



# Programming with Android: Application Resources

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# Outline

What is a **resource**?

**Declaration** of a resource

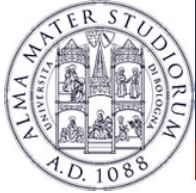
Resource **type**: *integer, string, array*

Resource **type**: *color, dimension, style*

Resource **type**: *drawable, raw, xml*

Defining **Configuration-specific** resources

Providing the **Best resources** for a device



# Application **Resources** Definition

- An Application is composed of: **code** and **resources**.

**DEF. Resources are everything that is not code** (including: XML layout files, language packs, images, audio/video files, etc)

Utilization of Resources... why?

- **Separate** data presentation (layout) from data management
- **Provide** alternative resources to support specific device configurations (e.g. different language packs)
- **Re-compile** only when strictly needed!



# Application **Resources** Definition

**PROBLEM.** An Android application might run on heterogenous devices with different characteristics (e.g. screen size, language support, keyboard type, input devices, etc).

**TRADITIONAL SOLUTION.** Foresee all the alternatives in Java code

- The code is full of **if-else** cases
- Recompile when need to change layout or add a new language package.

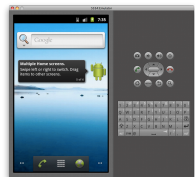
**ANDROID SOLUTION.** Separate code from application resources

- Use declative XML-based approach to define resources (images, files, layout, text, etc)

