView.OnItemClickListener;
import android.widget.ArrayAdapter;
import android.widget.ListView;
```

```
import android.widget.TextView;

public class SelectorDemo extends ListActivity {
    private static ColorStateList allWhite=ColorStateList.valueOf(0xFFFFFFFF);
    private static String[] items={"lorem", "ipsum", "dolor",
        "sit", "amet", "consectetuer",
        "adipiscing", "elit", "morbi",
        "vel", "ligula", "vitae",
        "arcu", "aliquet", "mollis",
        "etiam", "vel", "erat",
        "placerat", "ante",
        "porttitor", "sodales",
        "pellentesque", "augue",
        "purus"};

    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.main);
        setListAdapter(new SelectorAdapter(this));
        getListView().setOnItemSelectedListener(listener);
    }

    class SelectorAdapter extends ArrayAdapter {
        SelectorAdapter(Context ctx) {
            super(ctx, R.layout.row, items);
        }

        @Override
        public View getView(int position, View convertView,
            ViewGroup parent) {
            SelectorWrapper wrapper=null;

            if (convertView==null) {
                convertView=getLayoutInflater().inflate(R.layout.row,
                    parent, false);
                wrapper=new SelectorWrapper(convertView);
                wrapper.getLabel().setTextColor(allWhite);
                convertView.setTag(wrapper);
            }
            else {
                wrapper=(SelectorWrapper)convertView.getTag();
            }

            wrapper.getLabel().setText(items[position]);

            return(convertView);
        }
    }

    class SelectorWrapper {
        View row=null;
        TextView label=null;
        View bar=null;
    }
}
```

```
SelectorWrapper(View row) {
    this.row=row;
}

TextView getLabel() {
    if (label==null) {
        label=(TextView)row.findViewById(R.id.label);
    }

    return(label);
}

View getBar() {
    if (bar==null) {
        bar=row.findViewById(R.id.bar);
    }

    return(bar);
}
}

AdapterView.OnItemClickListener listener=new
AdapterView.OnItemClickListener() {
    View lastRow=null;

    public void onItemClick(AdapterView<?> parent,
                            View view, int position,
                            long id) {
        if (lastRow!=null) {
            SelectorWrapper wrapper=(SelectorWrapper)lastRow.getTag();

            wrapper.getBar().setVisibility(View.INVISIBLE);
        }

        SelectorWrapper wrapper=(SelectorWrapper)view.getTag();

        wrapper.getBar().setVisibility(View.VISIBLE);
        lastRow=view;
    }

    public void onNothingSelected(AdapterView<?> parent) {
        if (lastRow!=null) {
            SelectorWrapper wrapper=(SelectorWrapper)lastRow.getTag();

            wrapper.getBar().setVisibility(View.INVISIBLE);
            lastRow=null;
        }
    }
};
}
```

SelectorDemo sets up a SelectorAdapter, which follow the view-wrapper pattern established in *The Busy Coder's Guide to Android Development*. Each row is created from the layout shown earlier, with a SelectorWrapper providing access to both the TextView (for setting the text in a row) and the bar View.

Change the Row

Our AdapterView.OnItemClickListener instance keeps track of the last selected row (lastRow). When the selection changes to another row in onItemClick(), we make the bar from the last selected row invisible, before we make the bar visible on the newly-selected row. In onNothingSelected(), we make the bar invisible and make our last selected row be null.

The net effect is that as the selection changes, we toggle the bar off and on as needed to indicate which is the selected row.

In the layout for the activity's ListView, we turn off the regular highlighting:

```
<?xml version="1.0" encoding="utf-8"?>
<ListView
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:id="@android:id/list"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  android:listSelector="#00000000"
/>
```

The result is we are controlling the highlight, in the form of the yellow bar:

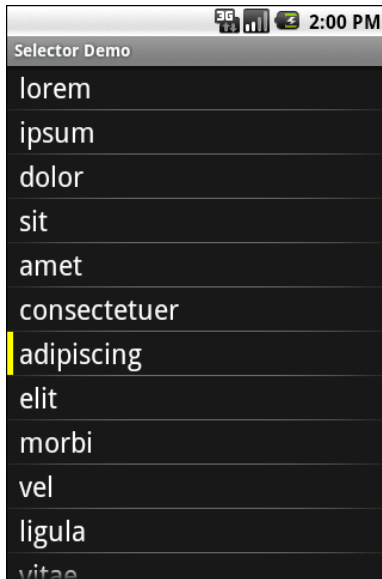


Figure 22. A ListView with a custom-drawn selector icon

Obviously, what we do to highlight a row could be much more elaborate than what is demonstrated here. At the same time, it needs to be fairly quick to execute, lest the list appear to be too sluggish.

Stating Your Selection

In the previous section, we removed the default `ListView` selection bar and implemented our own in Java code. That works, but there is another option: defining a custom selection bar `Drawable` resource.

In the [chapter](#) on custom `Drawable` resources, we introduced the `StateListDrawable`. This is an XML-defined resource that declares different `Drawable` resources to use when the `StateListDrawable` is in different states.

The standard `ListView` selector is, itself, a `StateListDrawable`, one that looks like this:

```
<?xml version="1.0" encoding="utf-8"?>
<!-- Copyright (C) 2008 The Android Open Source Project
```

```
Licensed under the Apache License, Version 2.0 (the "License");  
you may not use this file except in compliance with the License.  
You may obtain a copy of the License at
```

```
http://www.apache.org/licenses/LICENSE-2.0
```

```
Unless required by applicable law or agreed to in writing, software  
distributed under the License is distributed on an "AS IS" BASIS,  
WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.  
See the License for the specific language governing permissions and  
limitations under the License.
```

```
-->
```

```
<selector xmlns:android="http://schemas.android.com/apk/res/android">  
  
  <item android:state_window_focused="false"  
    android:drawable="@color/transparent" />  
  
  <!-- Even though these two point to the same resource, have two states so the  
  drawable will invalidate itself when coming out of pressed state. -->  
  <item android:state_focused="true" android:state_enabled="false"  
    android:state_pressed="true"  
    android:drawable="@drawable/list_selector_background_disabled" />  
  <item android:state_focused="true" android:state_enabled="false"  
    android:drawable="@drawable/list_selector_background_disabled" />  
  
  <item android:state_focused="true" android:state_pressed="true"  
    android:drawable="@drawable/list_selector_background_transition" />  
  <item android:state_focused="false" android:state_pressed="true"  
    android:drawable="@drawable/list_selector_background_transition" />  
  
  <item android:state_focused="true"  
    android:drawable="@drawable/list_selector_background_focus" />  
  
</selector>
```

Now, the most common reason people seem to want to change the selector is that they hate the orange bar. Perhaps it clashes with their application's color scheme, or they are allergic to citrus fruits, or something.

The `android:state_focused="true"` rule at the bottom of that XML is the one that defines the actual selection bar, in terms of what is seen when the user navigates with the D-pad or trackball. It points to a nine-patch PNG file, with different copies for different screen densities (one in `res/drawable-hdpi/`, etc.).

Hence, another approach to changing the selection bar is to:

1. Copy the above XML (found in `res/drawable/list_selector_background.xml` in your SDK) into your project
2. Copy the various other Drawable resources pointed to by that XML into your project
3. Modify the nine-patch images as needed to change the colors
4. Reference the local copy of the `StateListDrawable` in the `android:listSelector` attribute

Home Screen App Widgets

One of the oft-requested features added in Android 1.5 is the ability to add live elements to the home screen. Called "app widgets", these can be added by users via a long-tap on the home screen and choosing an appropriate widget from the available roster. Android ships with a few app widgets, such as a music player, but developers can add their own – in this chapter, we will see how this is done.

For the purposes of this book, "app widgets" will refer to these items that go on the home screen. Other uses of the term "widget" will be reserved for the UI widgets, subclasses of `View`, usually found in the `android.widget` Java package.

In this chapter, we briefly touch on the **security** ramifications of app widgets, before continuing on to discuss how Android offers a **secure app widget** framework. We then go through all the steps of **creating a basic app widget**. Next, we discuss how to deal with **multiple instances** of your app widget, the app widget **lifecycle**, alternative models for **updating** app widgets, and how to offer **multiple layouts** for your app widget (perhaps based on device characteristics). We wrap with some notes about **hosting** your own app widgets in your own home screen implementation.

East is East, and West is West...

Part of the reason it took as long as it did for app widgets to become available is security.

Android's security model is based heavily on Linux user, file, and process security. Each application is (normally) associated with a unique user ID. All of its files are owned by that user, and its process(es) run as that user. This prevents one application from modifying the files of another or otherwise injecting their own code into another running process.

In particular, the core Android team wanted to find a way that would allow app widgets to be displayed by the home screen application, yet have their content come from another application. It would be dangerous for the home screen to run arbitrary code itself or somehow allow its UI to be directly manipulated by another process.

The app widget architecture, therefore, is set up to keep the home screen application independent from any code that puts app widgets on that home screen, so bugs in one cannot harm the other.

The Big Picture for a Small App Widget

The way Android pulls off this bit of security is through the use of `RemoteViews`.

The application component that supplies the UI for an app widget is not an `Activity`, but rather a `BroadcastReceiver` (often in tandem with a `Service`). The `BroadcastReceiver`, in turn, does not inflate a normal `View` hierarchy, like an `Activity` would, but instead inflates a layout into a `RemoteViews` object.

`RemoteViews` encapsulates a limited edition of normal widgets, in such a fashion that the `RemoteViews` can be "easily" transported across process boundaries. You configure the `RemoteViews` via your `BroadcastReceiver` and make those `RemoteViews` available to Android. Android in turn delivers the

`RemoteViews` to the app widget host (usually the home screen), which renders them to the screen itself.

This architectural choice has many impacts:

1. You do not have access to the full range of widgets and containers. You can use `FrameLayout`, `LinearLayout`, and `RelativeLayout` for containers, and `AnalogClock`, `Button`, `Chronometer`, `ImageButton`, `ImageView`, `ProgressBar`, and `TextView` for widgets.
2. The only user input you can get is clicks of the `Button` and `ImageButton` widgets. In particular, there is no `EditText` for text input.
3. Because the app widgets are rendered in another process, you cannot simply register an `OnClickListener` to get button clicks; rather, you tell `RemoteViews` a `PendingIntent` to invoke when a given button is clicked.
4. You do not hold onto the `RemoteViews` and reuse them yourself. Rather, the pattern appears to be that you create and send out a brand-new `RemoteViews` whenever you want to change the contents of the app widget. This, coupled with having to transport the `RemoteViews` across process boundaries, means that updating the app widget is rather expensive in terms of CPU time, memory, and battery life.
5. Because the component handling the updates is a `BroadcastReceiver`, you have to be quick (lest you take too long and Android consider you to have timed out), you cannot use background threads, and your component itself is lost once the request has been completed. Hence, if your update might take a while, you will probably want to have the `BroadcastReceiver` start a `Service` and have the `Service` do the long-running task and eventual app widget update.

Crafting App Widgets

This will become somewhat easier to understand in the context of some sample code. In the `AppWidget/TwitterWidget` project, you will find an app

widget that shows the latest tweet in your **Twitter** timeline. If you have read *Android Programming Tutorials*, you will recognize the JTwitter JAR we will use for accessing the Twitter Web service.

The Manifest

First, we need to register our BroadcastReceiver (and, if relevant, Service) implementation in our AndroidManifest.xml file, along with a few extra features:

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.commonware.android.appwidget"
    android:versionCode="1"
    android:versionName="1.0">
    <uses-sdk
        android:minSdkVersion="6"
        android:targetSdkVersion="6"
    />
    <uses-permission android:name="android.permission.INTERNET" />
    <application android:label="@string/app_name"
        android:icon="@drawable/cw">
        <activity android:name=".TWPrefs"
            android:label="@string/app_name">
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />
                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
            <intent-filter>
                <action
                    android:name="android.appwidget.action.APPWIDGET_CONFIGURE" />
            </intent-filter>
        </activity>
        <receiver android:name=".TwitterWidget"
            android:label="@string/app_name"
            android:icon="@drawable/tw_icon">
            <intent-filter>
                <action
                    android:name="android.appwidget.action.APPWIDGET_UPDATE" />
            </intent-filter>
            <meta-data
                android:name="android.appwidget.provider"
                android:resource="@xml/widget_provider" />
        </receiver>
        <service android:name=".TwitterWidget$updateService" />
    </application>
</manifest>
```

Here we have an <activity>, a <receiver>, and a <service>. Of note:

- Our <receiver> has `android:label` and `android:icon` attributes, which are not normally needed on `BroadcastReceiver` declarations. However, in this case, those are used for the entry that goes in the menu of available widgets to add to the home screen. Hence, you will probably want to supply values for both of those, and use appropriate resources in case you want translations for other languages.
- Our <receiver> has an <intent-filter> for the `android.appwidget.action.APPWIDGET_UPDATE` action. This means we will get control whenever Android wants us to update the content of our app widget. There may be other actions we want to monitor – more on this in a [later section](#).
- Our <receiver> also has a <meta-data> element, indicating that its `android.appwidget.provider` details can be found in the `res/xml/widget_provider.xml` file. This metadata is described in the next section.
- Our <activity> has two <intent-filter> elements, the normal "put me in the Launcher" one and one looking for an action of `android.appwidget.action.APPWIDGET_CONFIGURE`.

The Metadata

Next, we need to define the app widget provider metadata. This has to reside at the location indicated in the manifest – in this case, in `res/xml/widget_provider.xml`:

```
<appwidget-provider xmlns:android="http://schemas.android.com/apk/res/android"
  android:minWidth="292dip"
  android:minHeight="72dip"
  android:updatePeriodMillis="900000"
  android:configure="com.commonware.android.appwidget.TWPrefs"
  android:initialLayout="@layout/widget"
/>
```

Here, we provide four pieces of information:

- The minimum width and height of the app widget (`android:minWidth` and `android:minHeight`). These are approximate – the app widget host (e.g., home screen) will tend to convert these values into "cells" based upon the overall layout of the UI where the app widgets will reside. However, they should be no smaller than the minimums cited here.
- The frequency in which Android should request an update of the widget's contents (`android:updatePeriodMillis`). This is expressed in terms of milliseconds, so a value of `3600000` is a 60-minute update cycle. Note that the minimum value for this attribute is 30 minutes – values less than that will be ignored.
- An activity class that will be used to configure the widget when it is first added to the screen (`android:configure`). This will be described in greater detail in a [later section](#).

The configuration activity is optional. However, if you skip the configuration activity, you do need to tell Android the initial layout to use for the app widget, via an `android:initialLayout` attribute.

The Layout

Eventually, you are going to need a layout that describes what the app widget looks like. So long as you stick to the widget and container classes noted above, this layout can otherwise look like any other layout in your project.

For example, here is the layout for the `TwitterWidget`:

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="horizontal"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:background="#FF000088"
    >
    <ImageButton android:id="@+id/refresh"
        android:layout_alignParentTop="true"
        android:layout_alignParentRight="true"
        android:src="@drawable/refresh"
```

```
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
    />
    <ImageButton android:id="@+id/configure"
        android:layout_alignParentBottom="true"
        android:layout_alignParentRight="true"
        android:src="@drawable/configure"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
    />
    <TextView android:id="@+id/friend"
        android:layout_alignParentTop="true"
        android:layout_alignParentLeft="true"
        android:layout_toLeftOf="@id/refresh"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:gravity="left"
        android:textStyle="bold"
        android:singleLine="true"
        android:ellipsize="end"
    />
    <TextView android:id="@+id/status"
        android:layout_below="@id/friend"
        android:layout_alignParentLeft="true"
        android:layout_toLeftOf="@id/refresh"
        android:layout_width="wrap_content"
        android:layout_height="fill_parent"
        android:gravity="top"
        android:singleLine="false"
        android:lines="4"
    />
</RelativeLayout>
```

All we have is a `TextView` to show the latest tweet, plus another one for the person issuing the tweet, and a pair of `ImageButton` widgets to allow the user to manually refresh the latest tweet and launch the configuration activity.

The BroadcastReceiver

Next, we need a `BroadcastReceiver` that can get control when Android wants us to update our `RemoteViews` for our app widget. To simplify this, Android supplies an `AppWidgetProvider` class we can extend, instead of the normal `BroadcastReceiver`. This simply looks at the received `Intent` and calls out to an appropriate lifecycle method based on the requested action.

The one method that invariably needs to be implemented on the provider is `onUpdate()`. Other lifecycle methods may be of interest and are discussed [later](#) in this chapter.

For example, here is the `onUpdate()` implementation of the `AppWidgetProvider` for `TwitterWidget`:

```
@Override
public void onUpdate(Context ctxt,
                    AppWidgetManager mgr,
                    int[] appWidgetIds) {
    ctxt.startService(new Intent(ctxt, UpdateService.class));
}
```

If our `RemoteViews` could be rapidly constructed, we could do the work right here. However, in our case, we need to make a Web service call to Twitter, which might take a while, so we instead call `startService()` on the `Service` we declared in our manifest, to have it make the updates.

The Service

The real work for `TwitterWidget` is mostly done in an `UpdateService` inner class of `TwitterWidget`.

`UpdateService` does not extend `Service`, but rather extends `IntentService`. `IntentService` is designed for patterns like this one, where our service is started multiple times, with each "start" representing a distinct piece of work to be accomplished (in this case, updating an app widget from Twitter). `IntentService` allows us to implement `onHandleIntent()` to do this work, and it arranges for `onHandleIntent()` to be called on a background thread. Hence, we do not need to deal with starting or stopping our thread, or even stopping our service when there is no more work to be done – Android handles that automatically.

Here is the `onHandleIntent()` implementation from `UpdateService`:

```
@Override
public void onHandleIntent(Intent intent) {
    ComponentName me=new ComponentName(this,
```

```
                TwitterWidget.class);
AppWidgetManager mgr=AppWidgetManager.getInstance(this);
mgr.updateAppWidget(me, buildUpdate(this));
}
```

To update the `RemoteViews` for our app widget, we need to build those `RemoteViews` (delegated to a `buildUpdate()` helper method) and tell an `AppWidgetManager` to update the widget via `updateAppWidget()`. In this case, we use a version of `updateAppWidget()` that takes a `ComponentName` as the identifier of the widget to be updated. Note that this means that we will update all instances of this app widget presently in use – the concept of multiple app widget instances is covered in greater detail [later](#) in this chapter.

Working with `RemoteViews` is a bit like trying to tie your shoes while wearing mittens – it may be possible, but it is a bit clumsy. In this case, rather than using methods like `findViewById()` and then calling methods on individual widgets, we need to call methods on `RemoteViews` itself, providing the identifier of the widget we wish to modify. This is so our requests for changes can be serialized for transport to the home screen process. It does, however, mean that our view-updating code looks a fair bit different than it would if this were the main `View` of an activity or row of a `ListView`.

For example, here is the `buildUpdate()` method from `UpdateService`, which builds a `RemoteViews` containing the latest Twitter information, using account information pulled from shared preferences:

```
private RemoteViews buildUpdate(Context context) {
    RemoteViews updateViews=new RemoteViews(context.getPackageName(),
                                           R.layout.widget);
    String user=prefs.getString("user", null);
    String password=prefs.getString("password", null);

    if (user!=null && password!=null) {
        Twitter client=new Twitter(user, password);
        List<Twitter.Status> timeline=client.getFriendsTimeline();

        if (timeline.size()>0) {
            Twitter.Status s=timeline.get(0);

            updateViews.setTextViewText(R.id.friend,
                                       s.user.screenName);
        }
    }
}
```

```
updateViews.setTextViewText(R.id.status,
                             s.text);

Intent i=new Intent(this, TwitterWidget.class);
PendingIntent pi=PendingIntent.getBroadcast(context,
                                             0 , i,
                                             0);

updateViews.setOnClickPendingIntent(R.id.refresh,
                                     pi);

i=new Intent(this, TWPrefs.class);
pi=PendingIntent.getActivity(context, 0 , i, 0);
updateViews.setOnClickPendingIntent(R.id.configure,
                                     pi);
}
}

return(updateViews);
}
```

To create the `RemoteViews`, we use a constructor that takes our package name and the identifier of our layout. This gives us a `RemoteViews` that contains all of the widgets we declared in that layout, just as if we inflated the layout using a `LayoutInflater`. The difference, of course, is that we have a `RemoteViews` object, not a `View`, as the result.

We then use methods like:

- `setTextViewText()` to set the text on a `TextView` in the `RemoteViews`, given the identifier of the `TextView` within the layout we wish to manipulate
- `setOnClickPendingIntent()` to provide a `PendingIntent` that should get fired off when a `Button` or `ImageButton` is clicked

Note, of course, that Android does not know anything about Twitter – the `Twitter` object comes from a `JTwitter` JAR located in the `libs/` directory of our project.

The Configuration Activity

Way back in the manifest, we included an `<activity>` element for a `TWPrefs` activity. And, in our widget metadata XML file, we said that `TWPrefs` was the

`android:configure` attribute value. In our `RemoteViews` for the widget itself, we connect a `configure` button to launch `TWPrefs` when clicked.

The net of all of this is that `TWPrefs` is the configuration activity. Specifically:

- It will be launched when we request to add this widget to our home screen
- It will be re-launched whenever we click the `configure` button in the widget itself

For the latter scenario, the activity need be nothing special. In fact, `TWPrefs` is mostly just a `PreferenceActivity`, updating the `SharedPreferences` for this application with the user's Twitter screen name and password, used for logging into Twitter and fetching the latest timeline entry.

The former scenario – defining a configuration activity in the metadata – requires a bit more work, though.

If we were to leave this out, and not have an `android:configure` attribute in the metadata, once the user chose to add our widget to their home screen, the widget would immediately appear. Behind the scenes, Android would ask our `AppWidgetProvider` to supply the `RemoteViews` for the widget body right away.

However, when we declare that we want a configuration activity, we must build the initial `RemoteViews` ourselves and return them as the activity's result. Behind the scenes, Android uses `startActivityForResult()` to launch our configuration activity, then looks at the result and uses the associated `RemoteViews` to create the initial look of the widget.

This approach is prone to code duplication, and it is not completely clear why Android elected to build the widget framework this way.

That being said, here is the implementation of `TWPrefs`:

```
package com.commonware.android.appwidget;

import android.app.Activity;
import android.appwidget.AppWidgetManager;
import android.appwidget.AppWidgetProvider;
import android.content.ComponentName;
import android.content.Intent;
import android.os.Build;
import android.os.Bundle;
import android.preference.PreferenceActivity;
import android.view.KeyEvent;
import android.widget.RemoteViews;

public class TWPrefs extends PreferenceActivity {
    private static String
    CONFIGURE_ACTION="android.appwidget.action.APPWIDGET_CONFIGURE";

    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);

        addPreferencesFromResource(R.xml.preferences);
    }

    @Override
    public boolean onKeyDown(int keyCode, KeyEvent event) {
        if (keyCode==KeyEvent.KEYCODE_BACK &&
            Integer.parseInt(Build.VERSION.SDK)<5) {
            onBackPressed();
        }

        return(super.onKeyDown(keyCode, event));
    }

    @Override
    public void onBackPressed() {
        if (CONFIGURE_ACTION.equals(getIntent().getAction())) {
            Intent intent=getIntent();
            Bundle extras=intent.getExtras();

            if (extras!=null) {
                int id=extras.getInt(AppWidgetManager.EXTRA_APPWIDGET_ID,
                    AppWidgetManager.INVALID_APPWIDGET_ID);
                AppWidgetManager mgr=AppWidgetManager.getInstance(this);
                RemoteViews views=new RemoteViews(getPackageName(),
                    R.layout.widget);

                mgr.updateAppWidget(id, views);

                Intent result=new Intent();

                result.putExtra(AppWidgetManager.EXTRA_APPWIDGET_ID,
                    id);
                setResult(RESULT_OK, result);
                sendBroadcast(new Intent(this,
```

```
        TwitterWidget.class));
    }
    super.onBackPressed();
}
```

We are using the same activity for two cases: for the initial configuration and for later on-demand reconfiguration via the configure button in the widget. We need to tell these apart. More importantly, we need to get control at an appropriate time to set our activity result in the initial configuration case. Alas, the normal activity lifecycle methods (e.g., `onDestroy()`) are too late, and `PreferenceActivity` offers no other explicit hook to find out when the user dismisses the preference screen.

So, we have to cheat a bit.

Specifically, we hook `onBackPressed()` and watch for the back button. When the back button is pressed, if we were launched by a widget configuration Intent (`CONFIGURE_ACTION.equals(getIntent().getAction())`), then we go through and:

- Get our widget instance identifier (described in greater detail later in this chapter)
- Get our `AppWidgetManager` and create a new `RemoteViews` inflated from our widget layout
- Pass the empty `RemoteViews` to the `AppWidgetManager` via `updateAppWidget()`
- Call `setResult()` with an Intent wrapping our widget instance identifier, so Android knows we have properly configured our widget
- Raise a broadcast Intent to ask our `WidgetProvider` to do the *real* initial version of the widget

This minimizes code duplication, but it does mean there is a slight hiccup, where the widget initially appears blank, before the first timeline entry appears. This is largely unavoidable in this case – we cannot wait for Twitter

to respond since `onBackPressed()` is called on the UI thread and we need to call `setResult()` now rather than wait for Twitter's response.

Undoubtedly, there are other patterns for handling this situation.

Note that `onBackPressed()` is new to Android 2.0. For earlier versions of Android, you will instead want to override `onKeyDown()` and look for `KeyEvent.KEYCODE_BACK` events.

The Result

If you compile and install all of this, you will have a new widget entry available when you long-tap on the home screen background:

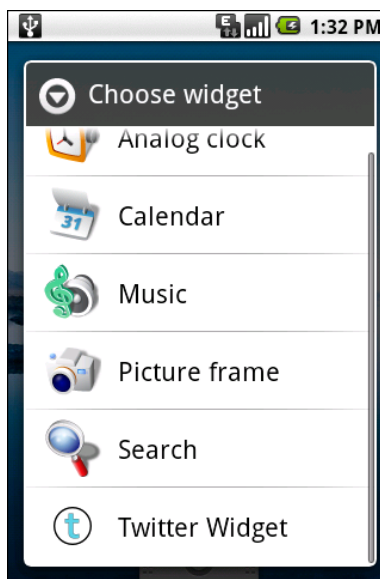


Figure 23. The roster of available widgets

When you choose Twitter Widget, you will initially be presented with the configuration activity:

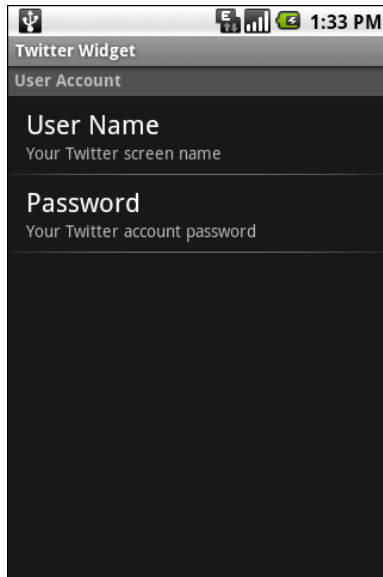


Figure 24. The TwitterWidget configuration activity

Once you set your Twitter screen name and password, and press the back button to exit the activity, your widget will appear with no contents:

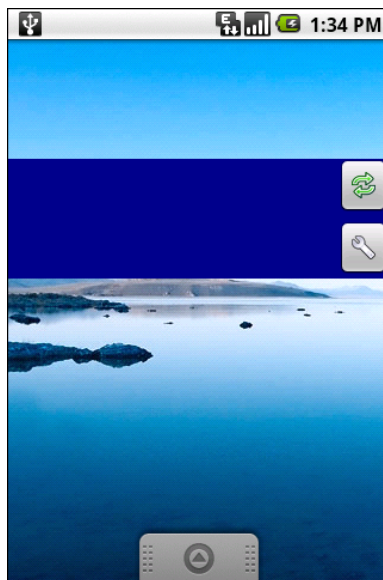


Figure 25. TwitterWidget, immediately after being added

After a moment, though, it will appear with the latest in your Twitter friends timeline:

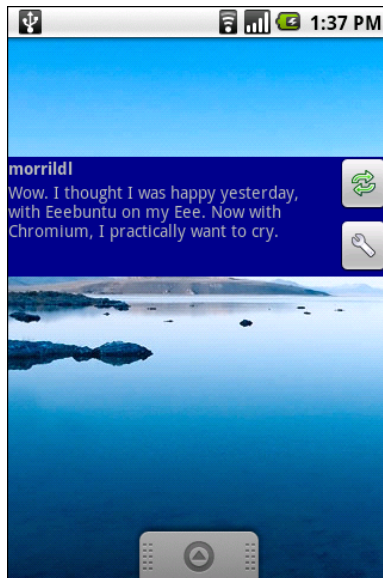


Figure 26. TwitterWidget, with a timeline entry

To change your Twitter credentials, you can either tap the configure icon in the widget or run the Twitter Widget application in your launcher. And, clicking the refresh button, or waiting 15 minutes, will cause the widget to update its contents.

Another and Another

As indicated above, you can have multiple instances of the same app widget outstanding at any one time. For example, one might have multiple picture frames, or multiple "show-me-the-latest-RSS-entry" app widgets, one per feed. You will distinguish between these in your code via the identifier supplied in the relevant `AppWidgetProvider` callbacks (e.g., `onUpdate()`).

If you want to support separate app widget instances, you will need to store your state on a per-app-widget-identifier basis. For example, while `TwitterWidget` uses preferences for the Twitter account details, you might

need multiple preference files, or use a SQLite database with an app widget identifier column, or something to distinguish one app widget instance from another. You will also need to use an appropriate version of `updateAppWidget()` on `AppWidgetManager` when you update the app widgets, one that takes app widget identifiers as the first parameter, so you update the proper app widget instances.

Conversely, there is nothing requiring you to support multiple instances as independent entities. For example, if you add more than one `TwitterWidget` to your home screen, nothing blows up – they just show the same tweet. In the case of `TwitterWidget`, they might not even show the same tweet all the time, since they will update on independent cycles, so one will get newer tweets before another.

App Widgets: Their Life and Times

`TwitterWidget` overrode two `AppWidgetProvider` methods:

- `onUpdate()`, invoked when the `android:updatePeriodMillis` time has elapsed
- `onReceive()`, the standard `BroadcastReceiver` callback, used to detect when we are invoked with no action, meaning we want to force an update due to the refresh button being clicked

There are three other lifecycle methods that `AppWidgetProvider` offers that you may be interested in:

- `onEnabled()` will be called when the first widget instance is created for this particular widget provider, so if there is anything you need to do once for all supported widgets, you can implement that logic here
- `onDeleted()` will be called when a widget instance is removed from the home screen, in case there is any data you need to clean up specific to that instance

- `onDisabled()` will be called when the last widget instance for this provider is removed from the home screen, so you can clean up anything related to all such widgets

Note, however, that there is a bug in Android 1.5, where `onDelete()` will not be properly called. You will need to implement `onReceive()` and watch for the `ACTION_APPWIDGET_DELETED` action in the received `Intent` and call `onDelete()` yourself. This should be fixed in a future edition of Android.

Controlling Your (App Widget's) Destiny

As `TwitterWidget` illustrates, you are not limited to updating your app widget only based on the timetable specified in your metadata. That timetable is useful if you can get by with a fixed schedule. However, there are cases in which that will not work very well:

- If you want the user to be able to configure the polling period (the metadata is baked into your APK and therefore cannot be modified at runtime)
- If you want the app widget to be updated based on external factors, such as a change in location

The recipe shown in `TwitterWidget` will let you use `AlarmManager` (described in a [later chapter](#)) or proximity alerts or whatever to trigger updates. All you need to do is:

- Arrange for something to broadcast an `Intent` that will be picked up by the `BroadcastReceiver` you are using for your app widget provider
- Have the provider process that `Intent` directly or pass it along to a `Service` (such as an `IntentService` as shown in `TwitterWidget`)

Also, note that the `updateTimeMillis` setting not only tells the app widget to update every so often, it will even *wake up the phone* if it is asleep so the widget can perform its update. On the plus side, this means you can easily keep your widgets up to date regardless of the state of the device. On the minus side, this will tend to drain the battery, particularly if the period is too fast. If you want to avoid this wakeup behavior, set `updateTimeMillis` to

0 and use `AlarmManager` to control the timing and behavior of your widget updates.

Change Your Look

If you have been doing most of your development via the Android emulator, you are used to all "devices" having a common look and feel, in terms of the home screen, lock screen, and so forth. This is the so-called "Google Experience" look, and many actual Android devices have it.

However, some devices have their own presentation layers. HTC has "Sense", seen on the HTC Hero and HTC Tattoo, among other devices. Motorola has MOTOBLUR, seen on the Motorola CLIQ and DEXT. Other device manufacturers are sure to follow suit. These presentation layers replace the home screen and lock screen, among other things. Moreover, they usually come with their own suite of app widgets with their own look and feel. Your app widget may look fine on a Google Experience home screen, but the look might clash when viewed on a Sense or MOTOBLUR device.

Fortunately, there are ways around this. You can set your app widget's look on the fly at runtime, to choose the layout that will look the best on that particular device.

The first step is to create an app widget layout that is initially invisible (`res/layout/invisible.xml`):

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="horizontal"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:visibility="invisible"
    >
</RelativeLayout>
```