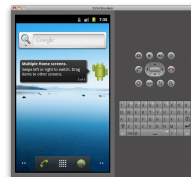


# Application **Resources** Definition

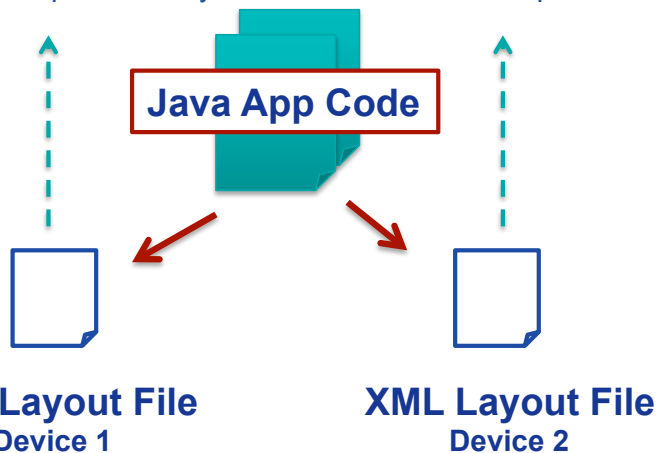
## EXAMPLE



**Device 1**  
HIGH screen pixel density



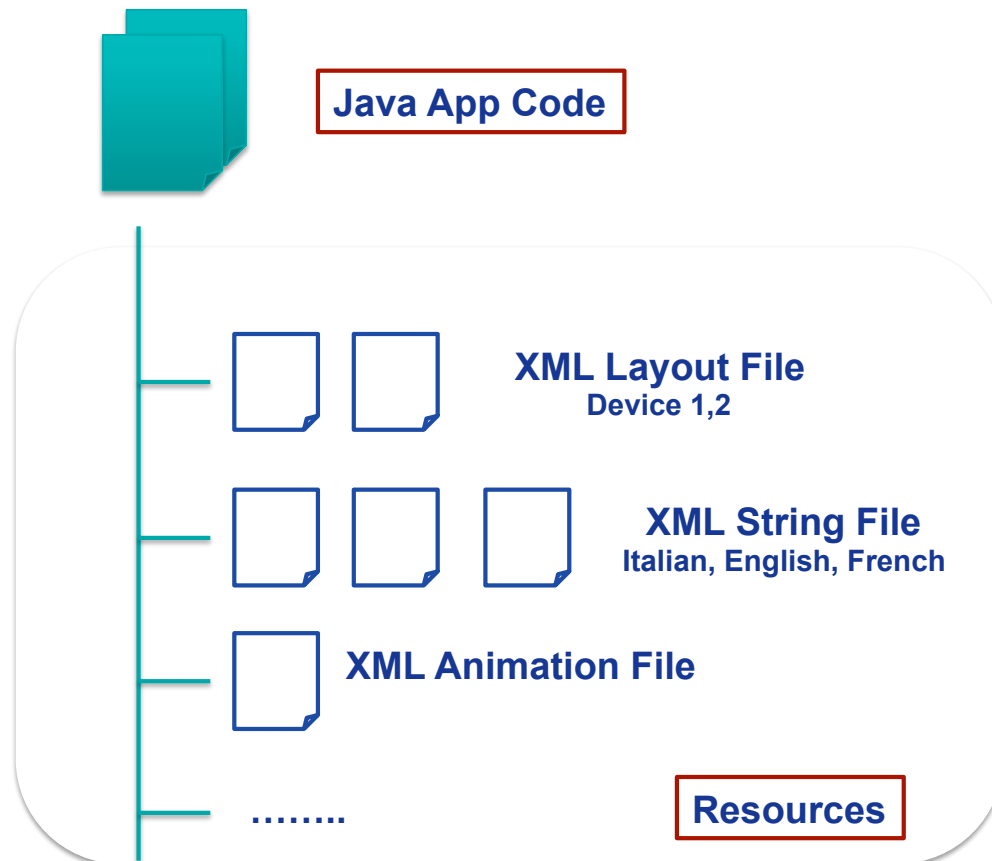
**Device 2**  
LOW screen pixel density



- Build the **application layout** through XML files (like HTML)
- Define **two** different XML **layouts** for two different devices
- At **runtime**, Android detects the current device configuration and loads the appropriate resources for the application
- **No need to recompile!**
- Just add a new XML file if you need to support a new device



# Application **Resources** Definition

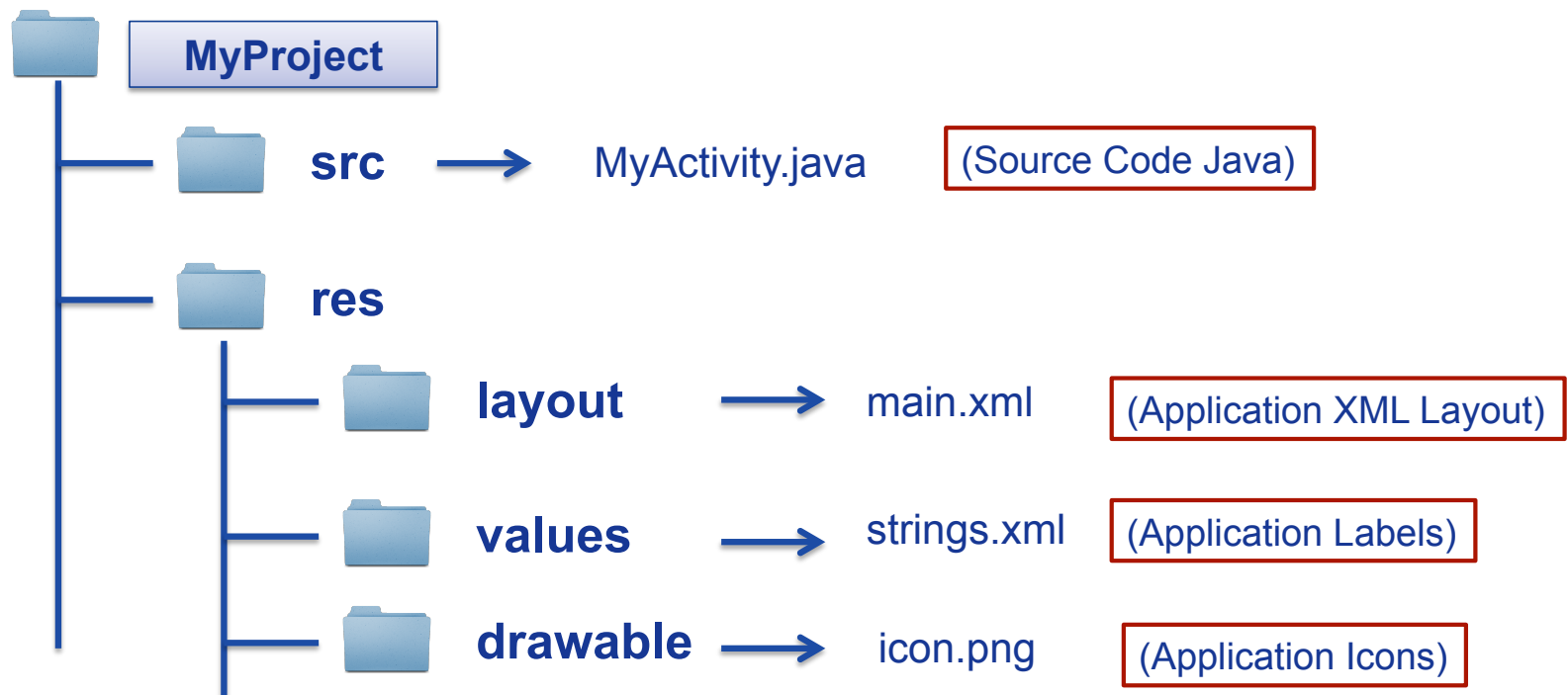


- Use XML files to define **(declarative approach)**:
  - *Application Layout*
  - *Text used in the applications*
  - *Application Menu*
  - *Animations*
  - ...
- Foresee different **resources alternatives** for different device configurations (e.g. screen resolution, language, input devices. etc)



# Application Resources Definition

- ❖ Resources are defined in the **res/** folder of the project.





# Application **Resources** Definition

Resource Type	Resource contained
<b>res/animator</b>	<i>XML files that define property animations.</i>
<b>res/anim</b>	<i>XML files that define tween animations.</i>
<b>res/colors</b>	<i>XML files that define a state list of colors.</i>
<b>res/drawable</b>	<i>Bitmap files (.png, .9.png, .jpg, .gif) or XML files that are compiled into other resources.</i>
<b>res/layout</b>	<i>XML files that define a user interface layout.</i>
<b>res/menu</b>	<i>XML files that define application menus.</i>
<b>res/raw</b>	<i>Arbitrary files to save in their raw form.</i>
<b>res/values</b>	<i>XML files that contain simple values, such as strings, integers, array.</i>
<b>res/xml</b>	<i>Arbitrary XML files.</i>





# Application **Resources** Definition

- Resources are defined in a **declarative** way through **XML**.
- Each resource has a name/Identifier (see details later).

Example: **string.xml** contains all the text that the application uses. For example, the name of buttons, labels, default text, etc

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

  <string name="hello"> Hello world! </string>
  <string name="labelButton"> Insert your username </string>

</resources>
```

**Resource type**  
(string)



## Application **Resources** Definition

- Resource can be accessed in the **Java** code through the **R class**, that works as a **glue** between the world of java and the world of resources.
- **Automatically generated** file, no need to modify it.
- **Recreated** in case of changes in the **res/** directory.

```
public final class R {  
    public static final class string {  
        public static final int hello=0x7f040001;  
        public static final int label1=0x7f040005;  
    }  
}
```

**R** contains **resource IDs** for all the resources in the **res/** directory.



## Application **Resources** Definition

- Resources can be accessed from Java code by using the **R** class and methods of the **Activity** class (details later).
- We just need to know the **resource Identifier (ID)** ... how to know it? (see next slides)

```
...  
final String hello=getResources().getString(R.string.hello);  
final String label=getResources().getString(R.string.labelButton);  
Log.i(STRING_TAG," String1 " + hello);  
Log.i(STRING_TAG," String2 " + label);  
...  
...
```



# Application **Resources** Definition

**STEP0: Declare resources in res/**

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

  <string name="hello"> Hello </string>
  <string name="label1"> Label </string>
</resources>
```

XML-Based, Declarative Approach

**STEP2: Access resources through R class**

```
public final class R {

  public static final class string {
    public static final int hello=0x7f040001;
    public static final int label1=0x7f040005;
  }
}
```

Java Code, Programmatic Approach

**STEP1: Compile the project**



# Access to Application Resources

- Each Resource is associated with an **Identifier (ID)**, that is composed of two parts:
  - The resource **type**: Each resource is grouped into a "type," (e.g. string, color, menu, drawable, layout, etc)
  - The resource **name**, which is either: the filename, excluding the extension; or the value in the XML `<android:name>` attribute.
  - Identifiers must be unique!!
- Two ways to access resources:
  - From the **Java Code**
  - From the **XML files**



## Access to Application Resources: XML

`@[<package_name>:]<resource_type>/<resource_name>`

- **<package\_name>** is the name of the package in which the resource is located (not required when referencing resources from the same package)
- **<resource\_type>** is the **R** subclass for the resource type
- **<resource\_name>** is either the resource filename without the extension or the android:name attribute value in the XML element.