This layout is then the one you would reference from your app widget metadata, to be used when the app widget is first created:

```
<appwidget-provider xmlns:android="http://schemas.android.com/apk/res/android"
    android:minWidth="292dip"
    android:minHeight="72dip"
    android:updatePeriodMillis="900000"
    android:configure="com.commonsware.android.appwidget.TWPrefs"
    android:initialLayout="@layout/invisible"
/>
```

This ensures that when your app widget is initially added, you do not get the "Problem loading widget" placeholder, yet you also do not choose one layout versus another – it is simply invisible for a brief moment.

Then, in your `AppWidgetProvider` (or attached `IntentService`), you can make the choice of what layout to inflate as part of your `RemoteViews`. Rather than using the invisible one, you can choose one based on the device or other characteristics.

For example, here is a revised version of our app widget layout that uses a different color background (`res/layout/widget_alt.xml`):

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="horizontal"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:background="#FF008800"
    >
    <ImageButton android:id="@+id/refresh"
        android:layout_alignParentTop="true"
        android:layout_alignParentRight="true"
        android:src="@drawable/refresh"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
    />
    <ImageButton android:id="@+id/configure"
        android:layout_alignParentBottom="true"
        android:layout_alignParentRight="true"
        android:src="@drawable/configure"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
    />
    <TextView android:id="@+id/friend"
        android:layout_alignParentTop="true"
        android:layout_alignParentLeft="true"
        android:layout_toLeftOf="@id/refresh"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:gravity="left"
    />
```

```
        android:textStyle="bold"
        android:singleLine="true"
        android:ellipsize="end"
    />
    <TextView android:id="@+id/status"
        android:layout_below="@id/friend"
        android:layout_alignParentLeft="true"
        android:layout_toLeftOf="@id/refresh"
        android:layout_width="wrap_content"
        android:layout_height="fill_parent"
        android:gravity="top"
        android:singleLine="false"
        android:lines="4"
    />
</RelativeLayout>
```

We can modify our IntentService to choose which layout – widget.xml or widget_alt.xml – to use. For example, the following code shows how we could use a specific layout for Android 2.1 devices:

```
int layout=R.layout.widget;

if (android.os.Build.VERSION.SDK_INT==7) {
    layout=R.layout.widget_alt;
}

RemoteViews updateViews=new RemoteViews(context.getPackageName(),
                                        layout);
```

The biggest challenge is that there is no good way to determine what presentation layer, if any, is in use on a device. For the time being, you will need to use the various fields in the android.os.Build class to "sniff" on the device model and make a decision that way.

Being a Good Host

In addition to creating your own app widgets, it is possible to host app widgets. This is mostly aimed for those creating alternative home screen applications, so they can take advantage of the same app widget framework and all the app widgets being built for it.

This is not very well documented at this juncture, but it apparently involves the AppWidgetHost and AppWidgetHostView classes. The latter is a View and so

should be able to reside in an app widget host's UI like any other ordinary widget.

Searching with SearchManager

One of the firms behind the Open Handset Alliance – Google – has a teeny weeny Web search service, one you might have heard of in passing. Given that, it's not surprising that Android has some amount of built-in search capabilities.

Specifically, Android has "baked in" the notion of searching not only on the device for data, but over the air to Internet sources of data.

Your applications can participate in the search process, by triggering searches or perhaps by allowing your application's data to be searched.

Hunting Season

There are two types of search in Android: local and global. Local search searches within the current application; global search searches the Web via Google's search engine. You can initiate either type of search in a variety of ways, including:

- You can call `onSearchRequested()` from a button or menu choice, which will initiate a local search (unless you override this method in your activity)
- You can directly call `startSearch()` to initiate a local or global search, including optionally supplying a search string to use as a starting point

- You can elect to have keyboard entry kick off a search via `setDefaultKeyMode()`, for either local search (`setDefaultKeyMode(DEFAULT_KEYS_SEARCH_LOCAL)`) or global search (`setDefaultKeyMode(DEFAULT_KEYS_SEARCH_GLOBAL)`)

In either case, the search appears as a set of UI components across the top of the screen, with a suggestion list (where available) and IME (where needed).

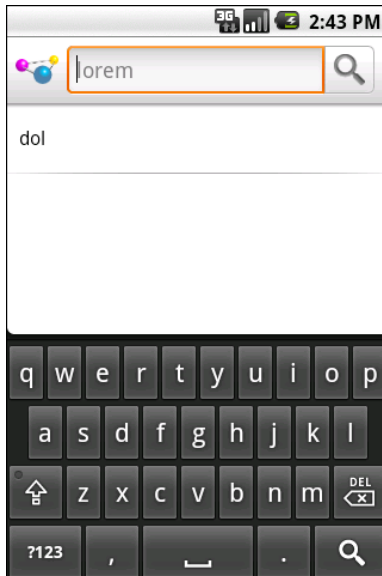


Figure 27. The Android local search popup, showing the IME and a previous search

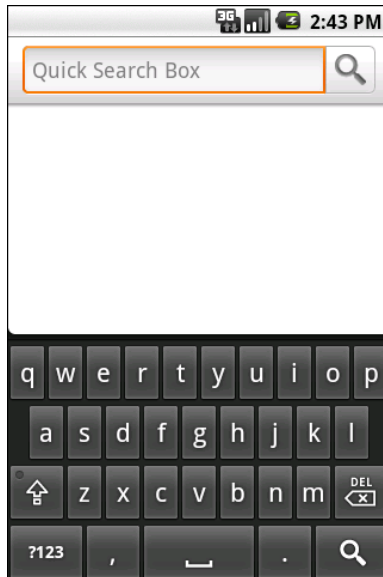


Figure 28. The Android global search popup

Where that search suggestion comes from for your local searches will be covered later in this chapter.

Search Yourself

Over the long haul, there will be two flavors of search available via the Android search system:

1. Query-style search, where the user's search string is passed to an activity which is responsible for conducting the search and displaying the results
2. Filter-style search, where the user's search string is passed to an activity on every keypress, and the activity is responsible for updating a displayed list of matches

Since the latter approach is decidedly under-documented, let's focus on the first one.

Craft the Search Activity

The first thing you are going to want to do if you want to support query-style search in your application is to create a search activity. While it might be possible to have a single activity be both opened from the launcher and opened from a search, that might prove somewhat confusing to users. Certainly, for the purposes of learning the techniques, having a separate activity is cleaner.

The search activity can have any look you want. In fact, other than watching for queries, a search activity looks, walks, and talks like any other activity in your system.

All the search activity needs to do differently is check the intents supplied to `onCreate()` (via `getIntent()`) and `onNewIntent()` to see if one is a search, and, if so, to do the search and display the results.

For example, let's look at the `Search/Lorem` sample application. This starts off as a clone of the `list-of-lorem-ipsu-words` application originally encountered in *The Busy Coder's Guide to Android Development*. Now, we update it to support searching the list of words for ones containing the search string.

The main activity and the search activity both share a common layout: a `ListView` plus a `TextView` showing the selected entry:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent" >
    <TextView
        android:id="@+id/selection"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
    />
    <ListView
        android:id="@android:id/list"
        android:layout_width="fill_parent"
        android:layout_height="fill_parent"
        android:drawSelectorOnTop="false"
```

```
</>  
</LinearLayout>
```

In terms of Java code, most of the guts of the activities are poured into an abstract `LoremBase` class:

```
abstract public class LoremBase extends ListActivity {  
    abstract ListAdapter makeMeAnAdapter(Intent intent);  
  
    private static final int LOCAL_SEARCH_ID = Menu.FIRST+1;  
    private static final int GLOBAL_SEARCH_ID = Menu.FIRST+2;  
    private static final int CLOSE_ID = Menu.FIRST+3;  
    TextView selection;  
    ArrayList<String> items=new ArrayList<String>();  
  
    @Override  
    public void onCreate(Bundle icle) {  
        super.onCreate(icle);  
        setContentView(R.layout.main);  
        selection=(TextView)findViewById(R.id.selection);  
  
        try {  
            XmlPullParser xpp=getResources().getXml(R.xml.words);  
  
            while (xpp.getEventType()!=XmlPullParser.END_DOCUMENT) {  
                if (xpp.getEventType()==XmlPullParser.START_TAG) {  
                    if (xpp.getName().equals("word")) {  
                        items.add(xpp.getAttributeValue(0));  
                    }  
                }  
  
                xpp.next();  
            }  
        }  
        catch (Throwable t) {  
            Toast  
                .makeText(this, "Request failed: "+t.toString(), 4000)  
                .show();  
        }  
  
        setDefaultKeyMode(DEFAULT_KEYS_SEARCH_LOCAL);  
  
        onNewIntent(getIntent());  
    }  
  
    @Override  
    public void onNewIntent(Intent intent) {  
        ListAdapter adapter=makeMeAnAdapter(intent);  
  
        if (adapter==null) {  
            finish();  
        }  
    }  
}
```

```
        else {
            setListAdapter(adapter);
        }
    }

    public void onItemClick(AdapterView parent, View v, int position,
        long id) {
        selection.setText(items.get(position).toString());
    }

    @Override
    public boolean onCreateOptionsMenu(Menu menu) {
        menu.add(Menu.NONE, LOCAL_SEARCH_ID, Menu.NONE, "Local Search")
            .setIcon(android.R.drawable.ic_search_category_default);
        menu.add(Menu.NONE, GLOBAL_SEARCH_ID, Menu.NONE, "Global Search")
            .setIcon(R.drawable.search)
            .setAlphabeticShortcut(SearchManager.MENU_KEY);
        menu.add(Menu.NONE, CLOSE_ID, Menu.NONE, "Close")
            .setIcon(R.drawable.eject)
            .setAlphabeticShortcut('c');

        return(super.onCreateOptionsMenu(menu));
    }

    @Override
    public boolean onOptionsItemSelected(MenuItem item) {
        switch (item.getItemId()) {
            case LOCAL_SEARCH_ID:
                onSearchRequested();
                return(true);

            case GLOBAL_SEARCH_ID:
                startSearch(null, false, null, true);
                return(true);

            case CLOSE_ID:
                finish();
                return(true);
        }

        return(super.onOptionsItemSelected(item));
    }
}
```

This activity takes care of everything related to showing a list of words, even loading the words out of the XML resource. What it does not do is come up with the `ListAdapter` to put into the `ListView` – that is delegated to the subclasses.

The main activity – `LoremDemo` – just uses a `ListAdapter` for the whole word list:

```
package com.commonware.android.search;

import android.content.Intent;
import android.widget.AdapterView;
import android.widget.ListAdapter;

public class LoremDemo extends LoremBase {
    @Override
    ListAdapter makeMeAnAdapter(Intent intent) {
        return(new ArrayAdapter<String>(this,
            android.R.layout.simple_list_item_1,
            items));
    }
}
```

The search activity, though, does things a bit differently.

First, it inspects the Intent supplied to the abstract makeMeAnAdapter() method. That Intent comes from either onCreate() or onNewIntent(). If the intent is an ACTION_SEARCH, then we know this is a search. We can get the search query and, in the case of this silly demo, spin through the loaded list of words and find only those containing the search string. That list then gets wrapped in a ListAdapter and returned for display:

```
ListAdapter makeMeAnAdapter(Intent intent) {
    ListAdapter adapter=null;

    if (intent.getAction().equals(Intent.ACTION_SEARCH)) {
        String query=intent.getStringExtra(SearchManager.QUERY);
        List<String> results=searchItems(query);

        adapter=new ArrayAdapter<String>(this,
            android.R.layout.simple_list_item_1,
            results);
        setTitle("LoremSearch for: "+query);
    }

    return(adapter);
}
```

Update the Manifest

While this implements search, it doesn't tie it into the Android search system. That requires a few changes to the auto-generated AndroidManifest.xml file:

```
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
  package="com.commonware.android.search">
  <uses-sdk
    android:minSdkVersion="3"
    android:targetSdkVersion="6"
  />
  <supports-screens
    android:largeScreens="false"
    android:normalScreens="true"
    android:smallScreens="false"
  />
  <application android:label="Lorem Ipsum"
    android:icon="@drawable/cw">
    <activity android:name=".LoremDemo" android:label="LoremDemo">
      <intent-filter>
        <action android:name="android.intent.action.MAIN" />
        <category android:name="android.intent.category.LAUNCHER" />
      </intent-filter>
      <meta-data android:name="android.app.default_searchable"
        android:value=".LoremSearch" />
    </activity>
    <activity
      android:name=".LoremSearch"
      android:label="LoremSearch"
      android:launchMode="singleTop">
      <intent-filter>
        <action android:name="android.intent.action.SEARCH" />
        <category android:name="android.intent.category.DEFAULT" />
      </intent-filter>
      <meta-data android:name="android.app.searchable"
        android:resource="@xml/searchable" />
    </activity>
    <provider android:name=".LoremSuggestionProvider"
      android:authorities="com.commonware.android.search.LoremSuggestionP
rovider" />
  </application>
</manifest>
```

The changes that are needed are:

1. The LoremDemo main activity gets a meta-data element, with an android:name of android.app.default_searchable and a android:value of the search implementation class (.LoremSearch)
2. The LoremSearch activity gets an intent filter for android.intent.action.SEARCH, so search intents will be picked up
3. The LoremSearch activity is set to have android:launchMode = "singleTop", which means at most one instance of this activity will be open at any time, so we don't wind up with a whole bunch of little search activities cluttering up the activity stack

4. Add `android:label` and `android:icon` attributes to the application element – these will influence how your application appears in the Quick Search Box among other places
5. The `LoremSearch` activity gets a meta-data element, with an `android:name` of `android.app.searchable` and a `android:value` of an XML resource containing more information about the search facility offered by this activity (`@xml/searchable`)

```
<searchable xmlns:android="http://schemas.android.com/apk/res/android"
  android:label="@string/searchLabel"
  android:hint="@string/searchHint"
  android:searchSuggestAuthority="com.commonware.android.search>LoremSuggestion
Provider"
  android:searchSuggestSelection=" ? "
  android:searchSettingsDescription="@string/global"
  android:includeInGlobalSearch="true"
/>
```

That XML resource provides many bits of information, of which only two are needed for simple search-enabled applications:

1. What name should appear in the search domain button to the left of the search field, identifying to the user where she is searching (`android:label`)
2. What hint text should appear in the search field, to give the user a clue as to what they should be typing in (`android:hint`)

The other attributes found in that file, and the other search-related bits found in the manifest, will be covered later in this chapter.

Searching for Meaning In Randomness

Given all that, search is now available – Android knows your application is searchable, what search domain to use when searching from the main activity, and the activity knows how to do the search.

The options menu for this application has both local and global search options. In the case of local search, we just call `onSearchRequested()`; in the

case of global search, we call `startSearch()` with `true` in the last parameter, indicating the scope is global.

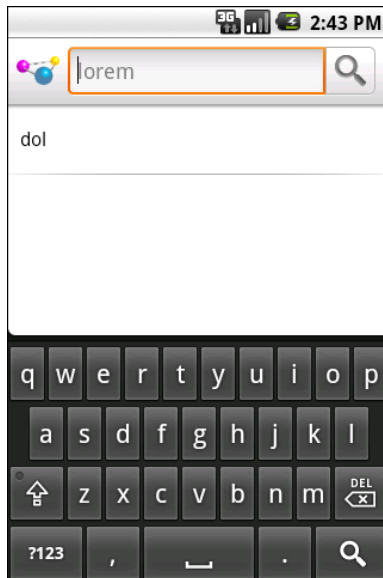


Figure 29. The Lorem sample application, showing the local search popup

Typing in a letter or two, then clicking Search, will bring up the search activity and the subset of words containing what you typed, with your search query in the activity title bar:



Figure 30. The results of searching for 'co' in the Lorem search sample

You can get the same effect if you just start typing in the main activity, since it is set up for triggering a local search.

May I Make a Suggestion?

When you do a global search, you are given "suggestions" of search words or phrases that may be what you are searching for, to save you some typing on a small keyboard:

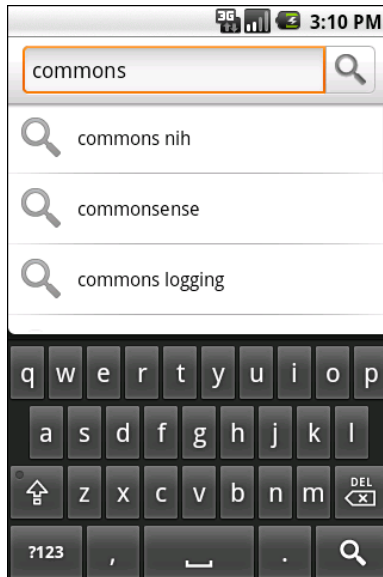


Figure 31. Search suggestions after typing some letters in global search

Your application, if it chooses, can offer similar suggestions. Not only will this give you the same sort of drop-down effect as you see with the global search above, but it also ties neatly into the Quick Search Box, as we will see later in this chapter.

To provide suggestions, you need to implement a `ContentProvider` and tie that provider into the search framework. You have two major choices for implementing a suggestion provider: use the built-in "recent" suggestion provider, or create your own from scratch.

SearchRecentSuggestionsProvider

The "recent" suggestions provider gives you a quick and easy way to remember past searches and offer those as suggestions on future searches.

To use this facility, you must first create a custom subclass of `SearchRecentSuggestionsProvider`. Your subclass may be very simple, perhaps just a two-line constructor with no other methods. However, since Android does not automatically record recent queries for you, you will also need to

give your search activity a way to record them such that the recent-suggestions provider can offer them as suggestions in the future.

Below, we have a `LoremSuggestionProvider`, extending `SearchRecentSuggestionsProvider`, that also supplies a "bridge" for the search activity to record searches:

```
package com.commonware.android.search;

import android.content.Context;
import android.content.SearchRecentSuggestionsProvider;
import android.provider.SearchRecentSuggestions;

public class LoremSuggestionProvider
    extends SearchRecentSuggestionsProvider {
    private static String
AUTH="com.commonware.android.search>LoremSuggestionProvider";

    static SearchRecentSuggestions getBridge(Context ctxt) {
        return(new SearchRecentSuggestions(ctxt, AUTH,
            DATABASE_MODE_QUERIES));
    }

    public LoremSuggestionProvider() {
        super();

        setupSuggestions(AUTH, DATABASE_MODE_QUERIES);
    }
}
```

The constructor, besides the obligatory chain to the superclass, simply calls `setupSuggestions()`. This takes two parameters:

- The authority under which you will register this provider in the manifest (see below)
- A flag indicating where the suggestions will come from – in this case, we supply the required `DATABASE_MODE_QUERIES` flag

Of course, since this is a `ContentProvider`, you will need to add it to your manifest:

```
android:label="LoremSearch"
android:launchMode="singleTop">
```

The other thing that `LoremSuggestionProvider` has is a static method that creates a properly-configured instance of a `SearchRecentSuggestions` object. This object knows how to save search queries to the database that the content provider uses, so they will be served up as future suggestions. It needs to know the same authority and flag that you provide to `setupSuggestions()`.

That `SearchRecentSuggestions` is then used by our `LoremSearch` class, inside its `searchItems()` method that actually examines the list of nonsense words for matches:

```
private List<String> searchItems(String query) {
    LoremSuggestionProvider
        .getBridge(this)
        .saveRecentQuery(query, null);

    List<String> results=new ArrayList<String>();

    for (String item : items) {
        if (item.indexOf(query)>-1) {
            results.add(item);
        }
    }

    return(results);
}
```

In this case, we always record the search, though you can imagine that some applications might not save searches that are invalid for one reason or another.

Custom Suggestion Providers

If you want to provide search suggestions based on something else – actual data, searches conducted by others that you aggregate via a Web service, etc. – you will need to implement your own `ContentProvider` that supplies that information. As with `SearchRecentSuggestionsProvider`, you will need to add your `ContentProvider` to the manifest so that Android knows it exists.

The details for doing this will be covered in a future edition of this book. For now, you are best served with the [Android SearchManager documentation on the topic](#).

Integrating Suggestion Providers

Before your suggestions will appear, though, you need to tell Android to use your `ContentProvider` as the source of suggestions. There are two attributes on your `searchable` XML that make this connection:

- `android:searchSuggestAuthority` indicates the content authority for your suggestions – this is the same authority you used for your `ContentProvider`
- `android:searchSuggestSelection` is how the suggestion should be packaged as a query in the `ACTION_SEARCH` Intent – unless you have some reason to do otherwise, " ? " is probably a fine value to use

The result is that when we do our local search, we get the drop-down of past searches as suggestions:

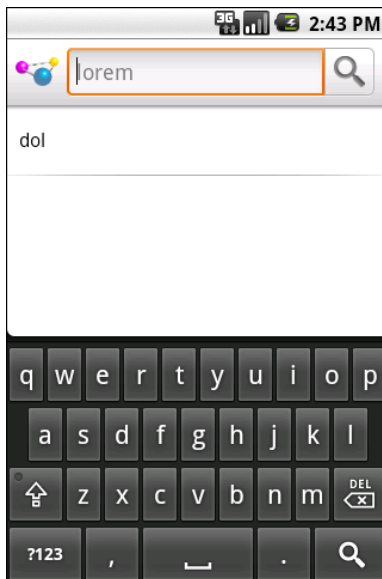


Figure 32. The Android local search popup, showing the IME and a previous search

There is also a `clearHistory()` method on `SearchRecentSuggestions` that you can use, perhaps from a menu choice, to clear out the search history, in case it is cluttered beyond usefulness.

Putting Yourself (Almost) On Par with Google

The Quick Search Box is Android's new term for the search widget at the top of the home screen. This is the same UI that appears when your application starts a global search. When you start typing, it shows possible matches culled from both the device and the Internet. If you choose one of the suggestions, it takes you to that item – choose a contact, and you visit the contact in the Contacts application. If you choose a Web search term, or you just submit whatever you typed in, Android will fire up a Browser instance showing you search results from Google. The order of suggestions is adaptive, as Android will attempt to show the user the sorts of things the user typically searches for (e.g., if the user clicks on contacts a lot in prior searches, it may prioritize suggested contacts in the suggestion list).

Your application can be tied into the Quick Search Box. However, it is important to understand that being in the Quick Search Box does *not* mean that your content will be searched. Instead, your *suggestions provider* will be queried based on what the user has typed in, and those suggestions will be blended into the overall results.

And, your application will not show up in Quick Search Box suggestions automatically – the user has to "opt in" to have your results included.

And, until the user demonstrates an interest in your results, your application's suggestions will be buried at the bottom of the list.

This means that integrating with the Quick Search Box, while still perhaps valuable, is not exactly what some developers will necessarily have in mind. That being said, here is how to achieve this integration.

Implement a Suggestions Provider

Your first step is to implement a suggestions provider, as described in the [previous section](#). Again, Android does not search your application, but rather queries your suggestions provider. If you do not have a suggestions provider, you will not be part of the Quick Search Box. As we will see below, this approach means you will need to think about what sort of suggestion provider to create.

Augment the Metadata

Next, you need to tell Android to tie your application into the Quick Search Box suggestion list. To do that, you need to add the `android:includeInGlobalSearch` attribute to your `searchable` XML, setting it to `true`. You probably also should consider adding the `android:searchSettingsDescription`, as this will be shown in the UI for the user to configure what suggestions the Quick Search Box shows.

Convince the User

Next, the user needs to activate your application to be included in the Quick Search Box suggestion roster. To do that, the user needs to go into `Settings > Search > Searchable Items` and check the checkbox associated with your application:

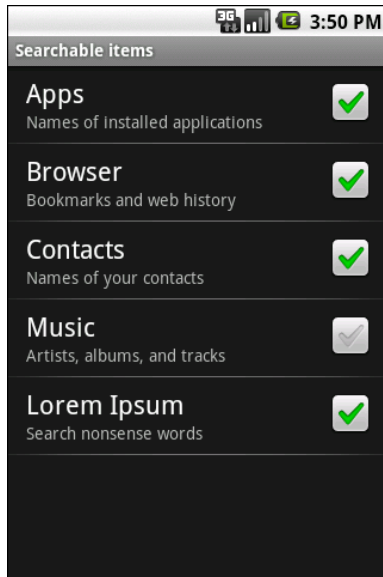


Figure 33. The Searchable Items settings screen

Your application's label and the value of `android:searchSettingsDescription` are what appears to the left of the checkbox.

You have no way of toggling this on yourself – the user has to do it. You may wish to mention this in the documentation for your application.