# Access to Application Resources: XML

```
<?xml version="1.0" encoding="utf-8"?>
<resources>
  <color name="opaque_red">#f00</color>
  <string name="labelButton"> Submit </string>
  <string name="labelText"> Hello world! </string>
</resources>
```

STRING.XML

```
<?xml version="1.0" encoding="utf-8"?>
<resources>
  <TextView android:id="@+id/label1" android:text="@string/labelText"
android:textcolor="@color/opaque_red">
  </TextView>
  <Button android:id="@+id/button1" android:text="@string/labelButton">
  </Button>
</resources>
```

MAIN.XML



# Access to Application Resources: Java

[<package\_name>.]**R**.<resource\_type>.<resource\_name>

- <package\_name> is the name of the package in which the resource is located (not required when referencing resources from the same package)
- <resource\_type> is the **R** subclass for the resource type
- <resource\_name> is either the resource filename without the extension or the android:name attribute value in the XML element.





## Access to Application Resources: Java

```
// Get a string resource from the string.xml file
final String hello=getResources().getString(R.string.hello);

// Get a color resource from the string.xml file
final int color=getResources().getColor(R.color.opaque_red);

// Load a custom layout for the current screen
setContentView(R.layout.main_screen);

// Set the text on a TextView object using a resource ID
TextView msgTextView = (TextView) findViewById(R.id.label1);
msgTextView.setText(R.string.labelText);
```



## Resources **Types: string and array**

Resource Type	File	Java constant	XML tag	Description
<b>string</b>	Any file in the res/values/	R.string.<key>	<string>	<b>String</b> value associated to a key.
<b>integer</b>	Any file in the res/values/	R.integer.<key>	<integer>	<b>Integer</b> value associated to a key.
<b>array</b>	Any file in the res/values/	R.array.<key>	<string-array> <item> <item> </string-array>	<b>Array of strings.</b> Each element is a described by an <item>
<b>array</b>	Any file in the res/values/	R.array.<key>	<integer-array> <item> <item> </integer-array>	<b>Array of integers.</b> Each element is a described by an <item>



## Resources **Types: string and array**

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

MYVALUES.XML

```
    <string name="app_title"> Example Application </string>  
    <string name="label" > Hello world! </string>  
    <integer name="val" > 53 </integer>  
    <string-array name="nameArray">  
        <item> John </item>  
        <item> Michael </item>  
    </string-array>  
    <integer-array name="valArray">  
        <item> 1 </item>  
        <item> 2 </item>  
    </integer-array>
```

```
</resources>
```



## Resources **Types: string and array**

MYFILE.JAVA

```
// Access the string value
final String hello=getResources().getString(R.string.app_title);

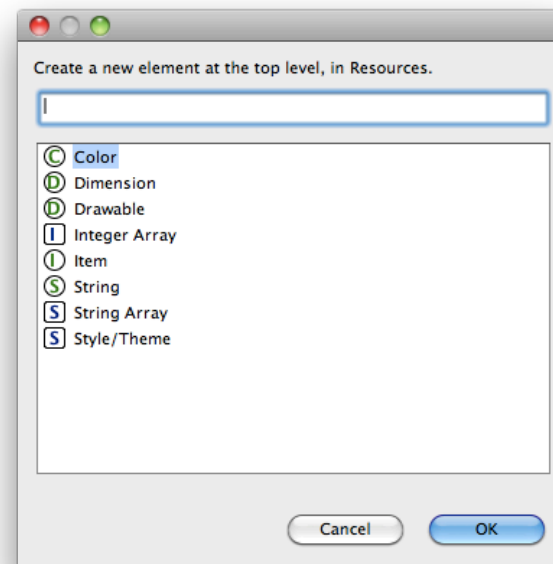
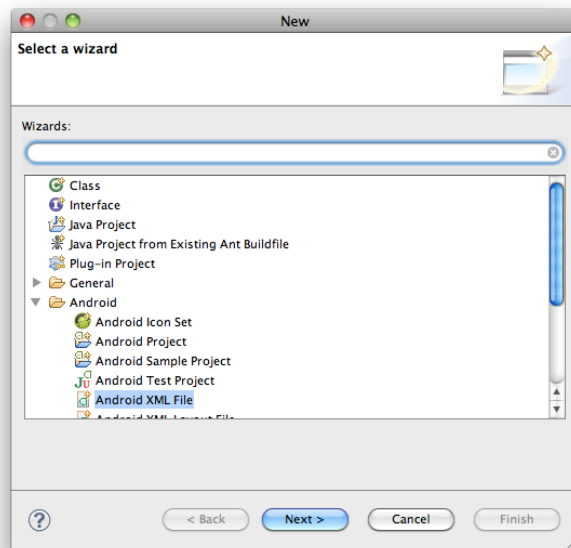
// Access the string-array values
final string[] nameS=getResources().getStringArray
                    (R.array.nameArray);

// Access the integer-array values
final int[] val=getResources().getIntArray(R.array.valArray);
```



## Resources **Types: string and array**

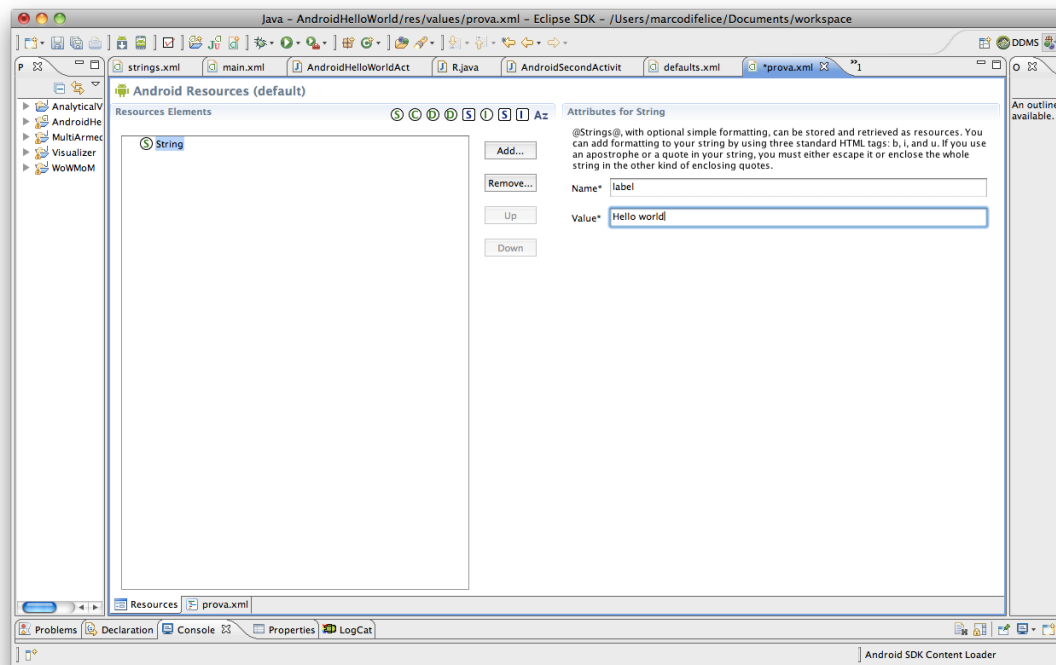
- Resources can be defined in the **res/string.xml** or in any **other file** defined by the users (File → New → Android XML File)





# Resources **Types: string and array**

- Android XML Files can be edited by hand or through the **Eclipse plugin** (recommended).





## Resources **Types: color, dimension, style**

Resource Type	File	Java constant	XML tag	Description
<b>color</b>	Any file in the res/values/	R.color.<key>	<color>	Definition of <b>colors</b> used in the GUI
<b>dimension</b>	Any file in the res/values/	R.dimen.<key>	<dimen>	Dimension <b>units</b> of the GUI components
<b>style/theme</b>	Any file in the res/values/	R.style.<key>	<style>	<b>Themes</b> and <b>styles</b> used by applications or by components



## Resources Types: color, dimension, style

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

```
<resources>
```

```
    <color name="red"> #FF0000 </color>
```

```
    <color name="red_transparent" > #66DDCCDD</color>
```

```
</resources>
```

MYVALUES.XML

- Color values can be defined based on one of these syntax rules: **#RGB**, **#ARGB**, **#RRGGBB**, **#AARRGGBB** (R=*red*, G=*green*, B=*blue*, A=*transparency*).

- From Java code:

```
int redTransparent=getResources.getColor(R.color.red_transparent)
```





## Resources **Types: color, dimension, style**

Code	Description
<b>px</b>	Pixel units
<b>in</b>	Inch units
<b>mm</b>	Millimeter units
<b>pt</b>	Points of 1/72 inch
<b>dp</b>	Abstract unit, independent from pixel density of a display
<b>sp</b>	Abstract unit, independent from pixel density of a display (font)

These units are relative to a 160 dpi (dots per inch) screen, on which 1dp is roughly equal to 1px. When running on a higher density screen, the number of pixels used to draw 1dp is scaled up by a factor appropriate for the screen's dpi. Likewise, when on a lower density screen, the number of pixels used for 1dp is scaled down