The Results

If you and the user do all of the above, now when the user initiates a search, your suggestions will be poured into the suggestions list, at the bottom:

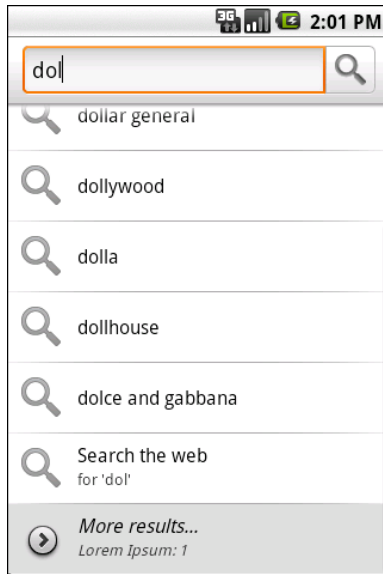


Figure 34. The Quick Search Box, showing a placeholder for application-supplied suggestions

To actually see your suggestions, the user also needs to click the arrow to "fold open" the actual suggestions:

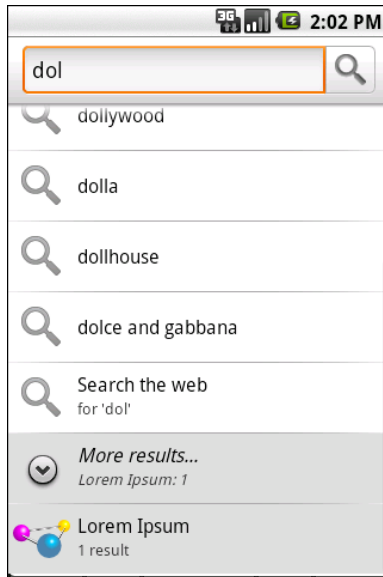


Figure 35. The Quick Search Box, showing another placeholder for application-supplied suggestions

Even here, we do not see the actual suggestion. However, if the user clicks on that item, your suggestions then take over the list:



Figure 36. The Quick Search Box, showing application-supplied suggestions

Again, Android is not showing *actual data* from your application – our list of nonsense words does not contain the value "dol". Instead, Android is showing *suggestions* from your suggestion provider based on what the user typed in. In this case, our application's suggestion provider is based on the built-in `SearchRecentSuggestionsProvider` class, meaning the suggestions are *past queries*, not actual results.

Hence, what you want to have appear in the Quick Search Box suggestion list will heavily influence what sort of suggestion provider you wish to create. While a `SearchRecentSuggestionsProvider` is simple, what you get in the Quick Search Box suggestions may not be that useful to users. Instead, you may wish to create your own custom suggestions provider, providing suggestions from actual data or other more useful sources, perhaps in addition to saved searches.

Interactive Maps

You probably have learned about basic operations with Google Maps elsewhere, perhaps in *The Busy Coder's Guide to Android Development*. As you may recall, after going through a fair amount of hassle to obtain and manage an API key, you need to put a `MapView` in a layout used by a `MapActivity`. Then, between the `MapView` and its `MapController`, you can manage what gets displayed on the map and, to a lesser extent, get user input from the map. Notably, you can add overlays that display things on top of the map that are tied to geographic coordinates (`GeoPoint` objects), so Android can keep the overlays in sync with the map contents as the user pans and zooms.

This chapter will get into some more involved topics in the use of `MapView`, such as displaying pop-up panels when the user taps on overlay items.

The examples in this chapter are based on the original `Maps/NooYawk` example from *The Busy Coder's Guide to Android Development*. That example does two things: it displays overlay items for four New York City landmarks, and it makes a mockery of Brooklyn accents (via the unusual spelling of the project name). If you have access to *The Busy Coder's Guide to Android Development*, you may wish to review that chapter and the original example before reading further here.

Get to the Point

By default, it appears that, when the user taps on one of your `OverlayItem` icons in an `ItemizedOverlay`, all you find out is which `OverlayItem` it is, courtesy of an index into your collection of items. However, Android does provide means to find out where that item is, both in real space and on the screen.

Getting the Latitude and Longitude

You supplied the latitude and longitude – in the form of a `GeoPoint` – when you created the `OverlayItem` in the first place. Not surprisingly, you can get that back via a `getPoint()` method on `OverlayItem`. So, in an `onTap()` method, you can do this to get the `GeoPoint`:

```
@Override
protected boolean onTap(int i) {
    OverlayItem item=getItem(i);
    GeoPoint geo=item.getPoint();

    // other good stuff here

    return(true);
}
```

Getting the Screen Position

If you wanted to find the screen coordinates for that `GeoPoint`, you might be tempted to find out where the map is centered (via `getCenter()` on `MapView`) and how big the map is in terms of screen size (`getWidth()`, `getHeight()` on `MapView`) and geographic area (`getLatitudeSpan()`, `getLongitudeSpan()` on `MapView`), and do all sorts of calculations.

Good news! You do not have to do any of that.

Instead, you can get a `Projection` object from the `MapView` via `getProjection()`. This object can do the conversions for you, such as `toPixels()` to convert a `GeoPoint` into a screen `Point` for the X/Y position.

For example, take a look at the `onTap()` implementation from the `NooYawk` class in the `Maps/NooYawkRedux` sample project:

```
@Override
protected boolean onTap(int i) {
    OverlayItem item=getItem(i);
    GeoPoint geo=item.getPoint();
    Point pt=map.getProjection().toPixels(geo, null);

    String message=String.format("Lat: %f | Lon: %f\nX: %d | Y %d",
        geo.getLatitudeE6()/1000000.0,
        geo.getLongitudeE6()/1000000.0,
        pt.x, pt.y);

    Toast.makeText(NooYawk.this,
        message,
        Toast.LENGTH_LONG).show();

    return(true);
}
```

Here, we get the `GeoPoint` (as in the previous section), get the `Point` (via `toPixels()`), and use those to customize a message for use with our `Toast`.

Note that our `Toast` message has an embedded newline (`\n`), so it is split over two lines:

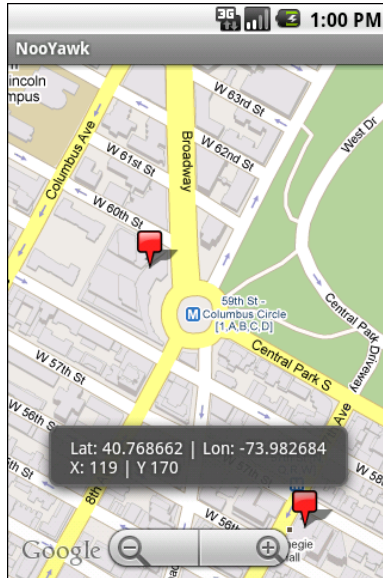


Figure 37. The NooYawkRedux application, showing the Toast with GeoPoint and Point data

Not-So-Tiny Bubbles

Of course, just because somebody taps on an item in your `ItemizedOverlay`, nothing really happens, other than letting you know of the tap. If you want something visual to occur – like the `Toast` displayed in the `Maps/NooYawkRedux` project – you have to do it yourself. And while a `Toast` is easy to implement, it tends not to be terribly useful in many cases.

A more likely reaction is to pop up some sort of bubble or panel on the screen, providing more details about the item that was tapped upon. That bubble might be display-only or fully interactive, perhaps leading to another activity for information beyond what the panel can hold.

While the techniques in this section will be couched in terms of pop-up panels over a `MapView`, the same basic concepts can be used just about anywhere in Android.

Options for Pop-up Panels

A pop-up panel is simply a `View` (typically a `ViewGroup` with contents, like a `RelativeLayout` containing widgets) that appears over the `MapView` on demand. To make one `View` appear over another, you need to use a common container that supports that sort of "Z-axis" ordering. The best one for that is `RelativeLayout`: children later in the roster of children of the `RelativeLayout` will appear over top of children that are earlier in the roster. So, if you have a `RelativeLayout` parent, with a full-screen `MapView` child followed by another `ViewGroup` child, that latter `ViewGroup` will appear to float over the `MapView`. In fact, with the use of a translucent background, you can even see the map peeking through the `ViewGroup`.

Given that, here are two main strategies for implementing pop-up panels.

One approach is to have the panel be part of the activity's layout from the beginning, but use a visibility of `GONE` to have it not be visible. In this case, you would define the panel in the main layout XML file, set `android:visibility="gone"`, and use `setVisibility()` on that panel at runtime to hide and show it. This works well, particularly if the panel itself is not changing much, just becoming visible and gone.

The other approach is to inflate the panel at runtime and dynamically add and remove it as a child of the `RelativeLayout`. This works well if there are many possible panels, perhaps dependent on the type of thing represented by an `OverlayItem` (e.g., restaurant versus hotel versus used car dealership).

In this section, we will examine the latter approach, as shown in the `Maps/EvenNooerYawk` sample project.

Defining a Panel Layout

The new version of `NooYawk` is designed to display panels when the user taps on items in the map, replacing the original `Toast`.

To do this, first, we need the actual content of a panel, as found in `res/layout/popup.xml`:

```
<?xml version="1.0" encoding="utf-8"?>
<TableLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:stretchColumns="1,3"
    android:background="@drawable/popup_frame">
    <TableRow>
        <TextView
            android:text="Lat:"
            android:layout_marginRight="10dip"
        />
        <TextView android:id="@+id/latitude" />
        <TextView
            android:text="Lon:"
            android:layout_marginRight="10dip"
        />
        <TextView android:id="@+id/longitude" />
    </TableRow>
    <TableRow>
        <TextView
            android:text="X:"
            android:layout_marginRight="10dip"
        />
        <TextView android:id="@+id/x" />
        <TextView
            android:text="Y:"
            android:layout_marginRight="10dip"
        />
        <TextView android:id="@+id/y"/>
    </TableRow>
</TableLayout>
```

Here, we have a `TableLayout` containing our four pieces of data (latitude, longitude, X, and Y), with a translucent gray background (courtesy of a [nine-patch graphic image](#)).

The intent is that we will inflate instances of this class when needed. And, as we will see, we will only need one in this example, though it is possible that other applications might need more.

Creating a PopupPanel Class

To manage our panel, `NooYawk` has an inner class named `PopupPanel1`. It takes the resource ID of the layout as a parameter, so it could be used to manage several different types of panels, not just the one we are using here.

Its constructor inflates the layout file (using the map's parent – the `RelativeLayout` – as the basis for inflation rules) and also hooks up a click listener to a `hide()` method (described below):

```
PopupPanel(int layout) {
    ViewGroup parent=(ViewGroup)map.getParent();

    popup=getLayoutInflater().inflate(layout, parent, false);

    popup.setOnClickListener(new View.OnClickListener() {
        public void onClick(View v) {
            hide();
        }
    });
}
```

`PopupPanel1` also tracks an `isVisible` data member, reflecting whether or not the panel is presently on the screen.

Showing and Hiding the Panel

When it comes time to show the panel, either it is already being shown, or it is not. The former would occur if the user tapped on one item in the overlay, then tapped another right away. The latter would occur, for example, for the first tap.

In either case, we need to determine where to position the panel. Having the panel obscure what was tapped upon would be poor form. So, `PopupPanel1` will put the panel either towards the top or bottom of the map, depending on where the user tapped – if they tapped in the top half of the map, the panel will go on the bottom. Rather than have the panel abut the edges of the map directly, `PopupPanel1` also adds some margins – this is also important for making sure the panel and the Google logo on the map do not interfere.

If the panel is visible, `PopupPanel` calls `hide()` to remove it, then adds the panel's view as a child of the `RelativeLayout` with a `RelativeLayout.LayoutParams` that incorporates the aforementioned rules:

```
void show(boolean alignTop) {
    RelativeLayout.LayoutParams lp=new RelativeLayout.LayoutParams(
        RelativeLayout.LayoutParams.WRAP_CONTENT,
        RelativeLayout.LayoutParams.WRAP_CONTENT
    );

    if (alignTop) {
        lp.addRule(RelativeLayout.ALIGN_PARENT_TOP);
        lp.setMargins(0, 20, 0, 0);
    }
    else {
        lp.addRule(RelativeLayout.ALIGN_PARENT_BOTTOM);
        lp.setMargins(0, 0, 0, 60);
    }

    hide();

    ((ViewGroup)map.getParent()).addView(popup, lp);
    isVisible=true;
}

void hide() {
```

The `hide()` method, in turn, removes the panel from the `RelativeLayout`:

```
void hide() {
    if (isVisible) {
        isVisible=false;
        ((ViewGroup)popup.getParent()).removeView(popup);
    }
}
```

`PopupPanel` also has a `getView()` method, so the overlay can get at the panel view in order to fill in the pieces of data at runtime:

```
View getView() {
    return(popup);
}
```

Tying It Into the Overlay

To use the panel, `NooYawk` creates an instance of one as a data member of the `ItemizedOverlay` class:

```
private PopupPanel panel=new PopupPanel(R.layout.popup);
```

Then, in the new `onTap()` method, the overlay gets the `view`, populates it, and shows it, indicating whether it should appear towards the top or bottom of the screen:

```
@Override
protected boolean onTap(int i) {
    OverlayItem item=getItem(i);
    GeoPoint geo=item.getPoint();
    Point pt=map.getProjection().toPixels(geo, null);

    View view=panel.getView();

    ((TextView)view.findViewById(R.id.latitude))
        .setText(String.valueOf(geo.getLatitudeE6()/1000000.0));
    ((TextView)view.findViewById(R.id.longitude))
        .setText(String.valueOf(geo.getLongitudeE6()/1000000.0));
    ((TextView)view.findViewById(R.id.x))
        .setText(String.valueOf(pt.x));
    ((TextView)view.findViewById(R.id.y))
        .setText(String.valueOf(pt.y));

    panel.show(pt.y*2>map.getHeight());

    return(true);
}
```

Here is the complete implementation of `NooYawk` from `Maps/EvenNooerYawk`, including the revised overlay class and the new `PopupPanel` class:

```
package com.commonware.android.maps;

import android.app.Activity;
import android.graphics.Canvas;
import android.graphics.Point;
import android.graphics.drawable.Drawable;
import android.os.Bundle;
import android.view.KeyEvent;
import android.view.View;
import android.view.ViewGroup;
import android.widget.LinearLayout;
```

```
import android.widget.RelativeLayout;
import android.widget.TextView;
import android.widget.Toast;
import com.google.android.maps.GeoPoint;
import com.google.android.maps.ItemizedOverlay;
import com.google.android.maps.MapActivity;
import com.google.android.maps.MapController;
import com.google.android.maps.MapView;
import com.google.android.maps.MapView.LayoutParams;
import com.google.android.maps.MyLocationOverlay;
import com.google.android.maps.OverlayItem;
import java.util.ArrayList;
import java.util.List;

public class NooYawk extends MapActivity {
    private MapView map=null;
    private MyLocationOverlay me=null;

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

        map=(MapView)findViewById(R.id.map);

        map.getController().setCenter(getPoint(40.76793169992044,
                                                -73.98180484771729));

        map.getController().setZoom(17);
        map.setBuiltInZoomControls(true);

        Drawable marker=getResources().getDrawable(R.drawable.marker);

        marker.setBounds(0, 0, marker.getIntrinsicWidth(),
                        marker.getIntrinsicHeight());

        map.getOverlays().add(new SitesOverlay(marker));

        me=new MyLocationOverlay(this, map);
        map.getOverlays().add(me);
    }

    @Override
    public void onResume() {
        super.onResume();

        me.enableCompass();
    }

    @Override
    public void onPause() {
        super.onPause();

        me.disableCompass();
    }
}
```

```
@Override
protected boolean isRouteDisplayed() {
    return(false);
}

@Override
public boolean onKeyDown(int keyCode, KeyEvent event) {
    if (keyCode == KeyEvent.KEYCODE_S) {
        map.setSatellite(!map.isSatellite());
        return(true);
    }
    else if (keyCode == KeyEvent.KEYCODE_Z) {
        map.displayZoomControls(true);
        return(true);
    }

    return(super.onKeyDown(keyCode, event));
}

private GeoPoint getPoint(double lat, double lon) {
    return(new GeoPoint((int)(lat*100000.0),
        (int)(lon*100000.0)));
}

private class SitesOverlay extends ItemizedOverlay<OverlayItem> {
    private List<OverlayItem> items=new ArrayList<OverlayItem>();
    private Drawable marker=null;
    private PopupPanel panel=new PopupPanel(R.layout.popup);

    public SitesOverlay(Drawable marker) {
        super(marker);
        this.marker=marker;

        items.add(new OverlayItem(getPoint(40.748963847316034,
            -73.96807193756104),
            "UN", "United Nations"));
        items.add(new OverlayItem(getPoint(40.76866299974387,
            -73.98268461227417),
            "Lincoln Center",
            "Home of Jazz at Lincoln Center"));
        items.add(new OverlayItem(getPoint(40.765136435316755,
            -73.97989511489868),
            "Carnegie Hall",
            "Where you go with practice, practice, practice"));
        items.add(new OverlayItem(getPoint(40.70686417491799,
            -74.01572942733765),
            "The Downtown Club",
            "Original home of the Heisman Trophy"));

        populate();
    }

    @Override
```

```
protected OverlayItem createItem(int i) {
    return(items.get(i));
}

@Override
public void draw(Canvas canvas, MapView mapView,
    boolean shadow) {
    super.draw(canvas, mapView, shadow);

    boundCenterBottom(marker);
}

@Override
protected boolean onTap(int i) {
    OverlayItem item=getItem(i);
    GeoPoint geo=item.getPoint();
    Point pt=map.getProjection().toPixels(geo, null);

    View view=panel.getView();

    ((TextView)view.findViewById(R.id.latitude))
        .setText(String.valueOf(geo.getLatitudeE6()/1000000.0));
    ((TextView)view.findViewById(R.id.longitude))
        .setText(String.valueOf(geo.getLongitudeE6()/1000000.0));
    ((TextView)view.findViewById(R.id.x))
        .setText(String.valueOf(pt.x));
    ((TextView)view.findViewById(R.id.y))
        .setText(String.valueOf(pt.y));

    panel.show(pt.y*2>map.getHeight());

    return(true);
}

@Override
public int size() {
    return(items.size());
}
}

class PopupPanel {
    View popup;
    boolean isVisible=false;

    PopupPanel(int layout) {
        ViewGroup parent=(ViewGroup)map.getParent();

        popup=getLayoutInflater().inflate(layout, parent, false);

        popup.setOnClickListener(new View.OnClickListener() {
            public void onClick(View v) {
                hide();
            }
        });
    }
};
```

```
}  
  
View getView() {  
    return(popup);  
}  
  
void show(boolean alignTop) {  
    RelativeLayout.LayoutParams lp=new RelativeLayout.LayoutParams(  
        RelativeLayout.LayoutParams.WRAP_CONTENT,  
        RelativeLayout.LayoutParams.WRAP_CONTENT  
    );  
  
    if (alignTop) {  
        lp.addRule(RelativeLayout.ALIGN_PARENT_TOP);  
        lp.setMargins(0, 20, 0, 0);  
    }  
    else {  
        lp.addRule(RelativeLayout.ALIGN_PARENT_BOTTOM);  
        lp.setMargins(0, 0, 0, 60);  
    }  
  
    hide();  
  
    ((ViewGroup)map.getParent()).addView(popup, lp);  
    isVisible=true;  
}  
  
void hide() {  
    if (isVisible) {  
        isVisible=false;  
        ((ViewGroup)popup.getParent()).removeView(popup);  
    }  
}  
}
```

The resulting panel looks like this when it is towards the bottom of the screen:

Interactive Maps

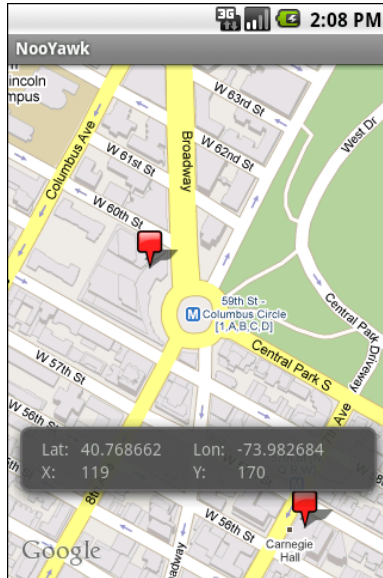


Figure 38. The EvenNooerYawk application, showing the PopupPanel towards the bottom

...and like this when it is towards the top:

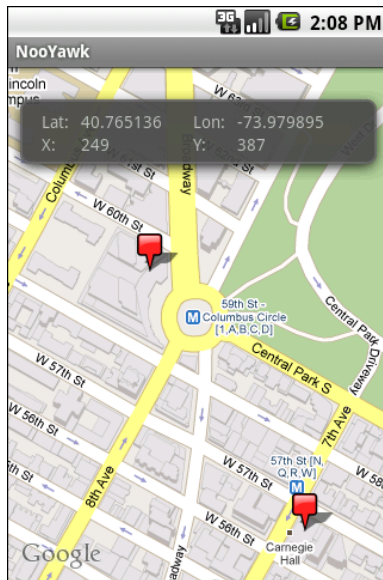


Figure 39. The EvenNooerYawk application, showing the PopupPanel towards the top

Sign, Sign, Everywhere a Sign

Our examples for Manhattan have treated each of the four locations as being the same – they are all represented by the same sort of marker. That is the natural approach to creating an `ItemizedOverlay`, since it takes the marker `Drawable` as a constructor parameter.

It is not the only option, though.

Selected States

One flaw in our current one-`Drawable`-for-everyone approach is that you cannot tell which item was selected by the user, either by tapping on it or by using the D-pad (or trackball or whatever). A simple PNG icon will look the same as it will in every other state.

However, back in the [chapter on Drawable techniques](#), we saw the `StateListDrawable` and its accompanying XML resource format. We can use one of those here, to specify a separate icon for selected and regular states.

In the `Maps/ILuvNooYawk` sample, we change up the icons used for our four `OverlayItem` objects. Specifically, in the next section, we will see how to associate a distinct `Drawable` for each item. Those `Drawable` resources will actually be `StateListDrawable` objects, using XML such as:

```
<selector xmlns:android="http://schemas.android.com/apk/res/android">
  <item
    android:state_selected="true"
    android:drawable="@drawable/blue_sel_marker"
  />
  <item
    android:drawable="@drawable/blue_marker"
  />
</selector>
```

This indicates that we should use one PNG in the default state and a different PNG (one with a yellow highlight) when the `OverlayItem` is selected.

Per-Item Drawables

To use a different `Drawable` per `OverlayItem`, we need to create a custom `OverlayItem` class. Normally, you can skip this, and just use `OverlayItem` directly. But, `OverlayItem` has no means to change its `Drawable` used for the marker, so we have to extend it and override `getMarker()` to handle a custom `Drawable`.

Here is one possible implementation of a `CustomItem` class:

```
class CustomItem extends OverlayItem {
    Drawable marker=null;

    CustomItem(GeoPoint pt, String name, String snippet,
        Drawable marker) {
        super(pt, name, snippet);

        this.marker=marker;
    }

    @Override
    public Drawable getMarker(int stateBitset) {
        setState(marker, stateBitset);

        return(marker);
    }
}
```

This class takes the `Drawable` to use as a constructor parameter, holds onto it, and returns it in the `getMarker()` method. However, in `getMarker()`, we also need to call `setState()` – if we are using `StateListDrawable` resources, the call to `setState()` will cause the `Drawable` to adopt the appropriate state (e.g., selected).

Of course, we need to prep and feed a `Drawable` to each of the `CustomItem` objects. In the case of `ILuvNooYawk`, when our `SitesOverlay` creates its items, it uses a `getMarker()` method to access each item's `Drawable`:

```
private Drawable getMarker(int resource) {
    Drawable marker=getResources().getDrawable(resource);

    marker.setBounds(0, 0, marker.getIntrinsicWidth(),
        marker.getIntrinsicHeight());
    boundCenter(marker);
}
```

```
return(marker);  
}
```

Here, we get the `Drawable` resources, set its bounds (for use with hit testing on taps), and use `boundCenter()` to control the way the shadow falls. For icons like the original push pin used by `NooYawk`, `boundCenterBottom()` will cause the icon and its shadow to make it seem like the icon is rising up off the face of the map. For icons like `ILuvNooYawk` uses, `boundCenter()` will cause the icon and shadow to make it seem like the icon is hovering flat over top of the map.

Changing Drawables Dynamically

It is also possible to change the `Drawable` used by a item at runtime, beyond simply changing it from normal to selected state. For example, `ILuvNooYawk` allows you to press the H key and toggle the selected item from its normal icon to a heart:

```
@Override  
public boolean onKeyDown(int keyCode, KeyEvent event) {  
    if (keyCode == KeyEvent.KEYCODE_S) {  
        map.setSatellite(!map.isSatellite());  
        return(true);  
    }  
    else if (keyCode == KeyEvent.KEYCODE_Z) {  
        map.displayZoomControls(true);  
        return(true);  
    }  
    else if (keyCode == KeyEvent.KEYCODE_H) {  
        sites.toggleHeart();  
  
        return(true);  
    }  
  
    return(super.onKeyDown(keyCode, event));  
}
```

To make this work, our `SitesOverlay` needs to implement `toggleHeart()`:

```
void toggleHeart() {  
    CustomItem focus=getFocus();  
  
    if (focus!=null) {
```

```
        focus.toggleHeart();
    }

    map.invalidate();
}
```

Here, we just find the selected item and delegate `toggleHeart()` to it. This, of course, assumes both that `CustomItem` has a `toggleHeart()` implementation and knows what heart to use.

So, rather than the simple `CustomItem` shown above, we need a more elaborate implementation:

```
class CustomItem extends OverlayItem {
    Drawable marker=null;
    boolean isHeart=false;
    Drawable heart=null;

    CustomItem(GeoPoint pt, String name, String snippet,
               Drawable marker, Drawable heart) {
        super(pt, name, snippet);

        this.marker=marker;
        this.heart=heart;
    }

    @Override
    public Drawable getMarker(int stateBitset) {
        Drawable result=(isHeart ? heart : marker);

        setState(result, stateBitset);

        return(result);
    }

    void toggleHeart() {
        isHeart=!isHeart;
    }
}
```

Here, the `CustomItem` gets its own icon and the heart icon in the constructor, and `toggleHeart()` just toggles between them. The key is that we `invalidate()` the `MapView` in the `SitesOverlay` implementation of `toggleHeart()` – that causes the map, and its overlay items, to be redrawn, causing the icon `Drawable` to change on the screen.

This means that while we start with custom icons per item:

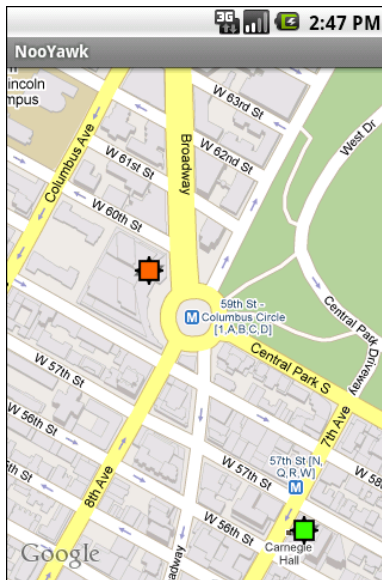


Figure 40. The ILuvNooYawk application, showing custom icons per item

...we can change those by clicking on an item and pressing the H key:

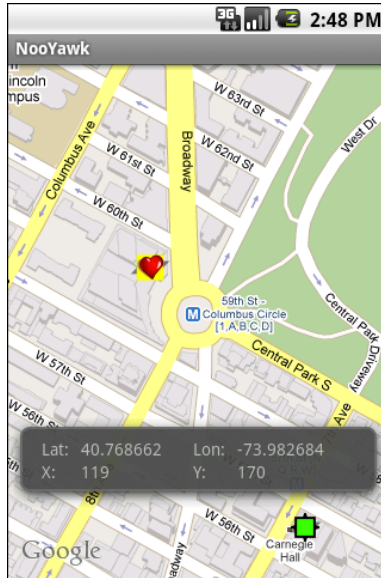


Figure 41. The ILuvNooYawk application, showing one item's icon toggled to a heart (and selected)

In A New York Minute. Or Hopefully a Bit Faster.

In the case of NooYawk, we have all our data points for the overlay items up front – they are hard-wired into the code. This is not going to be the case in most applications. Instead, the application will need to load the items out of a database or a Web service.

In the case of a database, assuming a modest number of items, the difference between having the items hard-wired in code or in the database is slight. Yes, the actual implementation will be substantially different, but you can query the database and build up your `ItemizedOverlay` all in one shot, when the map is slated to appear on-screen.

Where things get interesting is when you need to use a Web service or similar slow operation to get the data.

Where things get even more interesting is when you want that data to change after it was already loaded – on a timer, on user input, etc. For example, it may be that you have hundreds of thousands of data points, only a tiny fraction of which will be visible on the map at any time. If the user elects to visit a different portion of the map, you need to dump the old overlay items and grab a new set.