# Resources **Types: color, dimension, style**

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

    <dimen name="textview_height">25dp</dimen>
    <dimen name="textview_width">150dp</dimen>
    <dimen name="font_size">16sp</dimen>

</resources>
```

MYVALUES.XML

➤ **Applying dimensions** to attributes in the XML layout:

```
<TextView
    android:layout_height="@dimen/textview_height"
    android:layout_width="@dimen/textview_width"
    android:textSize="@dimen/font_size"/>
```

MAIN.XML



# Resources **Types: color, dimension, style**

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

    <dimen name="textview_height">25dp</dimen>
    <dimen name="textview_width">150dp</dimen>
    <dimen name="font_size">16sp</dimen>
</resources>
```

MYVALUES.XML

➤ **Applying dimensions** to attributes in the XML layout:

```
<TextView
    android:layout_height="@dimen/textview_height"
    android:layout_width="@dimen/textview_width"
    android:textSize="@dimen/font_size"/>
```

MAIN.XML



## Resources **Types: color, dimension, style**

- A **Style** is a set of **attributes** that can be applied to a specific component of the GUI (View) or to the whole screen or application (in this case, it is also referred as “theme”).
- A style is an XML resource that is referenced using the value provided in the **name** attribute.
- Styles can be organized in a **hierarchical** structure. A style can inherit properties from another style, through the **parent** attribute.
- Use `<style></style>` tags to define a style in the **res/** folder. Use `<item>` to define the attributes of the style.



# Resources **Types: color, dimension, style**

```
<?xml version="1.0" encoding="utf-8"?>
<resources>
  <style name="CustomText" parent="@style/Text">
    <item name="android:textSize">20sp</item>
    <item name="android:textColor">#008</item>
  </style>
</resources>
```

MYVALUES.XML

➤ **Applying a style** to a View in the XML layout:

```
<EditText style="@style/CustomText"
  android:layout_width="fill_parent"
  android:layout_height="wrap_content"
  android:text="Hello, World!" />
```

MAIN.XML



# Resources **Types: drawable**

Resource Type	File	Java constant	XML tag	Description
<b>drawable</b>	Any file in the res/drawable/	R.drawable. <key>	<drawable>	Images and everything that can be drawn

A **Drawable** resource is a general concept for a graphic that can be drawn on the screen:

- Images
- XML resources with attributes such as **android:drawable** and **android:icon** (e.g. a Button can have a drawable resource as background)

Complete list of drawable resource type can be found here:

<http://developer.android.com/guide/topics/resources/drawable-resource.html>



## Resources **Types: drawable**

- A **BitMap** file is a **.png**, **.jpg** or a **.gif** file.
- Android creates a **BitMap** resource for any of these files saved in the **res/drawable** directory.

This layout XML applies the file `myimage.png` saved in `res/drawable` to a **View**.

```
<ImageView  
    android:layout_width="fill_parent"  
    android:layout_height="wrap_content"  
    android:src="drawable/myimage" />
```

Retrieve the image as a `Drawable` from Java:

```
Drawable draw=res.getDrawable(R.drawable.myimage);
```



## Resources **Types: drawable**

- An **XMLBitmap** is an XML resource that **points to a bitmap file**.
- Usage: (i) **Alias** to the raw bitmap file, (ii) Specify additional properties such as **dithering** and **tiling**.

```
<?xml version="1.0" encoding="utf-8"?>  
<bitmap xmlns:android=http://schemas.android.com/apk/res/android"  
android:src="@drawable/tile"  
android:tileMode="repeat">
```

Some properties of an XMLBitmap:

**android:src, android:antialias, android:dither, android:filter, android:gravity**





## Resources **Types: drawable**

Drawable type	Description
<b>BitMap File</b>	A bitMap Graphic file (.png, .gif, .jpeg)
<b>Nine-Patch File</b>	A PNG file with stretchable regions to allow resizing
<b>Layer List</b>	A Drawable managing an array of other drawable
<b>State List</b>	A Drawable that references different graphics based on the states
<b>Level List</b>	An XML managing alternate Drawables. Each assigned a value
<b>Transition</b>	A Drawable that can cross-fade between two Drawable
<b>Inset</b>	A Drawable that insets another Drawable by a specific distance
<b>Clip</b>	A Drawable that clips another Drawable based on its current level
<b>Scale</b>	A Drawable that changes the size of another Drawable
<b>Shape</b>	An XML file that defines a geometric shape, colors and gradients

Complete list of drawable resource type can be found here:

<http://developer.android.com/guide/topics/resources/drawable-resource.html>



## Resources **Types: xml and raw**

Resource Type	File	Java constant	XML tag	Description
<b>xml</b>	Any file in the res/xml/	R.xml.<key>	<xml>	User-specific XML file with name equal to key
<b>raw</b>	Any file in the res/raw/	R.raw.<key>	<raw>	Raw resources, accessible through the R class but not optimized

Used to define resources for which no run-time optimization must be performed (e.g. audio/video files). They can be accessed as a stream of bytes, by using Java **InputStream** objects:

```
InputStream is= getResources().openRawResource(R.raw.videoFile)
```



## Resources **Types: xml and raw**

- The res/xml folder might contain arbitrary XML files that can be read at runtime through the `R.xml.<filename>` constant.
- It is possible to parse the XML file through a **XMLResourceParser** object, that implements an XML parser:

```
XMLResourceParser parser=getResources().getXML(R.xml.myfile)
```

```
<?xml version="1.0" encoding="utf-8"?>
<names>
  <name code="1234">Marco Di Felice </item>
  <name code="4324">Luca Bedogni </item>
</names>
```



## Other Resources **Types**

➤ Some other resources types (we will meet later ...)

Resource Type	File	Java constant	XML tag	Description
<b>layout</b>	Any file in the res/layout/	R.layout.<key>	<layout>	Defines a layout of the screen
<b>animation</b>	Any file in the res/anim/	R.anim.<key>	<anim>	Defines a property animation (not the only method!)
<b>menu</b>	Any file in the res/menu/	R.menu.<key>	<menu>	User-defined menus with multiple options



## Resources **Alternatives**

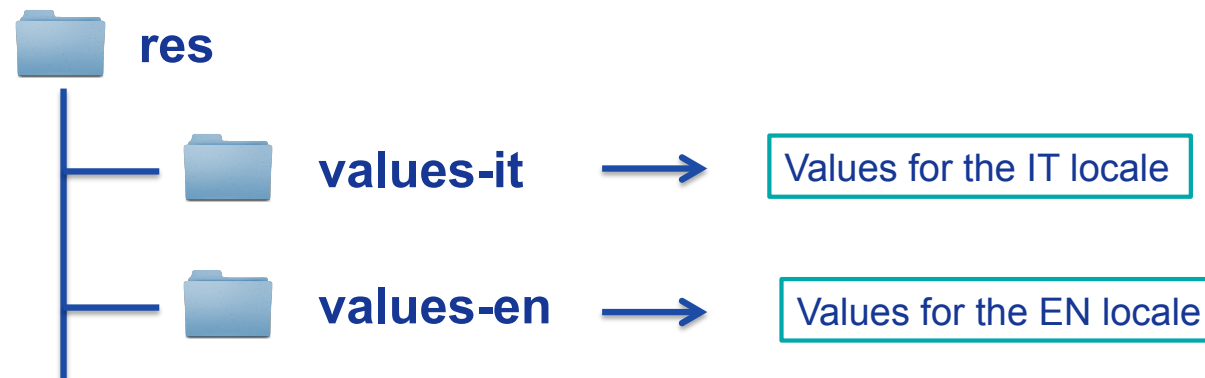
- Android applications might provide **alternative resources** to support specific device configurations (e.g. different languages).
- At runtime, Android **detects** the current device configuration and **loads** the appropriate resources for the application.
- To specify configuration-specific alternatives:
  1. Create a new directory in **res/** named in the form **<resources\_name>-<config\_qualifier>**
  2. Save the respective alternative resources in this new directory



# Resources **Alternatives**

Name of the folder: **<resources\_name>-<config\_qualifier>**.

- *<resources\_name>* is the directory name of the corresponding default resources (see previous slides).
- *<qualifier>* is a name that specifies an individual configuration for which these resources are to be used (see next slide).