In either case, you can use an `AsyncTask` to populate your `ItemizedOverlay` and add it to the map once the data is ready. You can see this in `Maps/NooYawkAsync`, where we kick off an `OverlayTask` in the `NooYawk` implementation of `onCreate()`:

```
@Override
public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.main);

    map=(MapView)findViewById(R.id.map);

    map.getController().setCenter(getPoint(40.76793169992044,
                                           -73.98180484771729));

    map.getController().setZoom(17);
    map.setBuiltInZoomControls(true);

    me=new MyLocationOverlay(this, map);
    map.getOverlays().add(me);

    new OverlayTask().execute();
}
```

...and then use that to load the data in the background, in this case using a `sleep()` call to simulate real work:

```
class OverlayTask extends AsyncTask<Void, Void, Void> {
    @Override
    public void onPreExecute() {
        if (sites!=null) {
            map.getOverlays().remove(sites);
            map.invalidate();
            sites=null;
        }
    }

    @Override
    public Void doInBackground(Void... unused) {
        SystemClock.sleep(5000); // simulated work
    }
}
```

```
sites=new SitesOverlay();

return(null);
}

@Override
public void onPostExecute(Void unused) {
    map.getOverlays().add(sites);
    map.invalidate();
}
}
```

As with changing an item's Drawable on the fly, you need to invalidate() the map to make sure it draws the overlay and its items.

In this case, we also hook up the R key to simulate a manual refresh of the data. This just invokes another OverlayTask, which removes the old overlay and creates a fresh one:

```
@Override
public boolean onKeyDown(int keyCode, KeyEvent event) {
    if (keyCode == KeyEvent.KEYCODE_S) {
        map.setSatellite(!map.isSatellite());
        return(true);
    }
    else if (keyCode == KeyEvent.KEYCODE_Z) {
        map.displayZoomControls(true);
        return(true);
    }
    else if (keyCode == KeyEvent.KEYCODE_H) {
        sites.toggleHeart();

        return(true);
    }
    else if (keyCode == KeyEvent.KEYCODE_R) {
        new OverlayTask().execute();

        return(true);
    }

    return(super.onKeyDown(keyCode, event));
}
```

PART II – Advanced Media

Animating Widgets

Android is full of things that move. You can swipe left and right on the home screen to view other panels of the desktop. You can drag icons around on the home screen. You can drag down the notifications area or drag up the applications drawer. And that is just on one screen!

Of course, it would be nice to employ such animations in your own application. While this chapter will not cover full-fledged drag-and-drop, we will cover some of the basic animations and how to apply them to your existing widgets.

After an overview of the role of the **animation** framework, we go in-depth to animate the **movement** of a widget across the screen. We then look at **alpha animations**, for fading widgets in and out. We then see how you can get control during the **lifecycle** of an animation, how to control the **acceleration** of animations, and how to **group** animations together for parallel execution. Finally, we see how the same framework can now be used to control the animation for the switching of **activities**.

It's Not Just For Toons Anymore

Android has a package of classes (`android.view.animation`) dedicated to animating the movement and behavior of widgets.

They center around an `Animation` base class that describes what is to be done. Built-in animations exist to move a widget (`TranslateAnimation`), change the transparency of a widget (`AlphaAnimation`), revolving a widget (`RotateAnimation`), and resizing a widget (`ScaleAnimation`). There is even a way to aggregate animations together into a composite `Animation` called an `AnimationSet`. Later sections in this chapter will examine the use of several of these animations.

Given that you have an animation, to apply it, you have two main options:

- You may be using a container that supports animating its contents, such as a `ViewFlipper` or `TextSwitcher`. These are typically subclasses of `ViewAnimator` and let you define the "in" and "out" animations to apply. For example, with a `ViewFlipper`, you can specify how it flips between views in terms of what animation is used to animate "out" the currently-visible view and what animation is used to animate "in" the replacement view. Examples of this sort of animation can be found in *The Busy Coder's Guide to Android Development*.
- You can simply tell any view to `startAnimation()`, given the `Animation` to apply to itself. This is the technique we will be seeing used in the examples in this chapter.

A Quirky Translation

Animation takes some getting used to. Frequently, it takes a fair bit of experimentation to get it all working as you wish. This is particularly true of `TranslateAnimation`, as not everything about it is intuitive, even to authors of Android books.

Mechanics of Translation

The simple constructor for `TranslateAnimation` takes four parameters describing how the widget should move: the before and after X offsets from the current position, and the before and after Y offsets from the current position. The Android documentation refers to these as `fromXDelta`, `toXDelta`, `fromYDelta`, and `toYDelta`.

In Android's pixel-space, an (x, y) coordinate of $(0, 0)$ represents the upper-left corner of the screen. Hence, if `toXDelta` is greater than `fromXDelta`, the widget will move to the right, if `toYDelta` is greater than `fromYDelta`, the widget will move down, and so on.

Imagining a Sliding Panel

Some Android applications employ a sliding panel, one that is off-screen most of the time but can be called up by the user (e.g., via a menu) when desired. When anchored at the bottom of the screen, the effect is akin to the Android menu system, with a container that slides up from the bottom and slides down and out when being removed. However, while menus are limited to menu choices, Android's animation framework lets one create a sliding panel containing whatever widgets you might want.

One way to implement such a panel is to have a container (e.g., a `LinearLayout`) whose contents are absent (`GONE`) when the panel is closed and is present (`VISIBLE`) when the drawer is open. If we simply toggled `setVisibility()` using the aforementioned values, though, the panel would wink open and closed immediately, without any sort of animation. So, instead, we want to:

- Make the panel visible and animate it up from the bottom of the screen when we open the panel
- Animate it down to the bottom of the screen and make the panel gone when we close the panel

The Aftermath

This brings up a key point with respect to `TranslateAnimation`: the animation temporarily moves the widget, but if you want the widget to stay where it is when the animation is over, you have to handle that yourself. Otherwise, the widget will snap back to its original position when the animation completes.

In the case of the panel opening, we handle that via the transition from `GONE` to `VISIBLE`. Technically speaking, the panel is always "open", in that we are not, in the end, changing its position. But when the body of the panel is `GONE`, it takes up no space on the screen; when we make it `VISIBLE`, it takes up whatever space it is supposed to.

Later in this chapter, we will cover how to use animation listeners to accomplish this end for closing the panel.

Introducing SlidingPanel

With all that said, turn your attention to the `Animation/SlidingPanel` project and, in particular, the `SlidingPanel` class.

This class implements a layout that works as a panel, anchored to the bottom of the screen. A `toggle()` method can be called by the activity to hide or show the panel. The panel itself is a `LinearLayout`, so you can put whatever contents you want in there.

We use two flavors of `TranslateAnimation`, one for opening the panel and one for closing it.

Here is the opening animation:

```
anim=new TranslateAnimation(0.0f, 0.0f,  
                           getLayoutParams().height,  
                           0.0f);
```

Our `fromXDelta` and `toXDelta` are both `0`, since we are not shifting the panel's position along the horizontal axis. Our `fromYDelta` is the panel's height according to its layout parameters (representing how big we want the panel to be), because we want the panel to start the animation at the bottom of the screen; our `toYDelta` is `0` because we want the panel to be at its "natural" open position at the end of the animation.

Conversely, here is the closing animation:

Animating Widgets

```
anim=new TranslateAnimation(0.0f, 0.0f, 0.0f,  
                           getLayoutParams().height);
```

It has the same basic structure, except the Y values are reversed, since we want the panel to start open and animate to a closed position.

The result is a container that can be closed:

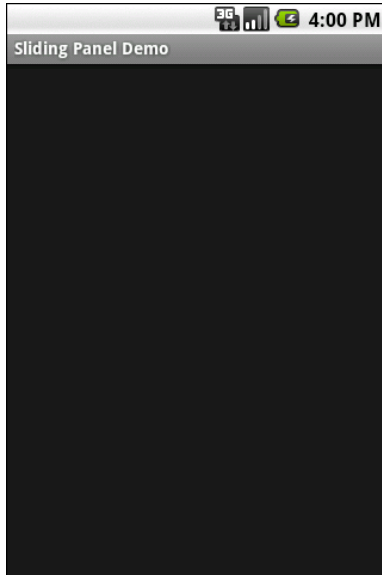


Figure 42. The SlidingPanel sample application, with the panel closed

...or open, in this case toggled via a menu choice in the `SlidingPanelDemo` activity:

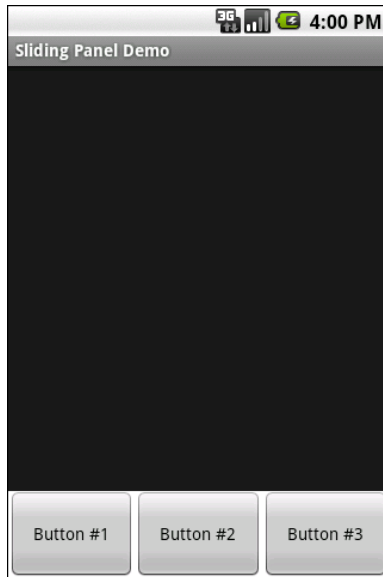


Figure 43. The SlidingPanel sample application, with the panel open

Using the Animation

When setting up an animation, you also need to indicate how long the animation should take. This is done by calling `setDuration()` on the animation, providing the desired length of time in milliseconds.

When we are ready with the animation, we simply call `startAnimation()` on the `SlidingPanel` itself, causing it to move as specified by the `TranslateAnimation` instance.

Fading To Black. Or Some Other Color.

`AlphaAnimation` allows you to fade a widget in or out by making it less or more transparent. The greater the transparency, the more the widget appears to be "fading".

Alpha Numbers

You may be used to alpha channels, when used in #AARRGGBB color notation, or perhaps when working with alpha-capable image formats like PNG.

Similarly, `AlphaAnimation` allows you to change the alpha channel for an entire widget, from fully-solid to fully-transparent.

In Android, a float value of `1.0` indicates a fully-solid widget, while a value of `0.0` indicates a fully-transparent widget. Values in between, of course, represent various amounts of transparency.

Hence, it is common for an `AlphaAnimation` to either start at `1.0` and smoothly change the alpha to `0.0` (a fade) or vice versa.

Animations in XML

With `TranslateAnimation`, we showed how to construct the animation in Java source code. One can also create animation resources, which define the animations using XML. This is similar to the process for defining layouts, albeit much simpler.

For example, there is a second animation project, `Animation/SlidingPanelEx`, which demonstrates a panel that fades out as it is closed. In there, you will find a `res/anim/` directory, which is where animation resources should reside. In there, you will find `fade.xml`:

```
<?xml version="1.0" encoding="utf-8"?>
<alpha xmlns:android="http://schemas.android.com/apk/res/android"
    android:fromAlpha="1.0"
    android:toAlpha="0.0" />
```

The name of the root element indicates the type of animation (in this case, alpha for an `AlphaAnimation`). The attributes specify the characteristics of the animation, in this case a fade from `1.0` to `0.0` on the alpha channel.

This XML is the same as calling `new AlphaAnimation(1.0f, 0.0f)` in Java.

Using XML Animations

To make use of XML-defined animations, you need to inflate them, much as you might inflate a `View` or `Menu` resource. This is accomplished by using the `loadAnimation()` static method on the `AnimationUtils` class:

```
fadeOut=AnimationUtils.loadAnimation(ctxt, R.anim.fade);
```

Here, we are loading our fade animation, given a `Context`. This is being put into an `Animation` variable, so we neither know nor care that this particular XML that we are loading defines an `AlphaAnimation` instead of, say, a `RotateAnimation`.

When It's All Said And Done

Sometimes, you need to take action when an animation completes.

For example, when we close the panel, we want to use a `TranslationAnimation` to slide it down from the open position to closed...then *keep* it closed. With the system used in `SlidingPanel`, keeping the panel closed is a matter of calling `setVisibility()` on the contents with `GONE`.

However, you cannot do that when the animation begins; otherwise, the panel is gone by the time you try to animate its motion.

Instead, you need to arrange to have it be gone when the animation ends. To do that, you use an animation listener.

An animation listener is simply an instance of the `AnimationListener` interface, provided to an animation via `setAnimationListener()`. The listener will be invoked when the animation starts, ends, or repeats (the latter courtesy of `CycleInterpolator`, discussed later in this chapter). You can put logic in the `onAnimationEnd()` callback in the listener to take action when the animation finishes.

For example, here is the `AnimationListener` for `SlidingPanel`:

```
Animation.AnimationListener collapseListener=new Animation.AnimationListener() {
    public void onAnimationEnd(Animation animation) {
        setVisibility(View.GONE);
    }

    public void onAnimationRepeat(Animation animation) {
        // not needed
    }

    public void onAnimationStart(Animation animation) {
        // not needed
    }
};
```

All we do is set the `ImageButton`'s image to be the upward-pointing arrow and setting our content's visibility to be `GONE`, thereby closing the panel.

Loose Fill

You will see attributes, available on `Animation`, named `android:fillEnabled` and `android:fillAfter`. Reading those, you may think that you can dispense with the `AnimationListener` and just use those to arrange to have your widget wind up being "permanently" in the state represented by the end of the animation. All you would have to do is set each of those to true in your animation XML (or the equivalent in Java), and you would be set.

At least for `TranslateAnimation`, you would be mistaken.

It actually will look like it works – the animated widgets will be drawn in their new location. However, if those widgets are clickable, they will not be clicked in their new location, but rather in their old one. This, of course, is not terribly useful.

Hence, even though it is annoying, you will want to use the `AnimationListener` techniques described in this chapter.

Hit The Accelerator

In addition to the `Animation` classes themselves, Android also provides a set of `Interpolator` classes. These provide instructions for how an animation is supposed to behave during its operating period.

For example, the `AccelerateInterpolator` indicates that, during the duration of an animation, the rate of change of the animation should begin slowly and accelerate until the end. When applied to a `TranslateAnimation`, for example, the sliding movement will start out slowly and pick up speed until the movement is complete.

There are several implementations of the `Interpolator` interface besides `AccelerateInterpolator`, including:

- `AccelerateDecelerateInterpolator`, which starts slowly, picks up speed in the middle, and slows down again at the end
- `DecelerateInterpolator`, which starts quickly and slows down towards the end
- `LinearInterpolator`, the default, which indicates the animation should proceed smoothly from start to finish
- `CycleInterpolator`, which repeats an animation for a number of cycles, following the `AccelerateDecelerateInterpolator` pattern (slow, then fast, then slow)

To apply an interpolator to an animation, simply call `setInterpolator()` on the animation with the `Interpolator` instance, such as the following line from `SlidingPanel`:

```
anim.setInterpolator(new AccelerateInterpolator(1.0f));
```

You can also specify one of the stock interpolators via the `android:interpolator` attribute in your animation XML file.

Android 1.6 added some new interpolators. Notable are `BounceInterpolator` (which gives a bouncing effect as the animation nears the end) and

OvershootInterpolator (which goes beyond the end of the animation range, then returns to the endpoint).

Animate. Set. Match.

For the Animation/SlidingPanelEx project, though, we want the panel to slide open, but also fade when it slides closed. This implies two animations working at the same time (a fade and a slide). Android supports this via the AnimationSet class.

An AnimationSet is itself an Animation implementation. Following the composite design pattern, it simply cascades the major Animation events to each of the animations in the set.

To create a set, just create an AnimationSet instance, add the animations, and configure the set. For example, here is the logic from the SlidingPanel implementation in Animation/SlidingPanelEx:

```
public void toggle() {
    TranslateAnimation anim=null;
    AnimationSet set=new AnimationSet(true);

    isOpen=!isOpen;

    if (isOpen) {
        setVisibility(View.VISIBLE);
        anim=new TranslateAnimation(0.0f, 0.0f,
                                   getLayoutParams().height,
                                   0.0f);
    }
    else {
        anim=new TranslateAnimation(0.0f, 0.0f, 0.0f,
                                   getLayoutParams().height);
        anim.setAnimationListener(collapseListener);
        set.addAnimation(fadeOut);
    }

    set.addAnimation(anim);
    set.setDuration(speed);
    set.setInterpolator(new AccelerateInterpolator(1.0f));
    startAnimation(set);
}
```

If the panel is to be opened, we make the contents visible (so we can animate the motion upwards), and create a `TranslateAnimation` for the upward movement. If the panel is to be closed, we create a `TranslateAnimation` for the downward movement, but also add a pre-defined `AlphaAnimation` (`fadeOut`) to an `AnimationSet`. In either case, we add the `TranslateAnimation` to the set, give the set a duration and interpolator, and run the animation.

Active Animations

Starting with Android 1.5, users could indicate if they wanted to have inter-activity animations: a slide-in/slide-out effect as they switched from activity to activity. However, at that time, they could merely toggle this setting on or off, and applications had no control over these animations whatsoever.

Starting in Android 2.0, though, developers have a bit more control. Specifically:

- Developers can call `overridePendingTransition()` on an Activity, typically after calling `startActivity()` to launch another activity or `finish()` to close up the current activity. The `overridePendingTransition()` indicates an in/out animation pair that should be applied as control passes from this activity to the next one, whether that one is being started (`startActivity()`) or is the one previous on the stack (`finish()`).
- Developers can start an activity via an Intent containing the `FLAG_ACTIVITY_NO_ANIMATION` flag. As the name suggests, this flag requests that animations on the transitions involving this activity be suppressed.

These are prioritized as follows:

1. Any call to `overridePendingTransition()` is always taken into account
2. Lacking that, `FLAG_ACTIVITY_NO_ANIMATION` will be taken into account
3. In the normal case, where neither of the two are used, whatever the user's preference, via the Settings application, is applied

Using the Camera

Most Android devices will have a camera, since they are fairly commonplace on mobile devices these days. You, as an Android developer, can take advantage of the camera, for everything from snapping tourist photos to scanning barcodes. For simple operations, the APIs needed to use the camera are fairly straight-forward, requiring a bit of boilerplate code plus your own unique application logic.

What is a problem is using the camera with the emulator. The emulator does not emulate a camera, nor is there a convenient way to pretend there are pictures via DDMS or similar tools. For the purposes of this chapter, it is assumed you have access to an actual Android-powered hardware device and can use it for development purposes.

First, we examine how to set up an activity showing a **preview** of the camera's output, much like the LCD viewfinder on a dedicated digital camera. We then extend that example to actually take and store a **picture**. After a brief discussion of **auto-focus**, we wrap with material on other **parameters** you may be able to set to control the actual picture being taken.

Sneaking a Peek

First, it is fairly common for a camera-using application to support a preview mode, to show the user what the camera sees. This will help make

sure the camera is lined up on the subject properly, whether there is sufficient lighting, etc.

So, let us take a look at how to create an application that shows such a live preview. The code snippets shown in this section are pulled from the Camera/Preview sample project.

The Permission

First, you need permission to use the camera. That way, when end users install your application off of the Internet, they will be notified that you intend to use the camera, so they can determine if they deem that appropriate for your application.

You simply need the CAMERA permission in your AndroidManifest.xml file, along with whatever other permissions your application logic might require. Here is the manifest from the Camera/Preview sample project:

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.commonware.android.camera"
    android:versionCode="1"
    android:versionName="1.0">
    <uses-sdk
        android:minSdkVersion="3"
        android:targetSdkVersion="6"
    />
    <supports-screens
        android:largeScreens="false"
        android:normalScreens="true"
        android:smallScreens="false"
    />
    <uses-feature android:name="android.hardware.camera" />
    <uses-permission android:name="android.permission.CAMERA" />
    <application android:label="@string/app_name">
        <activity android:name=".PreviewDemo"
            android:label="@string/app_name"
            android:configChanges="keyboardHidden|orientation"
            android:screenOrientation="landscape"
            android:theme="@android:style/Theme.NoTitleBar.Fullscreen">
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />
                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
    </application>
</manifest>
```

```
</application>  
</manifest>
```

Also note a few other things about our `PreviewDemo` activity as registered in this manifest:

- We use `android:configChanges = "keyboardHidden|orientation"` to ensure we control what happens when the keyboard is hidden or exposed, rather than have Android rotate the screen for us
- We use `android:screenOrientation = "landscape"` to tell Android we are always in landscape mode. This is necessary because of a bit of a bug in the camera preview logic, such that it works best in landscape mode.
- We use `android:theme = "@android:style/Fullscreen"` to get rid of the title bar and status bar, so the preview is truly full-screen (e.g., 480x320 on a T-Mobile G1).

The Manifest

Starting with Android 1.6, if your application absolutely needs a camera, you can include a `<uses-feature>` element in the `AndroidManifest.xml` file to declare that requirement, alongside your `<uses-permission>` element for the `CAMERA` permission:

```
<uses-feature android:name="android.hardware.camera" />
```

The SurfaceView

Next, you need a layout supporting a `SurfaceView`. `SurfaceView` is used as a raw canvas for displaying all sorts of graphics outside of the realm of your ordinary widgets. In this case, Android knows how to display a live look at what the camera sees on a `SurfaceView`, to serve as a preview pane.

For example, here is a full-screen `SurfaceView` layout as used by the `PreviewDemo` activity:

```
<?xml version="1.0" encoding="utf-8"?>
<android.view.SurfaceView
xmlns:android="http://schemas.android.com/apk/res/android"
    android:id="@+id/preview"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    >
</android.view.SurfaceView>
```

The Camera

The biggest step, of course, is telling Android to use the camera service and tie a camera to the `SurfaceView` to show the actual preview. We will also eventually need the camera service to take real pictures, as will be described in the next section.

There are three major components to getting picture preview working:

1. The `SurfaceView`, as defined in our layout
2. A `SurfaceHolder`, which is a means of controlling behavior of the `SurfaceView`, such as its size, or being notified when the surface changes, such as when the preview is started
3. A `Camera`, obtained from the `open()` static method on the `Camera` class

To wire these together, we first need to:

- Get the `SurfaceHolder` for our `SurfaceView` via `getHolder()`
- Register a `SurfaceHolder.Callback` with the `SurfaceHolder`, so we are notified when the `SurfaceView` is ready or changes
- Tell the `SurfaceView` (via the `SurfaceHolder`) that it has the `SURFACE_TYPE_PUSH_BUFFERS` type (`setType()`) – this indicates something in the system will be updating the `SurfaceView` and providing the bitmap data to display

This gives us a configured `SurfaceView` (shown below), but we still need to tie in the `Camera`.

```
@Override
public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.main);

    preview=(SurfaceView)findViewById(R.id.preview);
    previewHolder=preview.getHolder();
    previewHolder.addCallback(surfaceCallback);
    previewHolder.setType(SurfaceHolder.SURFACE_TYPE_PUSH_BUFFERS);
}
```

A Camera object has a `setPreviewDisplay()` method that takes a `SurfaceHolder` and, as you might expect, arranges for the camera preview to be displayed on the associated `SurfaceView`. However, the `SurfaceView` may not be ready immediately after being changed into `SURFACE_TYPE_PUSH_BUFFERS` mode. So, while the previous setup work could be done in `onCreate()`, you should wait until the `SurfaceHolder.Callback` has its `surfaceCreated()` method called, then register the Camera:

```
public void surfaceCreated(SurfaceHolder holder) {
    camera=Camera.open();

    try {
        camera.setPreviewDisplay(previewHolder);
    }
    catch (Throwable t) {
        Log.e("PreviewDemo-surfaceCallback",
            "Exception in setPreviewDisplay()", t);
        Toast
            .makeText(PreviewDemo.this, t.getMessage(), Toast.LENGTH_LONG)
            .show();
    }
}
```

Next, once the `SurfaceView` is set up and sized by Android, we need to pass configuration data to the Camera, so it knows how big to draw the preview. Since the preview pane is not a fixed size – it might vary based on hardware – we cannot safely pre-determine the size. It is simplest to wait for our `SurfaceHolder.Callback` to have its `surfaceChanged()` method called, when we are told the size of the surface. Then, we can pour that information into a `Camera.Parameters` object, update the Camera with those parameters, and have the Camera show the preview images via `startPreview()`:

```
public void surfaceChanged(SurfaceHolder holder,
    int format, int width,
```

```
        int height) {
    Camera.Parameters parameters=camera.getParameters();

    parameters.setPreviewSize(width, height);
    camera.setParameters(parameters);
    camera.startPreview();
}
```

Eventually, the preview needs to stop. In this particular case, that will be as the activity is being destroyed. It is important to release the Camera at this time – for many devices, there is only one physical camera, so only one activity can be using it at a time. Our `SurfaceHolder.Callback` will be told, via `surfaceDestroyed()`, when it is being closed up, and we can stop the preview (`stopPreview()`), release the camera (`release()`), and let go of it (`camera = null`) at that point:

```
public void surfaceDestroyed(SurfaceHolder holder) {
    camera.stopPreview();
    camera.release();
    camera=null;
}
```

If you compile and run the Camera/Preview sample application, you will see, on-screen, what the camera sees.

Here is the full `SurfaceHolder.Callback` implementation:

```
SurfaceHolder.Callback surfaceCallback=new SurfaceHolder.Callback() {
    public void surfaceCreated(SurfaceHolder holder) {
        camera=Camera.open();

        try {
            camera.setPreviewDisplay(previewHolder);
        }
        catch (Throwable t) {
            Log.e("PreviewDemo-surfaceCallback",
                "Exception in setPreviewDisplay()", t);
            Toast
                .makeText(PreviewDemo.this, t.getMessage(), Toast.LENGTH_LONG)
                .show();
        }
    }

    public void surfaceChanged(SurfaceHolder holder,
        int format, int width,
        int height) {
        Camera.Parameters parameters=camera.getParameters();
```

```
parameters.setPreviewSize(width, height);
camera.setParameters(parameters);
camera.startPreview();
}

public void surfaceDestroyed(SurfaceHolder holder) {
    camera.stopPreview();
    camera.release();
    camera=null;
}
};
```

Image Is Everything

Showing the preview imagery is nice and all, but it is probably more important to actually take a picture now and again. The previews show the user what the camera sees, but we still need to let our application know what the camera sees at particular points in time.

In principle, this is easy. Where things get a bit complicated comes with ensuring the application (and device as a whole) has decent performance, not slowing down to process the pictures.

The code snippets shown in this section are pulled from the `Camera/Picture` sample project, which builds upon the `Camera/Preview` sample shown in the previous section.

Asking for a Format

We need to tell the `Camera` what sort of picture to take when we decide to take a picture. The two options are raw and JPEG.

At least, that is the theory.

In practice, Android devices do not support raw output, only JPEG. So, we need to tell the `Camera` that we want JPEG output.

That is merely a matter of calling `setPictureFormat()` on the `Camera.Parameters` object when we configure our `Camera`, using the value `JPEG` to indicate that we, indeed, want JPEG:

```
public void surfaceChanged(SurfaceHolder holder,
                          int format, int width,
                          int height) {
    Camera.Parameters parameters=camera.getParameters();

    parameters.setPreviewSize(width, height);
    parameters.setPictureFormat(PixelFormat.JPEG);

    camera.setParameters(parameters);
    camera.startPreview();
}
```

Connecting the Camera Button

Somehow, your application will need to indicate when a picture should be taken. That could be via widgets on the UI, though in our samples here, the preview is full-screen.

An alternative is to use the camera hardware button. Like every hardware button other than the Home button, we can find out when the camera button is clicked via `onKeyDown()`:

```
@Override
public boolean onKeyDown(int keyCode, KeyEvent event) {
    if (keyCode==KeyEvent.KEYCODE_CAMERA ||
        keyCode==KeyEvent.KEYCODE_SEARCH) {
        takePicture();

        return(true);
    }

    return(super.onKeyDown(keyCode, event));
}
```

Since the HTC Magic does not have a hardware camera button, we also watch for `KEYCODE_SEARCH` for the dedicated search key, which is in the upper-right portion of the Magic's face when the device is held in landscape mode. You could similarly watch for a D-pad center button click or whatever you wish.

Taking a Picture

Once it is time to take a picture, all you need to do is tell the Camera to `takePicture()`:

The `takePicture()` method takes three parameters, all callback-style objects:

1. A "shutter" callback (`Camera.ShutterCallback`), which is notified when the picture has been captured by the hardware but the data is not yet available – you might use this to play a "camera click" sound
2. Callbacks to receive the image data, either in raw format or JPEG format

Since Android devices presently only support JPEG output, and because we do not want to fuss with a shutter click, `PictureDemo` only passes in the third parameter to `takePicture()`:

```
private void takePicture() {  
    camera.takePicture(null, null, photoCallback);  
}
```

The `Camera.PictureCallback` (`photoCallback`) needs to implement `onPictureTaken()`, which provides the picture data as a `byte[]`, plus the `Camera` object that took the picture. At this point, it is safe to start up the preview again.

Plus, of course, it would be nice to do something with that byte array.

The catch is that the byte array is going to be large. Writing that to flash, or sending it over the network, or doing just about anything with the data, will be slow. Slow is fine...so long as it is not on the UI thread.

That means we need to do a little more work.

Using AsyncTask

In theory, we could just fork a background thread to save off the image data or do whatever it is we wanted done with it. However, we could wind up with several such threads, particularly if we are sending the image over the Internet and do not have a fast connection to our destination server.

Android 1.5 offers a work queue model, in the form of `AsyncTask`. `AsyncTask` manages a thread pool and work queue – all we need to do is hand it the work to be done.

So, we can create an `AsyncTask` implementation, called `SavePhotoTask`, as follows:

```
class SavePhotoTask extends AsyncTask<byte[], String, String> {
    @Override
    protected String doInBackground(byte[]... jpeg) {
        File photo=new File(Environment.getExternalStorageDirectory(),
            "photo.jpg");

        if (photo.exists()) {
            photo.delete();
        }

        try {
            FileOutputStream fos=new FileOutputStream(photo.getPath());

            fos.write(jpeg[0]);
            fos.close();
        }
        catch (java.io.IOException e) {
            Log.e("PictureDemo", "Exception in photoCallback", e);
        }

        return(null);
    }
}
```

Our `doInBackground()` implementation gets the byte array we received from Android. The byte array is simply the JPEG itself, so the data could be written to a file, transformed, sent to a Web service, converted into a `BitmapDrawable` for display on the screen or whatever.

In the case of `PictureDemo`, we take the simple approach of writing the JPEG file as `photo.jpg` in the root of the SD card. The byte array itself will be garbage collected once we are done saving it, so there is no explicit "free" operation we need to do to release that memory.

Finally, we arrange for our `PhotoCallback` to execute our `SavePhotoTask`:

```
Camera.PictureCallback photoCallback=new Camera.PictureCallback() {
    public void onPictureTaken(byte[] data, Camera camera) {
        new SavePhotoTask().execute(data);
        camera.startPreview();
    }
};
```

Maintaining Your Focus

Android devices may support auto-focus. As with the camera itself, auto-focus is a device-specific capability and may not be available on all devices.

If you *need* auto-focus in your application, you will first need to add another `<uses-feature>` element to your manifest, to declare your interest in auto-focus:

```
<uses-feature android:name="android.hardware.camera.autofocus" />
```

Next, you need to determine when to apply auto-focus. For devices with a dedicated camera hardware button, that button might support a "half-press" that raises a `KEYCODE_FOCUS` `KeyEvent`. The T-Mobile G1 offers this, for example.

Then, to trigger auto-focus itself in your code, call `autoFocus()` on the `Camera` object. You will need to supply a callback object that will be notified when the focus operation is complete, so you know it is safe to take a picture, for example. If a device does not support auto-focus, the callback object will be notified anyway, so you can always rely upon the callback being notified when the camera is as focused as it will ever be.

Note that if you can take advantage of auto-focus but do not absolutely need it, there is an `android:required` attribute you can add to your `<uses-feature>` element – setting that to `false` means your application can use auto-focus methods but will still install on devices that lack an auto-focus camera (e.g., HTC Tattoo). Note that `android:required` is not presently documented, though that appears to be a documentation bug. To find out if auto-focus is available on a given device, call `getFocusMode()` on your `Camera.Parameters` object to see if it returns `FOCUS_MODE_FIXED`, in which case auto-focus is unavailable.

All the Bells and Whistles

Starting with Android 2.0, the `Camera.Parameters` object offers a wide range of settings that you can control over how a picture gets taken, much more than merely the size and file type. Settings you can manage include:

- Anti-banding effects
- Color effects (e.g., "negative" or inverse image, sepia-tone image)
- Flash settings (on? off? always on? anti-red-eye mode?)
- Focus mode (fixed? macro? infinity?)
- JPEG quality levels, for both the image and the thumbnail representation of the image
- White balance levels

For all of these, and others, not only can you get the current setting and change it, but you can also obtain a list of the available settings, perhaps to populate a `ListView` or selection dialog for the user.

You can now also supply GPS data to the camera, which will encode that information into the EXIF data of the JPEG image.

Playing Media

Pretty much every phone claiming to be a "smartphone" has the ability to at least play back music, if not video. Even many more ordinary phones are full-fledged MP3 players, in addition to offering ringtones and whatnot.

Not surprisingly, Android has multimedia support for you, as a developer, to build your own games, media players, and so on.

This chapter is focused on audio and video playback; other chapters will tackle media input, including the camera and audio recording.

Get Your Media On

In Android, you have five different places you can pull media clips from – one of these will hopefully fit your needs:

1. You can package media clips as raw resources (`res/raw` in your project), so they are bundled with your application. The benefit is that you're guaranteed the clips will be there; the downside is that they cannot be replaced without upgrading the application.
2. You can package media clips as assets (`assets/` in your project) and reference them via `file:///android_asset/` URLs in a `Uri`. The benefit over raw resources is that this location works with APIs that expect `Uri` parameters instead of resource IDs. The downside –

assets are only replaceable when the application is upgraded – remains.

3. You can store media in an application-local directory, such as content you download off the Internet. Your media may or may not be there, and your storage space isn't infinite, but you can replace the media as needed.
4. You can store media – or make use of media that the user has stored herself – that is on an SD card. There is likely more storage space on the card than there is on the device, and you can replace the media as needed, but other applications have access to the SD card as well.
5. You can, in some cases, stream media off the Internet, bypassing any local storage, as with the **StreamFurious** application

For the T-Mobile G1, the recommended approach for anything of significant size is to put it on the SD card, as there is very little on-board flash memory for file storage.

Making Noise

If you want to play back music, particularly material in MP3 format, you will want to use the `MediaPlayer` class. With it, you can feed it an audio clip, start/stop/pause playback, and get notified on key events, such as when the clip is ready to be played or is done playing.

You have three ways to set up a `MediaPlayer` and tell it what audio clip to play:

1. If the clip is a raw resource, use `MediaPlayer.create()` and provide the resource ID of the clip
2. If you have a `Uri` to the clip, use the `Uri`-flavored version of `MediaPlayer.create()`
3. If you have a string path to the clip, just create a `MediaPlayer` using the default constructor, then call `setDataSource()` with the path to the clip

Next, you need to call `prepare()` or `prepareAsync()`. Both will set up the clip to be ready to play, such as fetching the first few seconds off the file or stream. The `prepare()` method is synchronous; as soon as it returns, the clip is ready to play. The `prepareAsync()` method is asynchronous – more on how to use this version later.

Once the clip is prepared, `start()` begins playback, `pause()` pauses playback (with `start()` picking up playback where `pause()` paused), and `stop()` ends playback. One caveat: you cannot simply call `start()` again on the `MediaPlayer` once you have called `stop()` – we'll cover a workaround a bit later in this section.

To see this in action, take a look at the `Media/Audio` sample project. The layout is pretty trivial, with three buttons and labels for play, pause, and stop:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    >
    <LinearLayout
        android:orientation="horizontal"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:padding="4px"
    >
        <ImageButton android:id="@+id/play"
            android:src="@drawable/play"
            android:layout_height="wrap_content"
            android:layout_width="wrap_content"
            android:paddingRight="4px"
            android:enabled="false"
        />
        <TextView
            android:text="Play"
            android:layout_width="fill_parent"
            android:layout_height="fill_parent"
            android:gravity="center_vertical"
            android:layout_gravity="center_vertical"
            android:textAppearance="?android:attr/textAppearanceLarge"
        />
    </LinearLayout>
    <LinearLayout
        android:orientation="horizontal"
        android:layout_width="fill_parent"
```

```
        android:layout_height="wrap_content"
        android:padding="4px"
    >
    <ImageButton android:id="@+id/pause"
        android:src="@drawable/pause"
        android:layout_height="wrap_content"
        android:layout_width="wrap_content"
        android:paddingRight="4px"
    />
    <TextView
        android:text="Pause"
        android:layout_width="fill_parent"
        android:layout_height="fill_parent"
        android:gravity="center_vertical"
        android:layout_gravity="center_vertical"
        android:textAppearance="?android:attr/textAppearanceLarge"
    />
</LinearLayout>
<LinearLayout
    android:orientation="horizontal"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:padding="4px"
>
    <ImageButton android:id="@+id/stop"
        android:src="@drawable/stop"
        android:layout_height="wrap_content"
        android:layout_width="wrap_content"
        android:paddingRight="4px"
    />
    <TextView
        android:text="Stop"
        android:layout_width="fill_parent"
        android:layout_height="fill_parent"
        android:gravity="center_vertical"
        android:layout_gravity="center_vertical"
        android:textAppearance="?android:attr/textAppearanceLarge"
    />
</LinearLayout>
</LinearLayout>
```

The Java, of course, is where things get interesting:

```
public class AudioDemo extends Activity
    implements MediaPlayer.OnCompletionListener {

    private ImageButton play;
    private ImageButton pause;
    private ImageButton stop;
    private MediaPlayer mp;

    @Override
    public void onCreate(Bundle icle) {
```

```
super.onCreate( savedInstanceState );
setContentView(R.layout.main);

play=(ImageButton)findViewById(R.id.play);
pause=(ImageButton)findViewById(R.id.pause);
stop=(ImageButton)findViewById(R.id.stop);

play.setOnClickListener(new View.OnClickListener() {
    public void onClick(View view) {
        play();
    }
});

pause.setOnClickListener(new View.OnClickListener() {
    public void onClick(View view) {
        pause();
    }
});

stop.setOnClickListener(new View.OnClickListener() {
    public void onClick(View view) {
        stop();
    }
});

setup();
}

@Override
public void onDestroy() {
    super.onDestroy();

    if (stop.isEnabled()) {
        stop();
    }
}

public void onCompletion(MediaPlayer mp) {
    stop();
}

private void play() {
    mp.start();

    play.setEnabled(false);
    pause.setEnabled(true);
    stop.setEnabled(true);
}

private void stop() {
    mp.stop();
    play.setEnabled(true);
    pause.setEnabled(false);
    stop.setEnabled(false);
}
```

```
try {
    mp.prepare();
    mp.seekTo(0);
    play.setEnabled(true);
}
catch (Throwable t) {
    goBlooley(t);
}
}

private void pause() {
    mp.pause();

    play.setEnabled(true);
    pause.setEnabled(false);
    stop.setEnabled(true);
}

private void loadClip() {
    try {
        mp=MediaPlayer.create(this, R.raw.clip);
        mp.setOnCompletionListener(this);
    }
    catch (Throwable t) {
        goBlooley(t);
    }
}

private void setup() {
    loadClip();
    play.setEnabled(true);
    pause.setEnabled(false);
    stop.setEnabled(false);
}

private void goBlooley(Throwable t) {
    AlertDialog.Builder builder=new AlertDialog.Builder(this);

    builder
        .setTitle("Exception!")
        .setMessage(t.toString())
        .setPositiveButton("OK", null)
        .show();
}
}
```

In `onCreate()`, we wire up the three buttons to appropriate callbacks, then call `setup()`. In `setup()`, we create our `MediaPlayer`, set to play a clip we package in the project as a raw resource. We also configure the activity itself as the completion listener, so we find out when the clip is over. Note that, since we use the static `create()` method on `MediaPlayer`, we have

already implicitly called `prepare()`, so we do not need to call that separately ourselves.

The buttons simply work the `MediaPlayer` and toggle each others' states, via appropriately-named callbacks. So, `play()` starts `MediaPlayer` playback, `pause()` pauses playback, and `stop()` stops playback and resets our `MediaPlayer` to play again. The `stop()` callback is also used for when the audio clip completes of its own accord.

To reset the `MediaPlayer`, the `stop()` callback calls `prepare()` on the existing `MediaPlayer` to enable it to be played again and `seekTo()` to move the playback point to the beginning. If we were using an external file as our media source, it would be better to call `prepareAsync()`.

The UI is nothing special, but we are more interested in the audio in this sample, anyway:



Figure 44. The `AudioDemo` sample application

Moving Pictures

In addition to perhaps using `MediaPlayer`, video clips get their own widget, the `VideoView`. Put it in a layout, feed it an MP4 video clip, and you get playback! We will see using `MediaPlayer` for video in the next section.

For example, take a look at this layout, from the `Media/Video` sample project:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    >
    <VideoView
        android:id="@+id/video"
        android:layout_width="fill_parent"
        android:layout_height="fill_parent"
    />
</LinearLayout>
```

The layout is simply a full-screen video player. Whether it will use the full screen will be dependent on the video clip, its aspect ratio, and whether you have the device (or emulator) in portrait or landscape mode.

Wiring up the Java is almost as simple:

```
public class VideoDemo extends Activity {
    private VideoView video;
    private MediaController ctrlr;

    @Override
    public void onCreate(Bundle icle) {
        super.onCreate(icle);
        getWindow().setFormat(PixelFormat.TRANSLUCENT);
        setContentView(R.layout.main);

        File clip=new File(Environment.getExternalStorageDirectory(),
            "test.mp4");

        if (clip.exists()) {
            video=(VideoView)findViewById(R.id.video);
            video.setVideoPath(clip.getAbsolutePath());

            ctrlr=new MediaController(this);
```

```
ctrl.setMediaPlayer(video);
video.setMediaController(ctrl);
video.requestFocus();
    }
}
}
```

The biggest trick with `VideoView` is getting a video clip onto the device. While `VideoView` does support some streaming video, the requirements on the MP4 file are fairly stringent. If you want to be able to play a wider array of video clips, you need to have them on the device, preferably on an SD card.

The crude `VideoDemo` class assumes there is an MP4 file in `/sdcard/test.mp4` on your emulator. To make this a reality:

1. Find a clip, such as Aaron Rosenberg's *Documentaries and You* from Duke University's Center for the Study of the Public Domain's [Moving Image Contest](#), which was used in the creation of this book
2. Use `mksdcard` (in the Android SDK's tools directory) to create a suitably-sized SD card image (e.g., `mksdcard 128M sd.img`)
3. Use the `-sdcard` switch when launching the emulator, providing the path to your SD card image, so the SD card is "mounted" when the emulator starts
4. Use the `adb push` command (or DDMS or the equivalent in your IDE) to copy the MP4 file into `/sdcard/test.mp4`

Once there, the Java code shown above will give you a working video player:

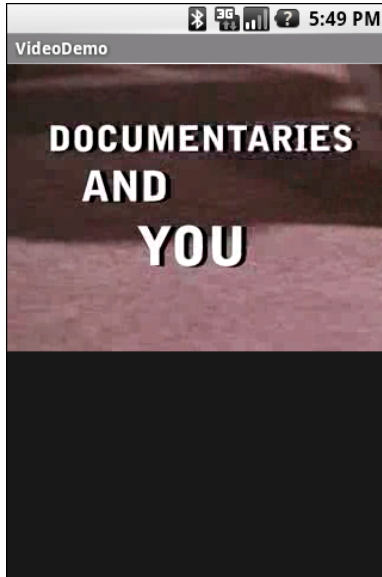


Figure 45. The VideoDemo sample application, showing a Creative Commons-licensed video clip

Tapping on the video will pop up the playback controls:



Figure 46. The VideoDemo sample application, with the media controls displayed

The video will scale based on space, as shown in this rotated view of the emulator (<Ctrl>-<F12>):

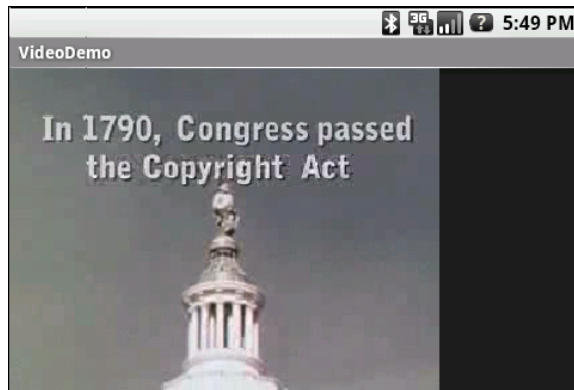


Figure 47. The VideoDemo sample application, in landscape mode, with the video clip scaled to fit

Note that playback may be rather jerky in the emulator, depending on the power of the PC that is hosting the emulator. For example, on a Pentium-M 1.6GHz PC, playback in the emulator is extremely jerky when it works at all, while playback on the T-Mobile G1 is very smooth.

Pictures in the Stream

VideoView is nice, but you get a bit more control if you use MediaPlayer. It is somewhat more involved to set up, though, in part because it involves a SurfaceView, introduced in the chapter on the camera.

The sample code for this project is released as a separate open source project, called vidtry, as it allows you to try video clips, with an emphasis on streaming video. You can find the complete source code to vidtry out on [Github](#). You may want to have the full source code with you when reviewing this section, as it is a bit more extensive than most.

NOTE: playing video on the Android emulator may work for you, but it is not terribly likely. Video playback requires graphic acceleration to work well, and the emulator does not have graphics acceleration – regardless of

the capabilities of the actual machine the emulator runs on. Hence, if you try playing back video in the emulator, expect problems. If you are serious about doing Android development with video playback, you definitely need to acquire a piece of Android hardware.

At its core, vidtry simply plays back video, much like the example of `VideoView` in the preceding section:

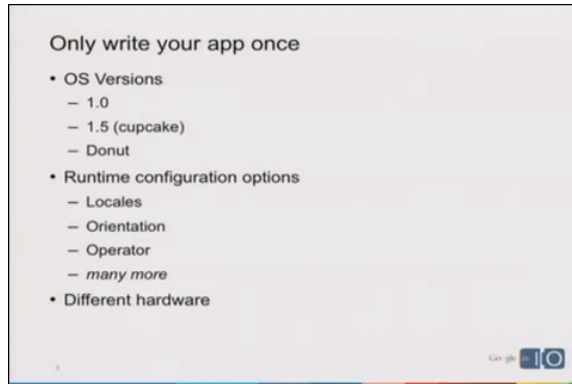


Figure 48. The vidtry sample application, showing a video from the 2009 Google I/O Conference

However, vidtry also supports streaming video and custom pop-up control panels:

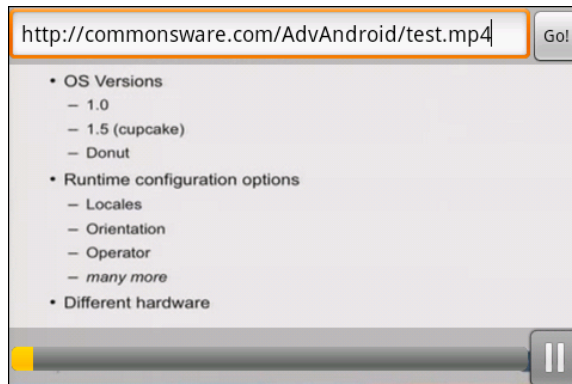


Figure 49. The vidtry sample application, showing pop-up panels overlaying the video

Rules for Streaming

Streaming video with Android is a dicey proposition. If you are in control of the media being streamed, getting it to work is eminently possible. If you are trying to stream existing media not designed for use with Android, as they say in the United States, "your mileage may vary".

This section focuses on HTTP streaming, as that is what most people would be in position to serve up. RTSP streaming should also be available, but there are far fewer RTSP servers than Web servers.

Here are some guidelines for serving HTTP streaming video to Android:

1. The media in question needs to be "safe for streaming". For MP4 files, for example, the rule is "the moov atom must appear before the mdat atom". That may happen as a result of how you create the MP4 files. If not, you may need to use tools to add "hints" to the MP4 file to achieve this atom ordering. For example, on Linux, you can use `MP4Box -hint` to accomplish this, where `MP4Box` can be found in the `gpac` package for Ubuntu.
2. There used to be a rule that the height and width each had to be divisible by 16. It is unclear if that is still a rule or merely an optimization at this point.
3. If you have the space to store multiple editions of the video for serving, consider creating ones for commonplace sizes, such as one designed to work on a 480x320 landscape screen. The less work the device has to do to scale the image, the better battery life will be.

Establishing the Surface

Setting up a `SurfaceView` for video playback works much the same way as setting up a `SurfaceView` for the camera preview. You create the `SurfaceView` and get its corresponding `SurfaceHolder`, then start using the surface once the surface has been prepared.

For example, here is where we set up a `SurfaceView` in `vidtry`, in the `Player` activity's `onCreate()` method:

```
surface=(TappableSurfaceView)findViewById(R.id.surface);
surface.addTapListener(onTap);
holder=surface.getHolder();
holder.addCallback(this);
holder.setType(SurfaceHolder.SURFACE_TYPE_PUSH_BUFFERS);
```

Note that we are using a `TappableSurfaceView`. This is a custom subclass of `SurfaceView` that supports touch events – more on this in a later section. Outside of touch behavior, though, `TappableSurfaceView` works identically to a regular `SurfaceView`.

So, we get the surface out of our layout, add a listener for touch events, get its `SurfaceHolder`, tell the `SurfaceHolder` to keep the `Player` informed of the surface's own lifecycle, and set the type of the surface to be `SURFACE_TYPE_PUSH_BUFFERS` (meaning lower level code gets to write directly to the surface). That, plus the regular view creation process, will trigger the `SurfaceView` to be constructed and made available for use.

Floating Panels

The `SurfaceView` is set up to take up whatever space it needs to play back the video. Typically, this will involve filling one of the two axes, depending on the aspect ratio of the video and the device's display.

Full-screen video playback is fairly normal for an application like this. However, what may not be obvious is how to handle pop-up control panels, where controls for pausing playback and such appear to float over top of the video.

There are three components of the technique for making that work:

1. In layouts, anything later in the container (e.g., later in the XML listing of the layout file) appears higher in the Z-axis. That means if you define the `SurfaceView` first, and other widgets later, those other widgets will appear to float over top of the video.

2. Since you control the visibility of any widget, you can arrange to have those floating widgets be invisible (or gone) normally, and only show up when the user requests, perhaps as a result of a screen tap.
3. If you have several controls that you want grouped in a translucent panel, just put them in one container (e.g., `RelativeLayout`) and set the background color of that container to be a translucent value (e.g., `#40808080` for a translucent light gray).

For example, here is the layout that drives the `Player` activity (`res/layout/main.xml`):

```
<?xml version="1.0" encoding="utf-8"?>
<FrameLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent">
    <com.commonware.android.vidtry.TappableSurfaceView
        android:id="@+id/surface"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_gravity="center">
    </com.commonware.android.vidtry.TappableSurfaceView>
    <RelativeLayout
        android:layout_width="fill_parent"
        android:layout_height="fill_parent"
    >
        <LinearLayout
            android:id="@+id/top_panel"
            android:layout_width="fill_parent"
            android:layout_height="wrap_content"
            android:orientation="horizontal"
            android:background="#40808080"
            android:visibility="visible"
            android:layout_alignParentTop="true"
        >
            <AutoCompleteTextView android:id="@+id/address"
                android:layout_width="0px"
                android:layout_weight="1"
                android:layout_height="wrap_content"
                android:completionThreshold="1"
            />
            <Button android:id="@+id/go"
                android:layout_width="wrap_content"
                android:layout_height="wrap_content"
                android:text="@string/go"
                android:enabled="false"
            />
        </LinearLayout>
    </RelativeLayout>
</LinearLayout>
```

```
        android:id="@+id/bottom_panel"
        android:layout_height="wrap_content"
        android:layout_width="fill_parent"
        android:orientation="horizontal"
        android:background="#40808080"
        android:visibility="gone"
        android:layout_alignParentBottom="true"
    >
    <ProgressBar android:id="@+id/timeline"
        style="?attr/progressBarStyleHorizontal"
        android:layout_width="0px"
        android:layout_weight="1"
        android:layout_height="wrap_content"
        android:layout_gravity="center"
        android:paddingLeft="2px"
    />
    <ImageButton android:id="@+id/media"
        style="@style/MediaButton"
        android:layout_height="wrap_content"
        android:layout_width="wrap_content"
        android:src="@drawable/ic_media_pause"
        android:enabled="false"
    />
</LinearLayout>
</RelativeLayout>
</FrameLayout>
```

You will see that, in addition to our `TappableSurfaceView`, the layout has a pair of `LinearLayout` widgets with the aforementioned background color. One, on the top, contains an `AutoCompleteTextView` to be used for entering URLs of videos to watch, plus a button to trigger playback of that video. The other contains a `ProgressBar` that will serve as the video playback timeline, plus a button to pause or resume playback. The bottom panel is set to have `android:visibility = "gone"`, so only the top panel will be visible when you first run the application.

Playing Video

When the user types in a URL and clicks the "go" button, we call `playVideo()` on our `Player`:

```
private void playVideo(String url) {
    try {
        media.setEnabled(false);

        if (player==null) {
```

```
        player=new MediaPlayer();
        player.setScreenOnWhilePlaying(true);
    }
    else {
        player.stop();
        player.reset();
    }

    player.setDataSource(url);
    player.setDisplay(holder);
    player.setAudioStreamType(AudioManager.STREAM_MUSIC);
    player.setOnPreparedListener(this);
    player.prepareAsync();
//    player.setOnBufferingUpdateListener(this);
    player.setOnCompletionListener(this);
}
catch (Throwable t) {
    Log.e(TAG, "Exception in media prep", t);
    goBlooey(t);
}
}
```

Here, we do several things of significance:

- We either create a new `MediaPlayer` (if this is the first video we have played) or `stop()` and `reset()` the existing player
- We tell the `MediaPlayer` to load the user-supplied URL into our `SurfaceView` (via its `SurfaceHolder`)
- We tell the `MediaPlayer` to let us know when the video is prepared and has finished playback
- We tell the `MediaPlayer` to `prepareAsync()`, which will begin streaming down the initial portion of the video file

Note that we also call `setScreenOnWhilePlaying()` – this will keep the screen lock from taking over while video is actually playing back.

After a few moments, `MediaPlayer` should have downloaded enough information to begin actually playing the video. At that point, it will call us back via the `onPrepared()` in the `Player`, as is required by the `MediaPlayer.OnPreparedListener` interface we are implementing and used in `setOnPreparedListener()`.

```
public void onPrepared(MediaPlayer mediaPlayer) {
    width=player.getVideoWidth();
    height=player.getVideoHeight();

    if (width!=0 && height!=0) {
        holder.setFixedSize(width, height);
        timeline.setProgress(0);
        timeline.setMax(player.getDuration());
        player.start();
    }

    media.setEnabled(true);
}
```

Here, we:

- Get the height and width of the video file from the `MediaPlayer`
- Tell the `SurfaceView` to use the same height and width – it will automatically determine appropriate scaling if the video is larger than the screen size
- Reset the timeline `ProgressBar` to 0 and set its maximum to be the duration of the video clip, as reported by the `MediaPlayer`
- Start actual playback of the video

Note that Android is very finicky about its streaming video. A video that might work fine on one device will not work well on another. If you are going to be developing applications that rely upon streaming video, it is best if you obtain 2-3 devices, with different screen sizes and from different manufacturers, and test your videos on those devices to ensure they will work.

Touchable Controls

We still have not done much about those two panels. One, containing the URL field and button, is still visible. The other, containing the timeline and play/pause button, is gone. It would be nice if both would be gone while the video is playing, yet still be retrievable when the user wants them.

The panels are set to "automatically" hide after a period of inactivity. That is accomplished by:

- Tracking the `lastActionTime` on any user input event (`lastActionTime = SystemClock.elapsedRealtime()`), so we know when the user last did something
- Use `postDelayed()` to set up a one-per-second check to see if enough time has elapsed since `lastActionTime`, at which point bottom panel is hidden
- The back button is used to close the top panel, when it is displayed

Bringing the panels up again is handled via touch events on our `SurfaceView`, implemented in a `TappableSurfaceView` class:

```
package com.commonware.android.vidtry;

import android.content.Context;
import android.view.GestureDetector;
import android.view.GestureDetector.SimpleOnGestureListener;
import android.view.MotionEvent;
import android.view.SurfaceView;
import android.util.AttributeSet;
import java.util.ArrayList;

public class TappableSurfaceView extends SurfaceView {
    private ArrayList<TapListener> listeners=new ArrayList<TapListener>();
    private GestureDetector gesture=null;

    public TappableSurfaceView(Context context,
                               AttributeSet attrs) {
        super(context, attrs);
    }

    public boolean onTouchEvent(MotionEvent event) {
        if (event.getAction()==MotionEvent.ACTION_UP) {
            gestureListener.onSingleTapUp(event);
        }

        return(true);
    }

    public void addTapListener(TapListener l) {
        listeners.add(l);
    }

    public void removeTapListener(TapListener l) {
        listeners.remove(l);
    }

    private GestureDetector.SimpleOnGestureListener gestureListener=
        new GestureDetector.SimpleOnGestureListener() {
```

```
@Override
public boolean onSingleTapUp(MotionEvent e) {
    for (TapListener l : listeners) {
        l.onTap(e);
    }

    return(true);
}
};

public interface TapListener {
    void onTap(MotionEvent event);
}
}
```

This crude touch interface watches for single taps on the screen, relaying those to a roster of supplied "tap listeners", which will do something on those taps.

The `Player` activity registers an `onTap` listener that displays either the top or bottom panel depending on which half of the screen the user tapped upon:

```
private TappableSurfaceView.TapListener onTap=
    new TappableSurfaceView.TapListener() {
        public void onTap(MotionEvent event) {
            lastActionTime=SystemClock.elapsedRealtime();

            if (event.getY()<surface.getHeight()/2) {
                topPanel.setVisibility(View.VISIBLE);
            }
            else {
                bottomPanel.setVisibility(View.VISIBLE);
            }
        }
    };
```

More coverage of touch interfaces will be added in another chapter in a future edition of this book.

The same once-a-second `postDelayed()` loop also updates our timeline, reflecting how much of the video has been played back:

```
private Runnable onEverySecond=new Runnable() {
    public void run() {
        if (lastActionTime>0 &&
            SystemClock.elapsedRealtime()-lastActionTime>3000) {
```

```
clearPanels(false);
}

if (player!=null) {
    timeline.setProgress(player.getCurrentPosition());
}

if (!isPaused) {
    surface.postDelayed(onEverySecond, 1000);
}
}
};
```

Other Ways to Make Noise

While `MediaPlayer` is the primary audio playback option, particularly for content along the lines of MP3 files, there are other alternatives if you are looking to build other sorts of applications, notably games and custom forms of streaming audio.

SoundPool

The `SoundPool` class's claim to fame is the ability to overlay multiple sounds, and do so in a prioritized fashion, so your application can just ask for sounds to be played and `SoundPool` deals with each sound starting, stopping, and blending while playing.

This may make more sense with an example.

Suppose you are creating a first-person shooter. Such a game may have several sounds going on at any one time:

- The sound of the wind whistling amongst the trees on the battlefield
- The sound of the surf crashing against the beach in the landing zone
- The sound of booted feet crunching on the sand
- The sound of the character's own panting as the character runs on the beach

- The sound of orders being barked by a sergeant positioned behind the character
- The sound of machine gun fire aimed at the character and the character's squad mates
- The sound of explosions from the gun batteries of the battleship providing suppression fire

And so on.

In principle, `SoundPool` can blend all of those together into a single audio stream for output. Your game might set up the wind and surf as constant background sounds, toggle the feet and panting on and off based on the character's movement, randomly add the barked orders, and tie the gunfire based on actual game play.

In reality, your average smartphone will lack the CPU power to handle all of that audio without harming the frame rate of the game. So, to keep the frame rate up, you tell `SoundPool` to play at most two streams at once. This means that when nothing else is happening in the game, you will hear the wind and surf, but during the actual battle, those sounds get dropped out – the user might never even miss them – so the game speed remains good.

AudioTrack

The lowest-level Java API for playing back audio is `AudioTrack`. It has two main roles:

- Its primary role is to support streaming audio, where the streams come in some format other than what `MediaPlayer` handles. While `MediaPlayer` can handle RTSP, for example, it does not offer SIP. If you want to create a SIP client (perhaps for a VOIP or Web conferencing application), you will need to convert the incoming data stream to PCM format, then hand the stream off to an `AudioTrack` instance for playback.
- It can also be used for "static" (versus streamed) bits of sound that you have pre-decoded to PCM format and want to play back with as

little latency as possible. For example, you might use this for a game for in-game sounds (beeps, bullets, or "boing"s). By pre-decoding the data to PCM and caching that result, then using `AudioTrack` for playback, you will use the least amount of overhead, minimizing CPU impact on game play and on battery life.

ToneGenerator

If you want your phone to sound like...well...a phone, you can use `ToneGenerator` to have it play back **dual-tone multi-frequency** (DTMF) tones. In other words, you can simulate the sounds played by a regular "touch-tone" phone in response to button presses. This is used by the Android dialer, for example, to play back the tones when users dial the phone using the on-screen keypad, as an audio reinforcement.

Note that these will play through the phone's earpiece, speaker, or attached headset. They do not play through the outbound call stream. In principle, you might be able to get `ToneGenerator` to play tones through the speaker loud enough to be picked up by the microphone, but this probably is not a recommended practice.

PART III – Advanced System

The Contacts Content Provider

One of the more popular stores of data on your average Android device is the contact list. This is particularly true with Android 2.0 and newer versions, which track contacts across multiple different "accounts", or sources of contacts. Some may come from your Google account, while others might come from Exchange or other services.

This chapter will walk you through some of the basics for accessing the contacts on the device. Along the way, we will revisit and expand upon our knowledge of using a `ContentProvider`.

First, we will review the `contacts APIs`, past and present. We will then demonstrate how you can connect to the contacts engine to let users `pick and view contacts`...all without your application needing to know much of how contacts work. We will then show how you can `query` the contacts provider to obtain contacts and some of their details, like email addresses and phone numbers. We wrap by showing how you can invoke a built-in activity to let the user `add a new contact`, possibly including some data supplied by your application.

Introducing You to Your Contacts

Android makes contacts available to you via a complex `ContentProvider` framework, so you can access many facets of a contact's data – not just their name, but addresses, phone numbers, groups, etc. Working with the

contacts `ContentProvider` set is simple...only if you have an established pattern to work with. Otherwise, it may prove somewhat daunting.

ContentProvider Recap

As you may recall from *The Busy Coder's Guide to Android Development* (or other Android programming books), a `ContentProvider` is an abstraction around a data source. Consumers of a `ContentProvider` can use a `ContentResolver` to query, insert, update, or delete data, or use `managedQuery()` on an `Activity` to do a query. In the latter case, the resulting `Cursor` is managed, meaning that it will be deactivated when the activity is stopped, requered when the activity is later restarted, and closed when the activity is destroyed.

Content providers use a "projection" to describe the columns to work with. One `ContentProvider` may expose many facets of data, which you can think of as being tables. However, bear in mind that content providers do not necessarily have to store their content in `SQLite`, so you will need to consult the documentation for the content provider to determine query language syntax, transaction support, and the like.

Organizational Structure

The contacts `ContentProvider` framework can be found as the set of `ContactsContract` classes and interfaces in the `android.provider` package. Unfortunately, there is a dizzying array of inner classes to `ContactsContract`.

Contacts can be broken down into two types: raw and aggregate. Raw contacts come from a sync provider or are hand-entered by a user. Aggregate contacts represent the sum of information about an individual culled from various raw contacts. For example, if your Exchange sync provider has a contact with an email address of `jdoe@foo.com`, and your Facebook sync provider has a contact with an email address of `jdoe@foo.com`, Android may recognize that those two raw contacts represent the same person and therefore combine those in the aggregate contact for the user.

The classes relating to raw contacts usually have `Raw` somewhere in their name, and these normally would be used only by custom sync providers.

The `ContactsContract.Contacts` and `ContactsContract.Data` classes represent the "entry points" for the `ContentProvider`, allowing you to query and obtain information on a wide range of different pieces of information. What is retrievable from these can be found in the various `ContactsContract.CommonDataKinds` series of classes. We will see examples of these operations later in this chapter.

A Look Back at Android 1.6

Prior to Android 2.0, Android had no contact synchronization built in. As a result, all contacts were in one large pool, whether they were hand-entered by users or were added via third-party applications. The API used for this is the `Contacts ContentProvider`.

In principle, the `Contacts ContentProvider` should still work, as it is merely deprecated in Android 2.0.1, not removed. In practice, you may encounter some issues, since the emulator may not have the same roster of synchronization providers as does a device, and so there may be differences in behavior.

Pick a Peck of Pickled People

Let's start by finding a contact. After all, that's what the contacts system is for.

Contacts, like anything stored in a `ContentProvider`, is identified by a `Uri`. Hence, we need a `Uri` we can use in the short term, perhaps to read some data, or perhaps just to open up the contact detail activity for the user.

We could ask for a raw contact, or we could ask for an aggregate contact. Since most consumers of the `contacts ContentProvider` will want the aggregate contact, we will use that.

For example, take a look at `Contacts/Pick` in the sample applications, as this shows how to pick a contact from a collection of contacts, then display the contact detail activity. This application gives you a really big “Gimme!” button, which when clicked will launch the contact-selection logic:

```
<?xml version="1.0" encoding="utf-8"?>
<Button xmlns:android="http://schemas.android.com/apk/res/android"
    android:id="@+id/pick"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:text="Gimme a contact!"
    android:layout_weight="1"
/>
```

Our first step is to determine the `Uri` to use to reference the collection of contacts we want to pick from. In the long term, there should be just one answer for aggregate contacts: `android.provider.ContactsContract.Contacts.CONTENT_URI`. However, that only works for Android 2.0 (SDK level 5) and higher. On older versions of Android, we need to stick with the original `android.provider.ContactsContract.Contacts.CONTENT_URI`. To accomplish this, we will use a pinch of reflection to determine our `Uri` via a static initializer when our activity starts:

```
private static Uri CONTENT_URI=null;

static {
    int sdk=new Integer(Build.VERSION.SDK).intValue();

    if (sdk>=5) {
        try {
            Class clazz=Class.forName("android.provider.ContactsContract$Contacts");

            CONTENT_URI=(Uri)clazz.getField("CONTENT_URI").get(clazz);
        }
        catch (Throwable t) {
            Log.e("PickDemo", "Exception when determining CONTENT_URI", t);
        }
    }
    else {
        CONTENT_URI=Contacts.People.CONTENT_URI;
    }
}
```

Then, you need to create an Intent for the ACTION_PICK on the chosen Uri, then start a sub activity (via startActivityForResult()) to allow the user to pick a piece of content of the specified type:

```
@Override
public void onCreate(Bundle icle) {
    super.onCreate(icle);

    if (CONTENT_URI==null) {
        Toast
            .makeText(this, "We are experiencing technical difficulties...",
                Toast.LENGTH_LONG)
            .show();
        finish();

        return;
    }

    setContentView(R.layout.main);

    Button btn=(Button)findViewById(R.id.pick);

    btn.setOnClickListener(new View.OnClickListener() {
        public void onClick(View view) {
            Intent i=new Intent(Intent.ACTION_PICK, CONTENT_URI);

            startActivityForResult(i, PICK_REQUEST);
        }
    });
}
```

When that sub-activity completes with RESULT_OK, the ACTION_VIEW is invoked on the resulting contact Uri, as obtained from the Intent returned by the pick activity:

```
@Override
protected void onActivityResult(int requestCode, int resultCode,
    Intent data) {
    if (requestCode==PICK_REQUEST) {
        if (resultCode==RESULT_OK) {
            startActivity(new Intent(Intent.ACTION_VIEW,
                data.getData()));
        }
    }
}
```

The result: the user chooses a collection, picks a piece of content, and views it.



Figure 50. The PickDemo sample application, as initially launched

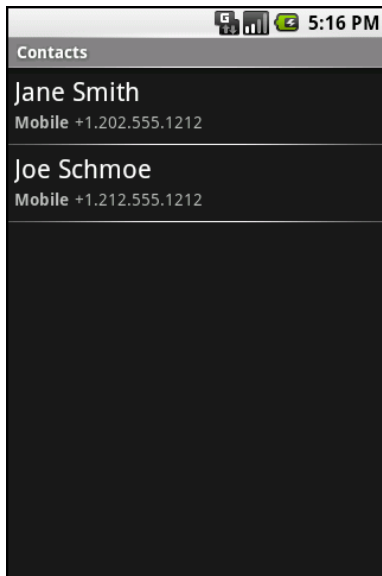


Figure 51. The same application, after clicking the "Gimme!" button, showing the list of available people

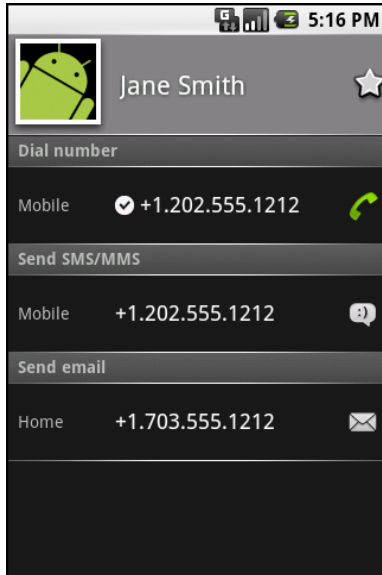


Figure 52. A view of a contact, launched by PickDemo after choosing one of the people from the pick list

Note that the `uri` we get from picking the contact is valid in the short term, but should not be held onto in a persistent fashion (e.g., put in a database). If you need to try to store a reference to a contact for the long term, you will need to get a "lookup `uri`" on it, to help deal with the fact that the aggregate contact may shift over time as raw contact information for that person comes and goes.

Spin Through Your Contacts

The preceding example allows you to work with contacts, yet not actually have any contact data other than a transient `uri`. All else being equal, it is best to use the contacts system this way, as it means you do not need any extra permissions that might raise privacy issues.

Of course, all else is rarely equal.

Your alternative, therefore, is to execute queries against the contacts `ContentProvider` to get actual contact detail data back, such as names,

phone numbers, and email addresses. The `Contacts/Spinners` sample application will demonstrate this technique.

Contact Permissions

Since contacts are privileged data, you need certain permissions to work with them. Specifically, you need the `READ_CONTACTS` permission to query and examine the `ContactsContract` content and `WRITE_CONTACTS` to add, modify, or remove contacts from the system.

For example, here is the manifest for the `Contacts/Spinners` sample application:

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.commonware.android.contacts.spinners"
    android:versionCode="1"
    android:versionName="1.0">
    <uses-permission android:name="android.permission.READ_CONTACTS" />
    <uses-sdk
        android:minSdkVersion="3"
        android:targetSdkVersion="6"
    />
    <application android:label="@string/app_name">
        <activity android:name=".ContactSpinners"
            android:label="@string/app_name">
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />
                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
    </application>
</manifest>
```

Pre-Joined Data

While the database underlying the `ContactsContract` content provider is private, one can imagine that it has several tables: one for people, one for their phone numbers, one for their email addresses, etc. These are tied together by typical database relations, most likely 1:N, so the phone number and email address tables would have a foreign key pointing back to the table containing information about people.

To simplify accessing all of this through the content provider interface, Android pre-joins queries against some of the tables. For example, you can query for phone numbers and get the contact name and other data along with the number – you do not have to do this join operation yourself.

The Sample Activity

The ContactsDemo activity is simply a `ListActivity`, though it sports a `Spinner` to go along with the obligatory `ListView`:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    >
    <Spinner android:id="@+id/spinner"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:drawSelectorOnTop="true"
    />
    <ListView
        android:id="@android:id/list"
        android:layout_width="fill_parent"
        android:layout_height="fill_parent"
        android:drawSelectorOnTop="false"
    />
</LinearLayout>
```

The activity itself sets up a listener on the `Spinner` and toggles the list of information shown in the `ListView` when the `Spinner` value changes:

```
package com.commonware.android.contacts.spinners;

import android.app.ListActivity;
import android.os.Bundle;
import android.view.View;
import android.widget.AdapterView;
import android.widget.AdapterView.OnItemClickListener;
import android.widget.ArrayAdapter;
import android.widget.ListAdapter;
import android.widget.Spinner;

public class ContactSpinners extends ListActivity
    implements AdapterView.OnItemClickListener {
    private static String[] options={"Contact Names",
        "Contact Names & Numbers",
        "Contact Names & Email Addresses"};
```

```
private ListAdapter[] listAdapters=new ListAdapter[3];

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

    initListAdapters();

    Spinner spin=(Spinner)findViewById(R.id.spinner);
    spin.setOnItemSelectedListener(this);

    ArrayAdapter<String> aa=new ArrayAdapter<String>(this,
        android.R.layout.simple_spinner_item,
        options);

    aa.setDropDownViewResource(
        android.R.layout.simple_spinner_dropdown_item);
    spin.setAdapter(aa);
}

public void onItemSelected(AdapterView<?> parent,
    View v, int position, long id) {
    setListAdapter(listAdapters[position]);
}

public void onNothingSelected(AdapterView<?> parent) {
    // ignore
}

private void initListAdapters() {
    listAdapters[0]=ContactsAdapterBridge.INSTANCE.buildNameAdapter(this);
    listAdapters[1]=ContactsAdapterBridge.INSTANCE.buildPhonesAdapter(this);
    listAdapters[2]=ContactsAdapterBridge.INSTANCE.buildEmailAdapter(this);
}
}
```

When the activity is first opened, it sets up three Adapter objects, one for each of three perspectives on the contacts data. The Spinner simply resets the list to use the Adapter associated with the Spinner value selected.

Dealing with API Versions

Of course, once again, we have to ponder different API levels.

Querying `ContactsContract` and querying `Contacts` is similar, yet different, both in terms of the `Uri` each uses for the query and in terms of the available column names for the resulting projection.

Rather than using reflection, this time we ruthlessly exploit a feature of the VM: classes are only loaded when first referenced. Hence, we can have a class that refers to new APIs (`ContactsContract`) on a device that lacks those APIs, so long as we do not reference that class.

To accomplish this, we define an abstract base class, `ContactsAdapterBridge`, that will have a singleton instance capable of running our queries and building a `ListAdapter` for each. Then, we create two concrete subclasses, one for the old API:

```
package com.commonware.android.contacts.spinners;

import android.app.Activity;
import android.database.Cursor;
import android.provider.Contacts;
import android.widget.ListAdapter;
import android.widget.SimpleCursorAdapter;

class OldContactsAdapterBridge extends ContactsAdapterBridge {
    ListAdapter buildNameAdapter(Activity a) {
        String[] PROJECTION=new String[] { Contacts.People._ID,
                                           Contacts.PeopleColumns.NAME
                                           };
        Cursor c=a.managedQuery(Contacts.People.CONTENT_URI,
                               PROJECTION, null, null,
                               Contacts.People.DEFAULT_SORT_ORDER);

        return(new SimpleCursorAdapter( a,
                                       android.R.layout.simple_list_item_1,
                                       c,
                                       new String[] {
                                           Contacts.PeopleColumns.NAME
                                       },
                                       new int[] {
                                           android.R.id.text1
                                       }));
    }

    ListAdapter buildPhonesAdapter(Activity a) {
        String[] PROJECTION=new String[] { Contacts.Phones._ID,
                                           Contacts.Phones.NAME,
                                           Contacts.Phones.NUMBER
                                           };
        Cursor c=a.managedQuery(Contacts.Phones.CONTENT_URI,
```

The Contacts Content Provider

```
        PROJECTION, null, null,
        Contacts.Phones.DEFAULT_SORT_ORDER);

    return(new SimpleCursorAdapter( a,
        android.R.layout.simple_list_item_2,
        c,
        new String[] {
            Contacts.Phones.NAME,
            Contacts.Phones.NUMBER
        },
        new int[] {
            android.R.id.text1,
            android.R.id.text2
        }
    ));
}

ListAdapter buildEmailAdapter(Activity a) {
    String[] PROJECTION=new String[] { Contacts.ContactMethods._ID,
        Contacts.ContactMethods.DATA,
        Contacts.PeopleColumns.NAME
    };

    Cursor c=a.managedQuery(Contacts.ContactMethods.CONTENT_EMAIL_URI,
        PROJECTION, null, null,
        Contacts.ContactMethods.DEFAULT_SORT_ORDER);

    return(new SimpleCursorAdapter( a,
        android.R.layout.simple_list_item_2,
        c,
        new String[] {
            Contacts.PeopleColumns.NAME,
            Contacts.ContactMethods.DATA
        },
        new int[] {
            android.R.id.text1,
            android.R.id.text2
        }
    ));
}
}
```

...and one for the new API:

```
package com.commonware.android.contacts.spinners;

import android.app.Activity;
import android.database.Cursor;
import android.provider.ContactsContract.Contacts;
import android.provider.ContactsContract.CommonDataKinds.Email;
import android.provider.ContactsContract.CommonDataKinds.Phone;
import android.widget.ListAdapter;
import android.widget.SimpleCursorAdapter;

class NewContactsAdapterBridge extends ContactsAdapterBridge {
    ListAdapter buildNameAdapter(Activity a) {
```

```
String[] PROJECTION=new String[] { Contacts._ID,
                                   Contacts.DISPLAY_NAME,
                                   };
Cursor c=a.managedQuery(Contacts.CONTENT_URI,
                        PROJECTION, null, null, null);

return(new SimpleCursorAdapter( a,
                                android.R.layout.simple_list_item_1,
                                c,
                                new String[] {
                                    Contacts.DISPLAY_NAME
                                },
                                new int[] {
                                    android.R.id.text1
                                }
));
}

ListAdapter buildPhonesAdapter(Activity a) {
String[] PROJECTION=new String[] { Contacts._ID,
                                   Contacts.DISPLAY_NAME,
                                   Phone.NUMBER
                                   };
Cursor c=a.managedQuery(Phone.CONTENT_URI,
                        PROJECTION, null, null, null);

return(new SimpleCursorAdapter( a,
                                android.R.layout.simple_list_item_2,
                                c,
                                new String[] {
                                    Contacts.DISPLAY_NAME,
                                    Phone.NUMBER
                                },
                                new int[] {
                                    android.R.id.text1,
                                    android.R.id.text2
                                }
));
}

ListAdapter buildEmailAdapter(Activity a) {
String[] PROJECTION=new String[] { Contacts._ID,
                                   Contacts.DISPLAY_NAME,
                                   Email.DATA
                                   };
Cursor c=a.managedQuery(Email.CONTENT_URI,
                        PROJECTION, null, null, null);

return(new SimpleCursorAdapter( a,
                                android.R.layout.simple_list_item_2,
                                c,
                                new String[] {
                                    Contacts.DISPLAY_NAME,
                                    Email.DATA
                                },
                                new int[] {
```

```
        android.R.id.text1,  
        android.R.id.text2  
    }));  
    }  
}
```

Our `ContactsAdapterBridge` class then uses the SDK level to determine which of those two classes to use as the singleton:

```
package com.commonware.android.contacts.spinners;  
  
import android.app.Activity;  
import android.os.Build;  
import android.widget.ListAdapter;  
  
abstract class ContactsAdapterBridge {  
    abstract ListAdapter buildNameAdapter(Activity a);  
    abstract ListAdapter buildPhonesAdapter(Activity a);  
    abstract ListAdapter buildEmailAdapter(Activity a);  
  
    public static final ContactsAdapterBridge INSTANCE=buildBridge();  
  
    private static ContactsAdapterBridge buildBridge() {  
        int sdk=new Integer(Build.VERSION.SDK).intValue();  
  
        if (sdk<5) {  
            return(new OldContactsAdapterBridge());  
        }  
  
        return(new NewContactsAdapterBridge());  
    }  
}
```

Accessing People

The first Adapter shows the names of all of the contacts. Since all the information we seek is in the contact itself, we can use the `CONTENT_URI` provider, retrieve all of the contacts in the default sort order, and pour them into a `SimpleCursorAdapter` set up to show each person on its own row:

Assuming you have some contacts in the database, they will appear when you first open the `ContactsDemo` activity, since that is the default perspective:

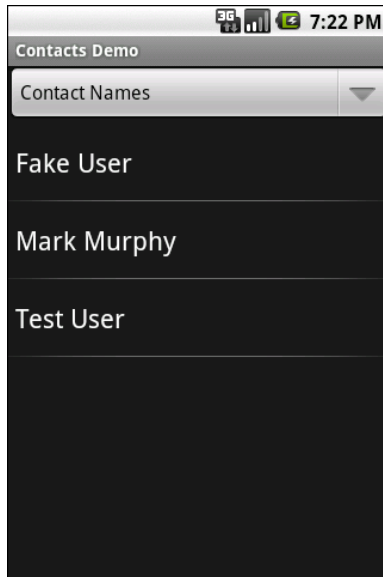


Figure 53. The ContactsDemo sample application, showing all contacts

Accessing Phone Numbers

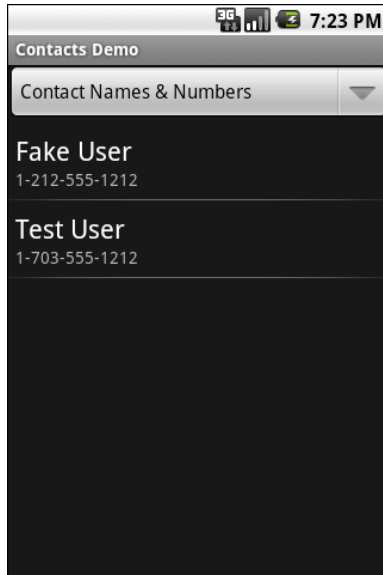


Figure 54. The ContactsDemo sample application, showing all contacts that have phone numbers

Accessing Email Addresses

Similarly, to get a list of all the email addresses, we can use the `CONTENT_URI` content provider. Again, the results are displayed via a two-line `SimpleCursorAdapter`:

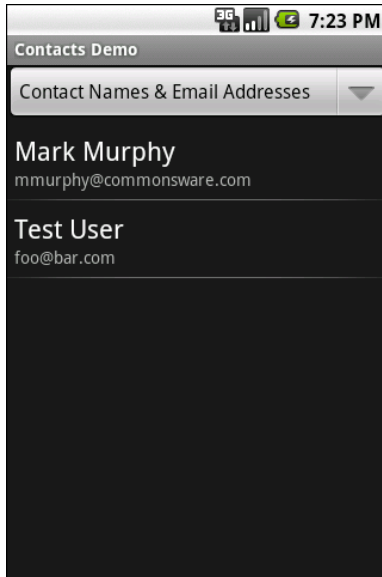


Figure 55. The ContactsDemo sample application, showing all contacts with email addresses

Makin' Contacts

Let's now take a peek at the reverse direction: adding contacts to the system. This was never particularly easy and now is...well, different.

First, we need to distinguish between sync providers and other apps. Sync providers are the guts underpinning the accounts system in Android, bridging some existing source of contact data to the Android device. Hence, you can have sync providers for Exchange, Facebook, and so forth. These will need to create raw contacts for newly-added contacts to their backing stores that are being sync'd to the device for the first time. Creating sync providers is outside of the scope of this book for now.

It is possible for other applications to create contacts. These, by definition, will be phone-only contacts, lacking any associated account, no different than if the user added the contact directly. The recommended approach to doing this is to collect the data you want, then spawn an activity to let the user add the contact – this avoids your application needing the `WRITE_CONTACTS` permission and all the privacy/data integrity issues that creates. In this case, we will stick with the new `ContactsContract` content provider, to simplify our code, at the expense of requiring Android 2.0 or newer.

To that end, take a look at the `Contacts/Inserter` sample project. It defines a simple activity with a two-field UI, with one field apiece for the person's first name and phone number:

```
<?xml version="1.0" encoding="utf-8"?>
<TableLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:stretchColumns="1"
    >
    <TableRow>
        <TextView
            android:text="First name:"
            />
        <EditText android:id="@+id/name"
            />
    </TableRow>
    <TableRow>
        <TextView
            android:text="Phone:"
            />
        <EditText android:id="@+id/phone"
            android:inputType="phone"
            />
    </TableRow>
    <Button android:id="@+id/insert" android:text="Insert!" />
</TableLayout>
```

The trivial UI also sports a button to add the contact:

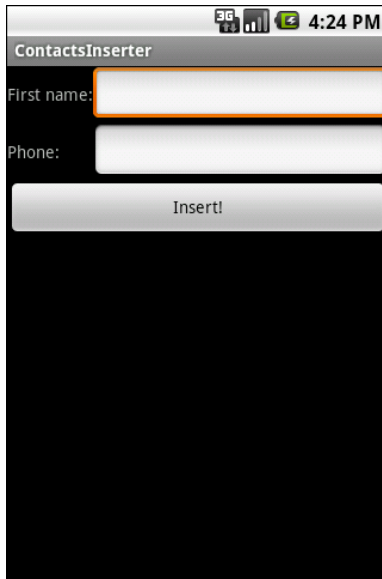


Figure 56. The ContactInserter sample application

When the user clicks the button, the activity gets the data and creates an Intent to be used to launch the add-a-contact activity. This uses the ACTION_INSERT_OR_EDIT action and a couple of extras from the ContactsContract.Intents.Insert class:

```
package com.commonware.android.inserter;

import android.app.Activity;
import android.content.Intent;
import android.os.Bundle;
import android.provider.ContactsContract.Contacts;
import android.provider.ContactsContract.Intents.Insert;
import android.view.View;
import android.widget.Button;
import android.widget.EditText;

public class ContactsInserter extends Activity {
    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.main);

        Button btn=(Button)findViewById(R.id.insert);

        btn.setOnClickListener(onInsert);
    }
}
```

```
View.OnClickListener onInsert=new View.OnClickListener() {
    public void onClick(View v) {
        EditText fld=(EditText)findViewById(R.id.name);
        String name=fld.getText().toString();

        fld=(EditText)findViewById(R.id.phone);

        String phone=fld.getText().toString();
        Intent i=new Intent(Intent.ACTION_INSERT_OR_EDIT);

        i.setType(Contacts.CONTENT_ITEM_TYPE);
        i.putExtra(Insert.NAME, name);
        i.putExtra(Insert.PHONE, phone);
        startActivity(i);
    }
};
}
```

We also need to set the MIME type on the Intent via `setType()`, to be `CONTENT_ITEM_TYPE`, so Android knows what sort of data we want to actually insert. Then, we call `startActivity()` on the resulting Intent. That brings up an add-or-edit activity:

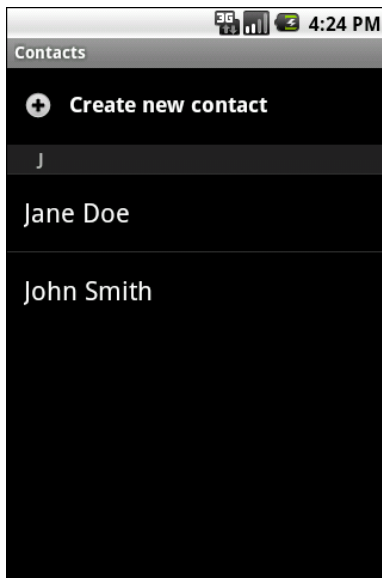


Figure 57. The add-or-edit-a-contact activity

...where if the user chooses "Create new contact", they are taken to the ordinary add-a-contact activity, with our data pre-filled in:

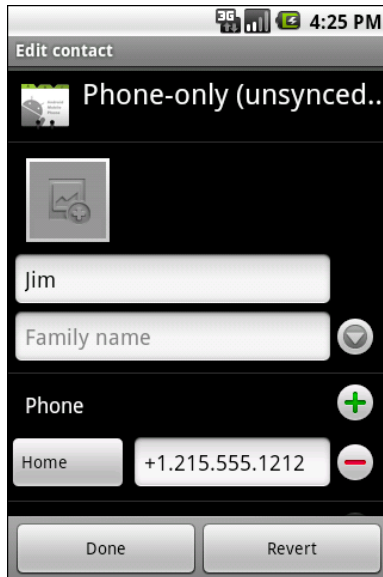


Figure 58. The edit-contact form, showing the data from the ContactInserter activity

Note that the user could choose an existing contact, rather than creating a new contact. If they choose an existing contact, the first name of that contact will be overwritten with the data supplied by the `ContactsInserter` activity, and a new phone number will be added from those `Intent` extras.

"Sensors" is Android's overall term for ways that Android can detect elements of the physical world around it, from magnetic flux to the movement of the device. Not all devices will have all possible sensors, and other sensors are likely to be added over time. In this chapter, we will explore what sensors are theoretically available and how to use a few of them that work on early Android devices like the T-Mobile G1.

The samples in this chapter assume that you have access to a piece of sensor-equipped Android hardware, such as a T-Mobile G1. The OpenIntents.org project has a [sensor simulator](#) which you can also use, though the use of this tool is not covered here.

The author would like to thank Sean Catlin for code samples that helped clear up confusion surrounding the use of sensors.

The Sixth Sense. Or Possibly the Seventh.

In theory, Android supports the following sensor types:

- An accelerometer, that tells you the motion of the device in space through all three dimensions
- An ambient light sensor, telling you how bright or dark the surroundings are

- A magnetic field sensor, to tell you where magnetic north is (unless some other magnetic field is nearby, such as from an electrical motor)
- An orientation sensor, to tell you how the device is positioned in all three dimensions
- A proximity sensor, to tell you how far the device is from some other specific object
- A temperature sensor, to tell you the temperature of the surrounding environment
- A tricorder sensor, to turn the device into "a fully functional Tricorder"

Clearly, not all of these possible sensors are available today, such as the last one. What definitely are available today on the T-Mobile G1 are the accelerometer, the magnetic field sensor, and the orientation sensor.

To access any of these sensors, you need a `SensorManager`, found in the `android.hardware` package. Like other aspects of Android, the `SensorManager` is a system service, and as such is obtained via the `getSystemService()` method on your `Activity` or other `Context`:

```
mgr=(SensorManager)getSystemService(Context.SENSOR_SERVICE);
```

Orienting Yourself

In principle, to find out which direction is north, you would use the magnetic flux sensor and go through a lovely set of calculations to figure out the appropriate direction.

Fortunately for us, Android did all that as part of the orientation sensor...so long as the device is held flat in the horizontal plane (e.g., on a level tabletop).

Akin to the location services, there is no way to ask the `SensorManager` what the current value of a sensor is. Instead, you need to hook up a

`SensorEventListener` and respond to changes in the sensor values. To do this, simply call `registerListener()` with your `SensorEventListener` and the `Sensor` you wish to hear from. You can get the `Sensor` by asking the `SensorManager` for the default `Sensor` for a particular type. For example, from the `Sensor/Compass` sample project, here is where we register our listener:

```
mgr.registerListener(listener,
    mgr.getDefaultSensor(Sensor.TYPE_ORIENTATION),
    SensorManager.SENSOR_DELAY_UI);
```

Note that you also specify the rate at which sensor updates will be received. Here, we use `SENSOR_DELAY_UI`, but you could say `SENSOR_DELAY_FASTEST` or various other values.

It is important to unregister the listener when the activity closes down; otherwise, the application will never really terminate and the listener will get updates indefinitely. To do this, just call `unregisterListener()` from a likely location, such as `onDestroy()`:

```
@Override
public void onDestroy() {
    super.onDestroy();
    mgr.unregisterListener(listener);
}
```

Your `SensorEventListener` implementation will need two methods. The one you probably will not use that often is `onAccuracyChanged()`, when you will be notified as a given sensor's accuracy changes from `SENSOR_STATUS_ACCURACY_HIGH` to `SENSOR_STATUS_ACCURACY_MEDIUM` to `SENSOR_STATUS_ACCURACY_LOW` to `SENSOR_STATUS_UNRELIABLE`.

The one you will use more commonly is `onSensorChanged()`, where you are provided a `SensorEvent` containing a `float[]` of values for the sensor. The tricky part is determining what these sensor values mean.

In the case of `TYPE_ORIENTATION`, the first of the supplied values represents the orientation of the device in degrees off of magnetic north. 90 degrees means east, 180 means south, and 270 means west, just like on a regular compass.

In Sensor/Compass, we update a TextView with each reading:

```
private SensorEventListener listener=new SensorEventListener() {
    public void onSensorChanged(SensorEvent e) {
        if (e.sensor.getType()==Sensor.TYPE_ORIENTATION) {
            degrees.setText(String.valueOf(e.values[0]));
        }
    }

    public void onAccuracyChanged(Sensor sensor, int accuracy) {
        // unused
    }
};
```

What you get is a trivial application showing where the top of the phone is pointing. Note that the sensor seems to take a bit to get initially stabilized, then will tend to lag actual motion a bit.

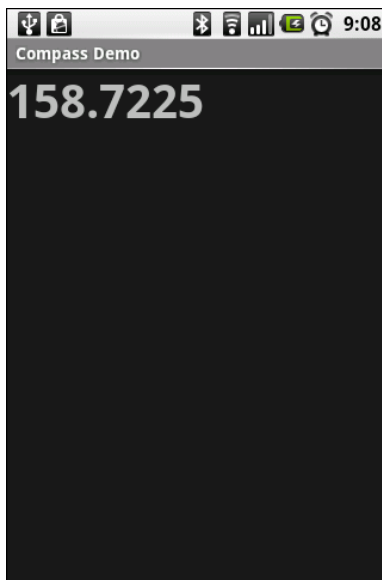


Figure 59. The CompassDemo application, showing a T-Mobile G1 pointing south-by-southeast

Steering Your Phone

In television commercials for other mobile devices, you may see them being used like a steering wheel, often times for playing a driving simulation game.

Android can do this too. You can see it in the `Sensor/Steering` sample application.

In the preceding section, we noted that `TYPE_ORIENTATION` returns in the first value of the `float[]` the orientation of the phone, compared to magnetic north, if the device is horizontal. When the device is held like a steering wheel, the second value of the `float[]` will change as the device is "steered".

This sample application is very similar to the `Sensor/Compass` one shown in the previous section. The biggest change comes in the `SensorEventListener` implementation:

```
private SensorEventListener listener=new SensorEventListener() {
    public void onSensorChanged(SensorEvent e) {
        if (e.sensor.getType()==Sensor.TYPE_ORIENTATION) {
            float orientation=e.values[1];

            if (prevOrientation!=orientation) {
                if (prevOrientation<orientation) {
                    steerLeft(orientation,
                        orientation-prevOrientation);
                }
                else {
                    steerRight(orientation,
                        prevOrientation-orientation);
                }

                prevOrientation=e.values[1];
            }
        }
    }

    public void onAccuracyChanged(Sensor sensor, int accuracy) {
        // unused
    }
};
```

Here, we track the previous orientation (`prevOrientation`) and call a `steerLeft()` or `steerRight()` method based on which direction the "wheel" is turned. For each, we provide the new current position of the wheel and the amount the wheel turned, measured in degrees.

The `steerLeft()` and `steerRight()` methods, in turn, simply dump their results to a "transcript": a `TextView` inside a `ScrollView`, set up to automatically keep scrolling to the bottom:

```
private void steerLeft(float position, float delta) {
    StringBuffer line=new StringBuffer("Steered left by ");

    line.append(String.valueOf(delta));
    line.append(" to ");
    line.append(String.valueOf(position));
    line.append("\n");
    transcript.setText(transcript.getText().toString()+line.toString());
    scroll.fullScroll(View.FOCUS_DOWN);
}

private void steerRight(float position, float delta) {
    StringBuffer line=new StringBuffer("Steered right by ");

    line.append(String.valueOf(delta));
    line.append(" to ");
    line.append(String.valueOf(position));
    line.append("\n");
    transcript.setText(transcript.getText().toString()+line.toString());
    scroll.fullScroll(View.FOCUS_DOWN);
}
```

The result is a log of the steering "events" as the device is turned like a steering wheel. Obviously, a real game would translate these events into game actions, such as changing your perspective of the driving course.

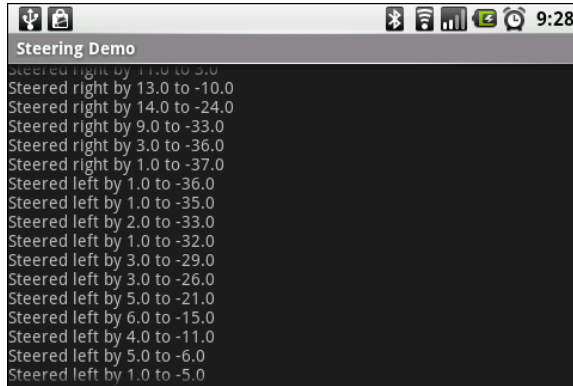


Figure 60. The SteeringDemo application

Do "The Shake"

Another demo you often see with certain other mobile devices is shaking the device to cause some on-screen effect, such as rolling dice or scrambling puzzle pieces.

Android can do this as well, as you can see in the Sensor/Shaker sample application, with our data provided by the accelerometer sensor (`TYPE_ACCELEROMETER`).

What the accelerometer sensor provides is the acceleration in each of three dimensions. At rest, the acceleration is equal to Earth's gravity (or the gravity of wherever you are, if you are not on Earth). When shaken, the acceleration should be higher than Earth's gravity – how much higher is dependent on how hard the device is being shaken. While the individual axes of acceleration might tell you, at any point in time, what direction the device is being shaken in, since a shaking action involves frequent constant changes in direction, what we really want to know is how fast the device is moving overall – a slow steady movement is not a shake, but something more aggressive is.

Once again, our UI output is simply a "transcript" `TextView` as before. This time, though, we separate out the actual shake-detection logic into a `Shaker` class which our `ShakerDemo` activity references, as shown below:

```
package com.commonware.android.sensor;

import android.app.Activity;
import android.os.Bundle;
import android.util.Log;
import android.view.View;
import android.widget.ScrollView;
import android.widget.TextView;

public class ShakerDemo extends Activity
    implements Shaker.Callback {
    private Shaker shaker=null;
    private TextView transcript=null;
    private ScrollView scroll=null;

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

        transcript=(TextView)findViewById(R.id.transcript);
        scroll=(ScrollView)findViewById(R.id.scroll);

        shaker=new Shaker(this, 1.25d, 500, this);
    }

    @Override
    public void onDestroy() {
        super.onDestroy();

        shaker.close();
    }

    public void shakingStarted() {
        Log.d("ShakerDemo", "Shaking started!");
        transcript.setText(transcript.getText().toString()+"Shaking started\n");
        scroll.fullScroll(View.FOCUS_DOWN);
    }

    public void shakingStopped() {
        Log.d("ShakerDemo", "Shaking stopped!");
        transcript.setText(transcript.getText().toString()+"Shaking stopped\n");
        scroll.fullScroll(View.FOCUS_DOWN);
    }
}
```

The shaker takes four parameters:

- A Context, so we can get access to the SensorManager service
- An indication of how hard a shake should qualify as a shake, expressed as a ratio applied to Earth's gravity, so a value of 1.25

means the shake has to be 25% stronger than gravity to be considered a shake

- An amount of time with below-threshold acceleration, after which the shake is considered "done"
- A `Shaker.Callback` object that will be notified when a shake starts and stops

While in this case, the callback methods (implemented on the `ShakerDemo` activity itself) simply log shake events to the transcript, a "real" application would, say, start an animation of dice rolling when the shake starts and end the animation shortly after the shake ends.

The `Shaker` simply converts the three individual acceleration components into a combined acceleration value (square root of the sum of the squares), then compares that value to Earth's gravity. If the ratio is higher than the supplied threshold, then we consider the device to be presently shaking, and we call the `shakingStarted()` callback method if the device was not shaking before. Once shaking ends, and time elapses, we call `shakingStopped()` on the callback object and assume that the shake has ended. A more robust implementation of `Shaker` would take into account the possibility that the sensor will not be updated for a while after the shake ends, though in reality, normal human movement will ensure that there are some sensor updates, so we can find out when the shaking ends.

```
package com.commonware.android.sensor;

import android.content.Context;
import android.hardware.Sensor;
import android.hardware.SensorEvent;
import android.hardware.SensorEventListener;
import android.hardware.SensorManager;
import android.os.SystemClock;
import java.util.ArrayList;
import java.util.List;

public class Shaker {
    private SensorManager mgr=null;
    private long lastShakeTimestamp=0;
    private double threshold=1.0d;
    private long gap=0;
    private Shaker.Callback cb=null;
}
```

```
public Shaker(Context ctxt, double threshold, long gap,
             Shaker.Callback cb) {
    this.threshold=threshold*threshold;
    this.threshold=this.threshold
                *SensorManager.GRAVITY_EARTH
                *SensorManager.GRAVITY_EARTH;

    this.gap=gap;
    this.cb=cb;

    mgr=(SensorManager)ctxt.getSystemService(Context.SENSOR_SERVICE);
    mgr.registerListener(listener,
                       mgr.getDefaultSensor(Sensor.TYPE_ACCELEROMETER),
                       SensorManager.SENSOR_DELAY_UI);
}

public void close() {
    mgr.unregisterListener(listener);
}

private void isShaking() {
    long now=SystemClock.uptimeMillis();

    if (lastShakeTimestamp==0) {
        lastShakeTimestamp=now;

        if (cb!=null) {
            cb.shakingStarted();
        }
    }
    else {
        lastShakeTimestamp=now;
    }
}

private void isNotShaking() {
    long now=SystemClock.uptimeMillis();

    if (lastShakeTimestamp>0) {
        if (now-lastShakeTimestamp>gap) {
            lastShakeTimestamp=0;

            if (cb!=null) {
                cb.shakingStopped();
            }
        }
    }
}

public interface Callback {
    void shakingStarted();
    void shakingStopped();
}

private SensorEventListener listener=new SensorEventListener() {
```

```
public void onSensorChanged(SensorEvent e) {
    if (e.sensor.getType()==Sensor.TYPE_ACCELEROMETER) {
        double netForce=e.values[0]*e.values[0];

        netForce+=e.values[1]*e.values[1];
        netForce+=e.values[2]*e.values[2];

        if (threshold<netForce) {
            isShaking();
        }
        else {
            isNotShaking();
        }
    }
}

public void onAccuracyChanged(Sensor sensor, int accuracy) {
    // unused
}
};
}
```

All the transcript shows, of course, is when shaking starts and stops:

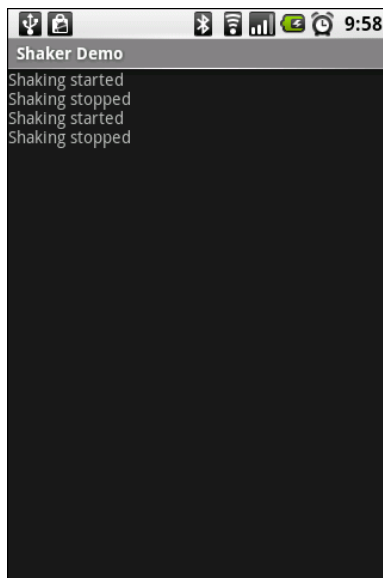


Figure 61. The ShakerDemo application, showing a pair of shakes

Handling System Events

If you have ever looked at the list of available `Intent` actions in the SDK documentation for the `Intent` class, you will see that there are lots of possible actions.

There are even actions that are not listed in that spot in the documentation, but are scattered throughout the rest of the SDK documentation.

The vast majority of these you will never raise yourself. Instead, they are broadcast by Android, to signify certain system events that have occurred and that you might want to take note of, if they affect the operation of your application.

This chapter examines a few of these, to give you the sense of what is possible and how to make use of these sorts of events.

Get Moving, First Thing

A popular request is to have a service get control when the device is powered on.

This is doable but somewhat dangerous, in that too many on-boot requests slow down the device startup and may make things sluggish for the user. Moreover, the more services that are running all the time, the worse the device performance will be.

A better pattern is to get control on boot to arrange for a service to do something periodically using the `AlarmManager` or via other system events. In this section, we will examine the on-boot portion of the problem – in the [next chapter](#), we will investigate `AlarmManager` and how it can keep services active yet not necessarily resident in memory all the time.

The Permission

In order to be notified when the device has completed its system boot process, you will need to request the `RECEIVE_BOOT_COMPLETED` permission. Without this, even if you arrange to receive the boot broadcast Intent, it will not be dispatched to your receiver.

As the Android documentation describes it:

Though holding this permission does not have any security implications, it can have a negative impact on the user experience by increasing the amount of time it takes the system to start and allowing applications to have themselves running without the user being aware of them. As such, you must explicitly declare your use of this facility to make that visible to the user.

The Receiver Element

There are two ways you can receive a broadcast Intent. One is to use `registerReceiver()` from an existing Activity, Service, or ContentProvider. The other is to register your interest in the Intent in the manifest in the form of a `<receiver>` element:

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.commonware.android.sysevents.boot"
    android:versionCode="1"
    android:versionName="1.0">
    <uses-sdk
        android:minSdkVersion="3"
```

```
        android:targetSdkVersion="6"
    />
    <supports-screens
        android:largeScreens="false"
        android:normalScreens="true"
        android:smallScreens="false"
    />
    <uses-permission android:name="android.permission.RECEIVE_BOOT_COMPLETED" />
    <application android:label="@string/app_name">
        <receiver android:name=".OnBootReceiver">
            <intent-filter>
                <action android:name="android.intent.action.BOOT_COMPLETED" />
            </intent-filter>
        </receiver>
    </application>
</manifest>
```

The above `AndroidManifest.xml`, from the `SystemEvents/OnBoot` sample project, shows that we have registered a broadcast receiver named `OnBootReceiver`, set to be given control when the `android.intent.action.BOOT_COMPLETED` Intent is broadcast.

In this case, we have no choice but to implement our receiver this way – by the time any of our other components (e.g., an Activity) were to get control and be able to call `registerReceiver()`, the `BOOT_COMPLETED` Intent will be long gone.

The Receiver Implementation

Now that we have told Android that we would like to be notified when the boot has completed, and given that we have been granted permission to do so by the user, we now need to actually do something to receive the Intent. This is a simple matter of creating a `BroadcastReceiver`, such as seen in the `OnBootCompleted` implementation shown below:

```
package com.commonware.android.sysevents.boot;

import android.content.BroadcastReceiver;
import android.content.Context;
import android.content.Intent;
import android.util.Log;

public class OnBootReceiver extends BroadcastReceiver {
    @Override
```

```
public void onReceive(Context context, Intent intent) {  
    Log.d("OnBootReceiver", "Hi, Mom!");  
}  
}
```

A `BroadcastReceiver` is not a `Context`, and so it gets passed a suitable `Context` object in `onReceive()` to use for accessing resources and the like. The `onReceive()` method also is passed the `Intent` that caused our `BroadcastReceiver` to be created, in case there are "extras" we need to pull out (none in this case).

In `onReceive()`, we can do whatever we want, subject to some limitations:

1. We are not a `Context`, like an `Activity`, so we cannot modify a UI or anything such as that
2. If we want to do anything significant, it is better to delegate that logic to a service that we start from here (e.g., calling `startService()` on the supplied `Context`) rather than actually doing it here, since `BroadcastReceiver` implementations need to be fast
3. We cannot start any background threads, directly or indirectly, since the `BroadcastReceiver` gets discarded as soon as `onReceive()` returns

In this case, we simply log the fact that we got control. In the [next chapter](#), we will see what else we can do at boot time, to ensure one of our services gets control later on as needed.

To test this, install it on an emulator (or device), shut down the emulator, then restart it.

I Sense a Connection Between Us...

Generally speaking, Android applications do not care what sort of Internet connection is being used – 3G, GPRS, WiFi, [lots of trained carrier pigeons](#), or whatever. So long as there is an Internet connection, the application is happy.

Sometimes, though, you may specifically want WiFi. This would be true if your application is bandwidth-intensive and you want to ensure that, should WiFi stop being available, you cut back on your work so as not to consume too much 3G/GPRS bandwidth, which is usually subject to some sort of cap or metering.

There is an `android.net.wifi.WIFI_STATE_CHANGED` Intent that will be broadcast, as the name suggests, whenever the state of the WiFi connection changes. You can arrange to receive this broadcast and take appropriate steps within your application.

This Intent requires no special permission, unlike the `BOOT_COMPLETED` Intent from the previous section. Hence, all you need to do is register a `BroadcastReceiver` for `android.net.wifi.WIFI_STATE_CHANGED`, either via `registerReceiver()`, or via the `<receiver>` element in `AndroidManifest.xml`, such as the one shown below, from the `SystemEvents/OnWiFiChange` sample project:

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.commonware.android.sysevents.wifi"
    android:versionCode="1"
    android:versionName="1.0">
    <application android:label="@string/app_name">
        <receiver android:name=".OnWiFiChangeReceiver">
            <intent-filter>
                <action android:name="android.net.wifi.WIFI_STATE_CHANGED" />
            </intent-filter>
        </receiver>
    </application>
</manifest>
```

All we do in the manifest is tell Android to create an `OnWiFiChangeReceiver` object when a `android.net.wifi.WIFI_STATE_CHANGED` Intent is broadcast, so the receiver can do something useful.

In the case of `OnWiFiChangeReceiver`, it examines the value of the `EXTRA_WIFI_STATE` "extra" in the supplied Intent and logs an appropriate message:

```
package com.commonware.android.sysevents.wifi;

import android.content.BroadcastReceiver;
import android.content.Context;
import android.content.Intent;
import android.net.wifi.WifiManager;
import android.util.Log;

public class OnWifiChangeReceiver extends BroadcastReceiver {
    @Override
    public void onReceive(Context context, Intent intent) {
        int state=intent.getIntExtra(WifiManager.EXTRA_WIFI_STATE, -1);
        String msg=null;

        switch (state) {
            case WifiManager.WIFI_STATE_DISABLED:
                msg="is disabled";
                break;

            case WifiManager.WIFI_STATE_DISABLING:
                msg="is disabling";
                break;

            case WifiManager.WIFI_STATE_ENABLED:
                msg="is enabled";
                break;

            case WifiManager.WIFI_STATE_ENABLING:
                msg="is enabling";
                break;

            case WifiManager.WIFI_STATE_UNKNOWN :
                msg="has an error";
                break;

            default:
                msg="is acting strangely";
                break;
        }

        if (msg!=null) {
            Log.d("OnWifiChanged", "WiFi "+msg);
        }
    }
}
```

The EXTRA_WIFI_STATE "extra" tells you what the state has become (e.g., we are now disabling or are now disabled), so you can take appropriate steps in your application.

Note that, to test this, you will need an actual Android device, as the emulator does not specifically support simulating WiFi connections.

Feeling Drained

One theme with system events is to use them to help make your users happier by reducing your impacts on the device while the device is not in a great state. In the preceding section, we saw how you could find out when WiFi was disabled, so you might not use as much bandwidth when on 3G/GPRS. However, not every application uses so much bandwidth as to make this optimization worthwhile.

However, most applications are impacted by battery life. Dead batteries run no apps.

So whether you are implementing a battery monitor or simply want to discontinue background operations when the battery gets low, you may wish to find out how the battery is doing.

There is an `ACTION_BATTERY_CHANGED` Intent that gets broadcast as the battery status changes, both in terms of charge (e.g., 80% charged) and charging (e.g., the device is now plugged into AC power). You simply need to register to receive this Intent when it is broadcast, then take appropriate steps.

One of the limitations of `ACTION_BATTERY_CHANGED` is that you have to use `registerReceiver()` to set up a `BroadcastReceiver` to get this Intent when broadcast. You cannot use a manifest-declared receiver as shown in the preceding two sections.

In `SystemEvents/OnBattery`, you will find a layout containing a `ProgressBar`, a `TextView`, and an `ImageView`, to serve as a battery monitor:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
```

```
>
<ProgressBar android:id="@+id/bar"
    style="?android:attr/progressBarStyleHorizontal"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content" />
<LinearLayout
    android:orientation="horizontal"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    >
    <TextView android:id="@+id/level"
        android:layout_width="0px"
        android:layout_height="wrap_content"
        android:layout_weight="1"
        android:textSize="16pt"
    />
    <ImageView android:id="@+id/status"
        android:layout_width="0px"
        android:layout_height="wrap_content"
        android:layout_weight="1"
    />
</LinearLayout>
</LinearLayout>
```

This layout is used by a `BatteryMonitor` activity, which registers to receive the `ACTION_BATTERY_CHANGED` Intent in `onResume()` and unregisters in `onPause()`:

```
package com.commonware.android.sysevents.battery;

import android.app.Activity;
import android.content.BroadcastReceiver;
import android.content.Context;
import android.content.Intent;
import android.content.IntentFilter;
import android.os.Bundle;
import android.os.BatteryManager;
import android.widget.ProgressBar;
import android.widget.ImageView;
import android.widget.TextView;

public class BatteryMonitor extends Activity {
    private ProgressBar bar=null;
    private ImageView status=null;
    private TextView level=null;

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

        bar=(ProgressBar)findViewById(R.id.bar);
```

```
status=(ImageView)findViewById(R.id.status);
level=(TextView)findViewById(R.id.level);
}

@Override
public void onResume() {
    super.onResume();

    registerReceiver(onBatteryChanged,
        new IntentFilter(Intent.ACTION_BATTERY_CHANGED));
}

@Override
public void onPause() {
    super.onPause();

    unregisterReceiver(onBatteryChanged);
}

BroadcastReceiver onBatteryChanged=new BroadcastReceiver() {
    public void onReceive(Context context, Intent intent) {
        int pct=100*intent.getIntExtra("level", 1)/intent.getIntExtra("scale", 1);

        bar.setProgress(pct);
        level.setText(String.valueOf(pct));

        switch(intent.getIntExtra("status", -1)) {
            case BatteryManager.BATTERY_STATUS_CHARGING:
                status.setImageResource(R.drawable.charging);
                break;

            case BatteryManager.BATTERY_STATUS_FULL:
                int plugged=intent.getIntExtra("plugged", -1);

                if (plugged==BatteryManager.BATTERY_PLUGGED_AC ||
                    plugged==BatteryManager.BATTERY_PLUGGED_USB) {
                    status.setImageResource(R.drawable.full);
                }
                else {
                    status.setImageResource(R.drawable.unplugged);
                }
                break;

            default:
                status.setImageResource(R.drawable.unplugged);
                break;
        }
    }
};
}
```

The key to `ACTION_BATTERY_CHANGED` is in the "extras". Many "extras" are packaged in the `Intent`, to describe the current state of the battery, such as the following constants defined on the `BatteryManager` class:

- `EXTRA_HEALTH`, which should generally be `BATTERY_HEALTH_GOOD`
- `EXTRA_LEVEL`, which is the proportion of battery life remaining as an integer, specified on the scale described by the scale "extra"
- `EXTRA_PLUGGED`, which will indicate if the device is plugged into AC power (`BATTERY_PLUGGED_AC`) or USB power (`BATTERY_PLUGGED_USB`)
- `EXTRA_SCALE`, which indicates the maximum possible value of level (e.g., 100, indicating that level is a percentage of charge remaining)
- `EXTRA_STATUS`, which will tell you if the battery is charging (`BATTERY_STATUS_CHARGING`), full (`BATTERY_STATUS_FULL`), or discharging (`BATTERY_STATUS_DISCHARGING`)
- `EXTRA_TECHNOLOGY`, which indicates what sort of battery is installed (e.g., "Li-Ion")
- `EXTRA_TEMPERATURE`, which tells you how warm the battery is, in tenths of a degree Celsius (e.g., 213 is 21.3 degrees Celsius)
- `EXTRA_VOLTAGE`, indicating the current voltage being delivered by the battery, in millivolts

In the case of `BatteryMonitor`, when we receive an `ACTION_BATTERY_CHANGED` `Intent`, we do three things:

1. We compute the percentage of battery life remaining, by dividing the level by the scale
2. We update the `ProgressBar` and `TextView` to display the battery life as a percentage
3. We display an icon, with the icon selection depending on whether we are charging (status is `BATTERY_STATUS_CHARGING`), full but on the charger (status is `BATTERY_STATUS_FULL` and plugged is `BATTERY_PLUGGED_AC` or `BATTERY_PLUGGED_USB`), or are not plugged in

This only really works on a device, where you can plug and unplug it, plus get a varying charge level:

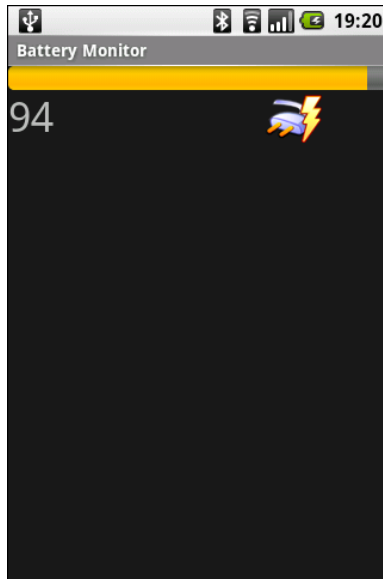


Figure 62. The BatteryMonitor application

Sticky Intents and the Battery

Android has a notion of "sticky broadcast Intents". Normally, a broadcast Intent will be delivered to interested parties and then discarded. A sticky broadcast Intent is delivered to interested parties and retained until the next matching Intent is broadcast. Applications can call `registerReceiver()` with an `IntentFilter` that matches the sticky broadcast, but with a `null BroadcastReceiver`, and get the sticky Intent back as a result of the `registerReceiver()` call.

This may sound confusing. Let's look at this in the context of the battery.

Earlier in this section, you saw how to register for `ACTION_BATTERY_CHANGED` to get information about the battery delivered to you. You can also, though, get the latest battery information without registering a receiver. Just create an `IntentFilter` to match `ACTION_BATTERY_CHANGED` (as shown above) and call `registerReceiver()` with that filter and a `null BroadcastReceiver`. The Intent you get back from `registerReceiver()` is the last `ACTION_BATTERY_CHANGED` Intent that was broadcast, with the same extras. Hence, you can use this to

get the current (or near-current) battery status, rather than having to bother registering an actual `BroadcastReceiver`.

Other Power Triggers

If you are only interested in knowing when the device has been attached to, or detached from, a source of external power, there are different broadcast Intent actions you can monitor: `ACTION_POWER_CONNECTED` and `ACTION_POWER_DISCONNECTED`. These are only broadcast when the power source changes, not just every time the battery changes charge level. Hence, these will be more efficient, as your code will be invoked less frequently. Better still, you can use manifest-registered broadcast receivers for these, bypassing the limits the system puts on `ACTION_BATTERY_CHANGED`.

Using System Services

Android offers a number of system services, usually obtained by `getSystemService()` from your Activity, Service, or other Context. These are your gateway to all sorts of capabilities, from settings to volume to WiFi. Throughout the course of this book and its [companion](#), we have seen several of these system services. In this chapter, we will take a look at others that may be of value to you in building compelling Android applications.

Get Alarmed

A common question when doing Android development is "where do I set up cron jobs?"

The `cron` utility – popular in Linux – is a way of scheduling work to be done periodically. You teach `cron` what to run and when to run it (e.g., weekdays at noon), and `cron` takes care of the rest. Since Android has a Linux kernel at its heart, one might think that `cron` might literally be available.

While `cron` itself is not, Android does have a system service named `AlarmManager` which fills a similar role. You give it a `PendingIntent` and a time (and optionally a period for repeating) and it will fire off the `Intent` as needed. By this mechanism, you can get a similar effect to `cron`.

There is one small catch, though: Android is designed to run on mobile devices, particularly ones powered by all-too-tiny batteries. If you want

your periodic tasks to be run even if the device is "asleep", you will need to take a fair number of extra steps, mostly stemming around the concept of the `WakeLock`.

Concept of WakeLocks

Most of the time in Android, you are developing code that will run while the user is actually using the device. Activities, for example, only really make sense when the device is fully awake and the user is tapping on the screen or keyboard.

Particularly with scheduled background tasks, though, you need to bear in mind that the device will eventually "go to sleep". In full sleep mode, the display, main CPU, and keyboard are all powered off, to maximize battery life. Only on a low-level system event, like an incoming phone call, will anything wake up.

Another thing that will partially wake up the phone is an `Intent` raised by the `AlarmManager`. So long as broadcast receivers are processing that `Intent`, the `AlarmManager` ensures the CPU will be running (though the screen and keyboard are still off). Once the broadcast receivers are done, the `AlarmManager` lets the device go back to sleep.

You can achieve the same effect in your code via a `WakeLock`, obtained via the `PowerManager` system service. When you acquire a "partial `WakeLock`" (`PARTIAL_WAKE_LOCK`), you prevent the CPU from going back to sleep until you release said `WakeLock`. By proper use of a partial `WakeLock`, you can ensure the CPU will not get shut off while you are trying to do background work, while still allowing the device to sleep most of the time, in between alarm events.

However, using a `WakeLock` is a bit tricky, particularly when responding to an alarm `Intent`, as we will see in the next few sections. The good news is that CommonsWare has packaged up a pattern for dealing with this situation – an alarm triggering work that needs to keep the device awake – in a component called the `WakefulIntentService`.

The WakeLock Problem

The `AlarmManager` will arrange for the device to stay awake, via a `WakeLock`, for as long as the `BroadcastReceiver`'s `onReceive()` method is executing. For some situations, that may be all that is needed. However, `onReceive()` is called on the main application thread, and Android will kill off the receiver if it takes too long.

Your natural inclination in this case is to have the `BroadcastReceiver` arrange for a `Service` to do the long-running work on a background thread, since `BroadcastReceiver` objects should not be starting their own threads. Perhaps you would use an `IntentService`, which packages up this "start a `Service` to do some work in the background" pattern. And, given the preceding section, you might try acquiring a partial `WakeLock` at the beginning of the work and release it at the end of the work, so the CPU will keep running while your `IntentService` does its thing.

This strategy will work...some of the time.

The problem is that there is a gap in `WakeLock` coverage, as depicted in the following diagram:

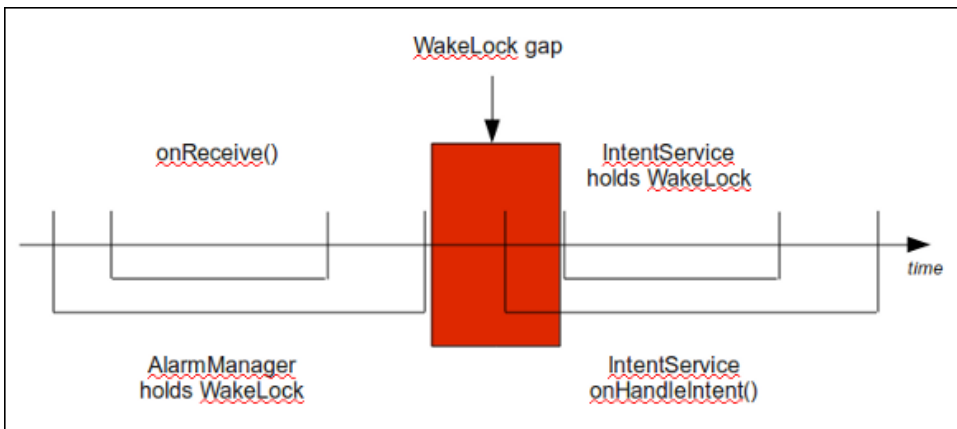


Figure 63. The WakeLock gap

The `BroadcastReceiver` will call `startService()` to send work to the `IntentService`, but that service will not start up until after `onReceive()` ends. As a result, there is a window of time between the end of `onReceive()` and when your `IntentService` can acquire its own `WakeLock`. During that window, the device might fall back asleep. Sometimes it will, sometimes it will not.

What you need to do, instead, is arrange for overlapping `WakeLock` instances. You need to acquire a `WakeLock` in your `BroadcastReceiver`, during the `onReceive()` execution, and hold onto that `WakeLock` until the work is completed by the `IntentService`:

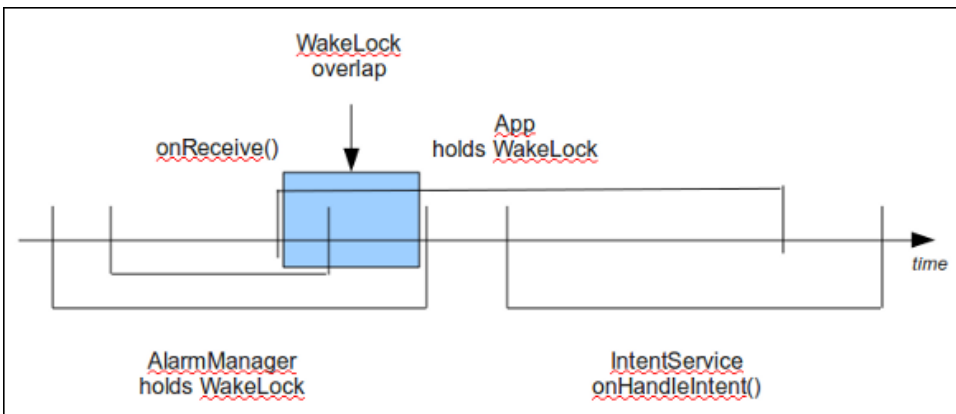


Figure 64. The WakeLock overlap

Then you are assured that the device will stay awake as long as the work remains to be done.

The following sections will show how you can achieve this effect.

Scheduling Alarms

The first step to creating a `cron` workalike is to arrange to get control when the device boots. After all, the `cron` daemon starts on boot as well, and we have no other way of ensuring that our background tasks start firing after a phone is reset.

We saw how to do that in a [previous chapter](#) – set up an `RECEIVE_BOOT_COMPLETED` `BroadcastReceiver`, with appropriate permissions. Here, for example, is the `AndroidManifest.xml` from `SystemServices/Alarm`:

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.commonware.android.syssvc.alarm"
    android:versionCode="1"
    android:versionName="1.0">
    <uses-sdk
        android:minSdkVersion="3"
        android:targetSdkVersion="6"
    />
    <supports-screens
        android:largeScreens="false"
        android:normalScreens="true"
        android:smallScreens="false"
    />
    <uses-permission android:name="android.permission.RECEIVE_BOOT_COMPLETED" />
    <uses-permission android:name="android.permission.WAKE_LOCK" />
    <uses-permission android:name="android.permission.WRITE_EXTERNAL_STORAGE"/>
    <application android:label="@string/app_name">
        <receiver android:name=".OnBootReceiver">
            <intent-filter>
                <action android:name="android.intent.action.BOOT_COMPLETED" />
            </intent-filter>
        </receiver>
        <receiver android:name=".OnAlarmReceiver">
        </receiver>
        <service android:name=".AppService">
        </service>
    </application>
</manifest>
```

We ask for an `OnBootReceiver` to get control when the device starts up, and it is in `OnBootReceiver` that we schedule our recurring alarm:

```
package com.commonware.android.syssvc.alarm;

import android.app.AlarmManager;
import android.app.PendingIntent;
import android.content.BroadcastReceiver;
import android.content.Context;
import android.content.Intent;
import android.os.SystemClock;
import android.util.Log;

public class OnBootReceiver extends BroadcastReceiver {
    private static final int PERIOD=300000; // 5 minutes

    @Override
```

```
public void onReceive(Context context, Intent intent) {
    AlarmManager
mgr=(AlarmManager)context.getSystemService(Context.ALARM_SERVICE);
    Intent i=new Intent(context, OnAlarmReceiver.class);
    PendingIntent pi=PendingIntent.getBroadcast(context, 0,
                                                i, 0);

    mgr.setRepeating(AlarmManager.ELAPSED_REALTIME_WAKEUP,
                    SystemClock.elapsedRealtime()+60000,
                    PERIOD,
                    pi);
}
}
```

We get the AlarmManager via `getSystemService()`, create an Intent referencing another BroadcastReceiver (`OnAlarmReceiver`), wrap that Intent in a PendingIntent, and tell the AlarmManager to set up a repeating alarm via `setRepeating()`. By saying we want a `ELAPSED_REALTIME_WAKEUP` alarm, we indicate that we want the alarm to wake up the device (even if it is asleep) and to express all times using the time base used by `SystemClock.elapsedRealtime()`. In this case, our alarm is set to go off every five minutes.

This will cause the AlarmManager to raise our Intent imminently, and every five minutes thereafter.

Arranging for Work From Alarms

When an alarm goes off, our `OnAlarmReceiver` will get control. It needs to arrange for a service (in this case, named `AppService`) to do its work in the background, but then release control quickly – `onReceive()` cannot take very much time.

Here is the tiny implementation of `OnAlarmReceiver` from `SystemServices/Alarm`:

```
package com.commonware.android.syssvc.alarm;

import android.content.BroadcastReceiver;
import android.content.Context;
import android.content.Intent;
import android.util.Log;
```

```
public class OnAlarmReceiver extends BroadcastReceiver {
    @Override
    public void onReceive(Context context, Intent intent) {
        WakefulIntentService.acquireStaticLock(context);

        context.startService(new Intent(context, AppService.class));
    }
}
```

While there is very little code in this class, it is merely deceptively simple.

First, we acquire a WakeLock from our AppService's parent class, WakefulIntentService, via `acquireStaticLock()`, shown below:

```
private static PowerManager.WakeLock lockStatic=null;

public static void acquireStaticLock(Context context) {
    getLock(context).acquire();
}

synchronized private static PowerManager.WakeLock getLock(Context context) {
    if (lockStatic==null) {
        PowerManager
mgr=(PowerManager)context.getSystemService(Context.POWER_SERVICE);

        lockStatic=mgr.newWakeLock(PowerManager.PARTIAL_WAKE_LOCK,
                                LOCK_NAME_STATIC);
        lockStatic.setReferenceCounted(true);
    }

    return(lockStatic);
}
```

The `getLock()` implementation lazy-creates our WakeLock by getting the PowerManager, creating a new partial WakeLock, and setting it to be reference counted (meaning if it is acquired several times, it takes a corresponding number of `release()` calls to truly release the lock). If we have already retrieved the WakeLock in a previous invocation, we reuse the same lock.

Back in `OnAlarmReceiver`, up until this point, the CPU was running because AlarmManager held a partial WakeLock. Now, the CPU is running because both AlarmManager *and* WakefulIntentService hold a partial WakeLock.

Then, `OnAlarmReceiver` starts the `AppService` instance (remember: `acquireStaticLock()` was a *static* method) and exits. Notably, `OnAlarmReceiver` does not release the `WakeLock` it acquired. This is important, as we need to ensure that the service can get its work done while the CPU is running. Had we released the `WakeLock` before returning, it is possible that the device would fall back asleep before our service had a chance to acquire a fresh `WakeLock`. This is one of the keys of using `WakeLock` successfully – as needed, use overlapping `WakeLock` instances to ensure constant coverage as you pass from component to component.

Now, our service will start up and be able to do something, while the CPU is running due to our acquired `WakeLock`.

Staying Awake At Work

So, `AppService` will now get control, under an active `WakeLock`. At minimum, our service will be called via `onStart()`, and possibly also `onCreate()` if the service had been previously stopped. Our mission is to do our work and release the `WakeLock`.

Since services should not do long-running tasks in `onStart()`, we could fork a `Thread`, have it do the work in the background, then have it release the `WakeLock`. Note that we cannot release the `WakeLock` in `onStart()` in this case – just because we have a background thread does not mean the device will keep the CPU running.

There are issues with forking a `Thread` for every incoming request, though:

- If the work needed to be done sometimes takes longer than the alarm period, we could wind up with many background threads, which is inefficient. It also means our `WakeLock` management gets much trickier, since we will not have released the `WakeLock` before the alarm tries to `acquire()` it again.
- If we also are invoked in `onStart()` via some foreground activity, we might wind up with many more bits of work to be done, again

causing confusion with our `WakeLock` and perhaps slowing things down due to too many background threads.

Android has a class that helps with parts of this, `IntentService`. It arranges for a work queue of inbound `Intents` – rather than overriding `onStart()`, you override `onHandleIntent()`, which is called from a background thread. Android handles all the details of shutting down your service when there is no more outstanding work, managing the background thread, and so on.

However, `IntentService` does not do anything to hold a `WakeLock`.

Hence, this sample project uses `WakefulIntentService` as a subclass of `IntentService`. `WakefulIntentService` handles most of the `WakeLock` logic, so `AppService` (inheriting from `WakefulIntentService`) can just focus on the work it needs to do. You can find the `WakefulIntentService` in the [CommonsWare set of github repositories](#), as it is one of the CommonsWare Android Components (CWAC), which we will explore in greater detail in a future edition of this book.

`WakefulIntentService` handles the `WakeLock` logic in two components:

1. It offers the public static method `acquireStaticLock()`, which needs to be called by whoever is calling `startService()` on our `WakefulIntentService` subclass.
2. In `onHandleIntent()`, it releases the static `WakeLock`. Since this `WakeLock` is reference-counted, the lock will only fully release once every `Intent` enqueued by `onStart()` has been handled by `onHandleIntent()`. It requires subclasses to implement `doWakefulWork()` – in there, the subclass can do whatever it might ordinarily have done in `onHandleIntent()`, just with the assurance that the device will stay awake while doing it.

With all that supporting us, `AppService` need only implement `doWakefulWork()` and do its work:

```
package com.commonware.android.syssvc.alarm;
import android.content.Intent;
```

```
import android.os.Environment;
import android.util.Log;
import java.io.BufferedWriter;
import java.io.File;
import java.io.FileWriter;
import java.io.IOException;
import java.util.Date;

public class AppService extends WakefulIntentService {
    public AppService() {
        super("AppService");
    }

    @Override
    protected void doWakefulWork(Intent intent) {
        File log=new File(Environment.getExternalStorageDirectory(),
            "AlarmLog.txt");

        try {
            BufferedWriter out=new BufferedWriter(
                new FileWriter(log.getAbsolutePath(),
                    log.exists()));

            out.write(new Date().toString());
            out.write("\n");
            out.close();
        }
        catch (IOException e) {
            Log.e("AppService", "Exception appending to log file", e);
        }
    }
}
```

The "fake work" being done by this AppService is simply logging the fact that work needed to be done to a log file on the SD card.

Note that if you attempt to build and run this project that you will need an SD card in the device (or card image attached to your emulator).

Note that there is another kind of "wake lock": `wifiLock`. As the name suggests, this keeps the WiFi radio on even if the device is idle. Ordinarily, the WiFi radio shuts down after a period of inactivity, to save battery life. If you are downloading large files or otherwise need continuous WiFi access while your application is running, consider a `wifiLock`, but do not overuse it.

Setting Expectations

If you have an Android device, you probably have spent some time in the Settings application, tweaking your device to work how you want – ringtones, WiFi settings, USB debugging, etc. Many of those settings are also available via Settings class (in the `android.provider` package), and particularly the `Settings.System` and `Settings.Secure` public inner classes.

Basic Settings

`Settings.System` allows you to get and, with the `WRITE_SETTINGS` permission, alter these settings. As one might expect, there are a series of typed getter and setter methods on `Settings.System`, each taking a key as a parameter. The keys are class constants, such as:

- `INSTALL_NON_MARKET_APPS` to control whether you can install applications on a device from outside of the Android Market
- `LOCK_PATTERN_ENABLED` to control whether the user needs to enter a lock pattern to enable use of the device
- `LOCK_PATTERN_VISIBLE` to control whether the lock pattern is drawn on-screen as it is swiped by the user, or if the swipes are "invisible"

The `SystemServices/Settings` project has a `SettingsSetter` sample application that displays a checklist:

```
<?xml version="1.0" encoding="utf-8"?>
<ListView xmlns:android="http://schemas.android.com/apk/res/android"
    android:id="@android:id/list"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
/>
```

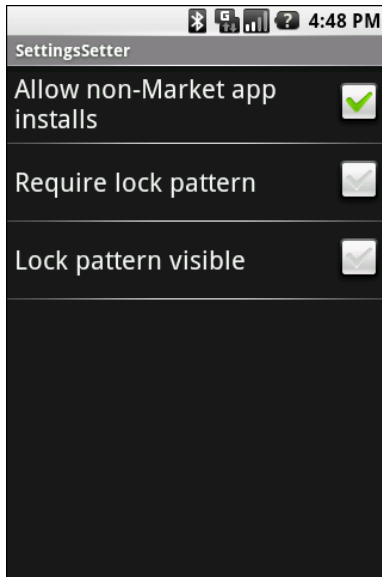


Figure 65. The SettingsSetter application

The checklist itself is filled with a few `BooleanSetting` objects, which map a display name with a `Settings.System` key:

```
static class BooleanSetting {
    String key;
    String displayName;
    boolean isSecure=false;

    BooleanSetting(String key, String displayName) {
        this(key, displayName, false);
    }

    BooleanSetting(String key, String displayName,
        boolean isSecure) {
        this.key=key;
        this.displayName=displayName;
        this.isSecure=isSecure;
    }

    @Override
    public String toString() {
        return(displayName);
    }

    boolean isChecked(ContentResolver cr) {
        try {
            int value=0;

```

```
    if (isSecure) {
        value=Settings.Secure.getInt(cr, key);
    }
    else {
        value=Settings.System.getInt(cr, key);
    }

    return(value!=0);
}
catch (Settings.SettingNotFoundException e) {
    Log.e("SettingsSetter", e.getMessage());
}

return(false);
}

void setChecked(ContentResolver cr, boolean value) {
    try {
        if (isSecure) {
            Settings.Secure.putInt(cr, key, (value ? 1 : 0));
        }
        else {
            Settings.System.putInt(cr, key, (value ? 1 : 0));
        }
    }
}
```

Three such settings are put in the list, and as the checkboxes are checked and unchecked, the values are passed along to the settings themselves:

```
@Override
public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.main);

    getListView().setChoiceMode(ListView.CHOICE_MODE_MULTIPLE);
    setListAdapter(new ArrayAdapter<this,
        android.R.layout.simple_list_item_multiple_choi
ce,
        settings>);

    ContentResolver cr=getContentResolver();

    for (int i=0;i<settings.size();i++) {
        BooleanSetting s=settings.get(i);

        getListView().setItemChecked(i, s.isChecked(cr));
    }
}

@Override
protected void onItemClick(ListView l, View v,
    int position, long id) {
```

```
super.onListItemClick(l, v, position, id);  
  
BooleanSetting s=settings.get(position);  
  
s.setChecked(getContentResolver(),  
             l.isItemChecked(position));  
}
```

The SettingsSetter activity also has an option menu containing four items:

```
<?xml version="1.0" encoding="utf-8"?>  
<menu xmlns:android="http://schemas.android.com/apk/res/android">  
  <item android:id="@+id/app"  
        android:title="Application"  
        android:icon="@drawable/ic_menu_manage" />  
  <item android:id="@+id/security"  
        android:title="Security"  
        android:icon="@drawable/ic_menu_close_clear_cancel" />  
  <item android:id="@+id/wireless"  
        android:title="Wireless"  
        android:icon="@drawable/ic_menu_set_as" />  
  <item android:id="@+id/all"  
        android:title="All Settings"  
        android:icon="@drawable/ic_menu_preferences" />  
</menu>
```

These items correspond to four activity Intent values identified by the Settings class:

```
menuActivities.put(R.id.app,  
                  Settings.ACTION_APPLICATION_SETTINGS);  
menuActivities.put(R.id.security,  
                  Settings.ACTION_SECURITY_SETTINGS);  
menuActivities.put(R.id.wireless,  
                  Settings.ACTION_WIRELESS_SETTINGS);  
menuActivities.put(R.id.all,  
                  Settings.ACTION_SETTINGS);
```

When an option menu is chosen, the corresponding activity is launched:

```
@Override  
public boolean onOptionsItemSelected(MenuItem item) {  
    String activity=menuActivities.get(item.getItemId());  
  
    if (activity!=null) {  
        startActivity(new Intent(activity));  
  
        return(true);  
    }  
}
```

```
return(super.onOptionsItemSelected(item));  
}
```

This way, you have your choice of either directly manipulating the settings or merely making it easier for users to get to the Android-supplied activity for manipulating those settings.

Secure Settings

You will notice that if you use the above code and try changing the value of "Allow non-Market app installs", the application blows up.

Once upon a time – Android 1.1 and earlier – you could modify this setting.

Now, though, that setting is one that Android deems "secure". The constant has been moved from `Settings.System` to `Settings.Secure`, though the old constant is still there, flagged as deprecated.

These so-called "secure" settings are ones that Android does not allow applications to change. No permission resolves this problem. The only option is to display the official Settings activity and let the user change the setting.

Can You Hear Me Now? OK, How About Now?

The fancier the device, the more complicated controlling sound volume becomes.

On a simple MP3 player, there is usually only one volume control. That is because there is only one source of sound: the music itself, played through speakers or headphones.

In Android, though, there are several sources of sounds:

- Ringing, to signify an incoming call

- Voice calls
- Alarms, such as those raised by the Alarm Clock application
- System sounds (error beeps, USB connection signal, etc.)
- Music, as might come from the MP3 player

Android allows the user to configure each of these volume levels separately. Usually, the user does this via the volume rocker buttons on the device, in the context of whatever sound is being played (e.g., when on a call, the volume buttons change the voice call volume). Also, there is a screen in the Android Settings application that allows you to configure various volume levels.

The `AudioService` in Android allows you, the developer, to also control these volume levels, for all five "streams" (i.e., sources of sound). In the `SystemServices/Volume` project, we create a `Volumizer` application that displays and modifies all five volume levels.

Attaching SeekBars to Volume Streams

The standard widget for allowing choice along a range of integer values is the `SeekBar`, a close cousin of the `ProgressBar`. `SeekBar` has a thumb that the user can slide to choose a value between 0 and some maximum that you set. So, we will use a set of five `SeekBar` widgets to control our five volume levels.

First, we need to create a layout with a `SeekBar` per stream:

```
<?xml version="1.0" encoding="utf-8"?>
<TableLayout xmlns:android="http://schemas.android.com/apk/res/android"
  xmlns:app="http://schemas.android.com/apk/res/com.commonware.android.syssvc.v
olume"
  android:stretchColumns="1"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  >
  <TableRow
    android:paddingTop="10px"
    android:paddingBottom="20px">
    <TextView android:text="Alarm:" />
    <SeekBar
```

```
        android:id="@+id/alarm"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
    />
</TableRow>
<TableRow
    android:paddingBottom="20px">
    <TextView android:text="Music:" />
    <SeekBar
        android:id="@+id/music"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
    />
</TableRow>
<TableRow
    android:paddingBottom="20px">
    <TextView android:text="Ring:" />
    <SeekBar
        android:id="@+id/ring"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
    />
</TableRow>
<TableRow
    android:paddingBottom="20px">
    <TextView android:text="System:" />
    <SeekBar
        android:id="@+id/system"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
    />
</TableRow>
<TableRow>
    <TextView android:text="Voice:" />
    <SeekBar
        android:id="@+id/voice"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
    />
</TableRow>
</TableLayout>
```

Then, we need to wire up each of those bars in the `onCreate()` for `Volumizer`, calling an `initBar()` method for each of the five bars:

```
public class Volumizer extends Activity {
    SeekBar alarm=null;
    SeekBar music=null;
    SeekBar ring=null;
    SeekBar system=null;
    SeekBar voice=null;
    AudioManager mgr=null;
```

```
@Override
public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.main);

    mgr=(AudioManager) getSystemService(Context.AUDIO_SERVICE);

    alarm=(SeekBar)findViewById(R.id.alarm);
    music=(SeekBar)findViewById(R.id.music);
    ring=(SeekBar)findViewById(R.id.ring);
    system=(SeekBar)findViewById(R.id.system);
    voice=(SeekBar)findViewById(R.id.voice);

    initBar(alarm, AudioManager.STREAM_ALARM);
    initBar(music, AudioManager.STREAM_MUSIC);
    initBar(ring, AudioManager.STREAM_RING);
    initBar(system, AudioManager.STREAM_SYSTEM);
    initBar(voice, AudioManager.STREAM_VOICE_CALL);
}

private void initBar(SeekBar bar, final int stream) {
    bar.setMax(mgr.getStreamMaxVolume(stream));
    bar.setProgress(mgr.getStreamVolume(stream));

    bar.setOnSeekBarChangeListener(new SeekBar.OnSeekBarChangeListener() {
```

In `initBar()`, we set the appropriate size for the Meter bar via `setMax()`, set the initial value via `setProgress()`, and hook up an `OnSeekBarChangeListener` to find out when the user slides the bar, so we can set the volume on the stream via the `VolumeManager`:

```
        boolean fromUser) {
            mgr.setStreamVolume(stream, progress,
                AudioManager.FLAG_PLAY_SOUND);
        }

    public void onStartTrackingTouch(SeekBar bar) {
        // no-op
    }

    public void onStopTrackingTouch(SeekBar bar) {
        // no-op
    }
});
}
```

The net result is that when the user slides a `SeekBar`, it adjusts the stream to match:

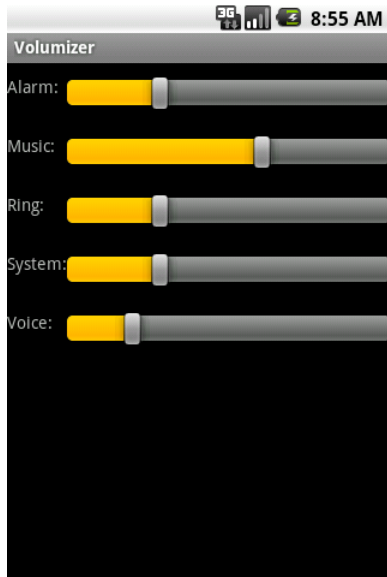


Figure 66. The Volumizer application