# Resources **Alternatives:** Qualifiers

Configuration	Values Example	Description
<b>MCC and MNC</b>	mcc310, mcc208, etc	mobile country code (MCC)
<b>Language and region</b>	en, fr, en-rUS, etc	ISO 639-1 language code
<b>smallestWidth</b>	sw320dp, etc	shortest dimension of screen
<b>Available width</b>	w720dp, w320dp, etc	minimum available screen width
<b>Available height</b>	h720dp, etc	minimum available screen height
<b>Screen size</b>	small, normal, large	screen size expressed in dp
<b>Screen aspect</b>	long, notlong	aspect ratio of the screen
<b>Screen orientation</b>	port, land	screen orientation (can change!)
<b>Screen pixel density (dpi)</b>	ldpi, mdpi, hdpi	screen pixel density
<b>Keyboard availability</b>	keysexposed, etc	type of keyboard
<b>Primary text input method</b>	nokeys, qwerty	availability of qwerty keyboard
<b>Navigation key availability</b>	navexposed, etc	navigation keys of the application
<b>Platform Version (API level)</b>	v3, v4, v7, etc	API supported by the device



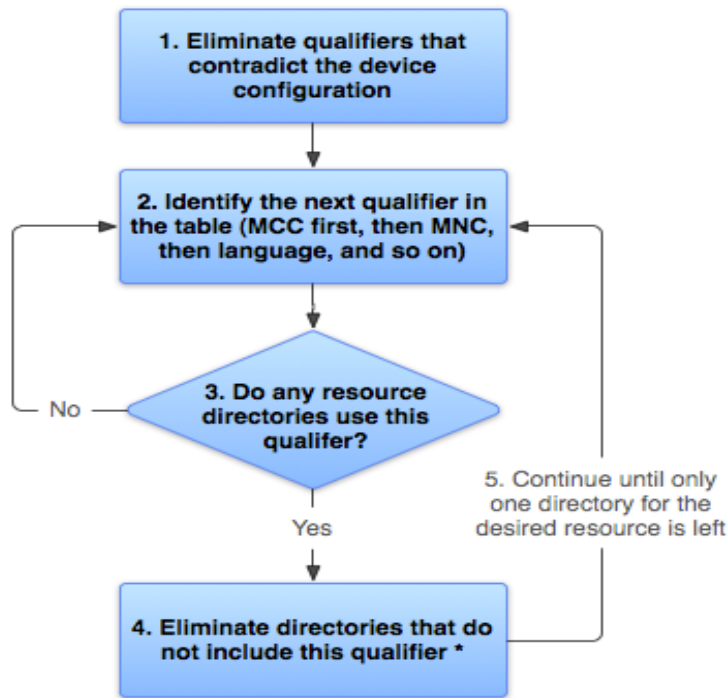
## Resources **Alternatives**

- Android applications might provide **alternative resources** to support specific device configurations (e.g. different languages).
- At runtime, Android **detects** the current device configuration and **loads** the appropriate resources for the application.
- To specify configuration-specific alternatives:
  1. Create a new directory in **res/** named in the form **<resources\_name>-<config\_qualifier>**
  2. Save the respective alternative resources in this new directory





# Resources **Alternatives Matching**

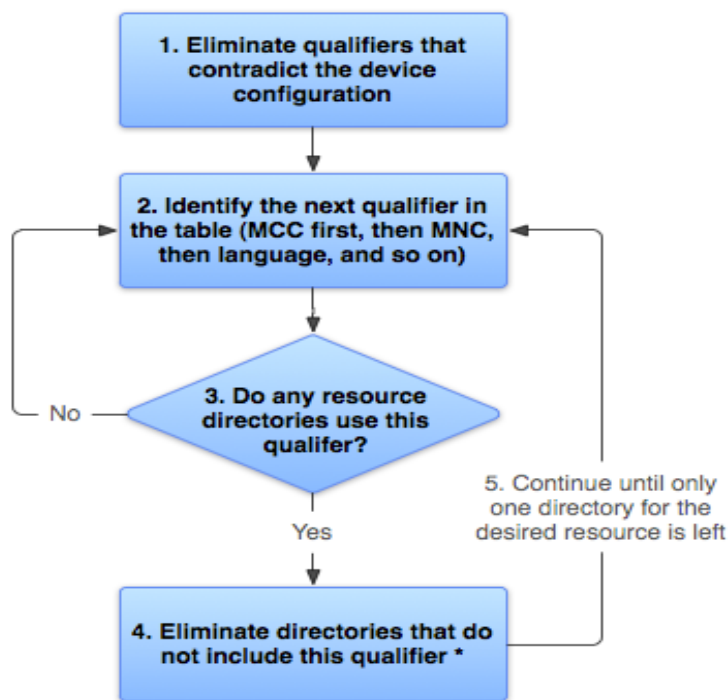


\* If the qualifier is screen density, the system selects the "best match" and the process is done

➤ When the application requests a resource for which there are multiple alternatives, **Android selects which alternative resource to use at runtime, depending on the current device configuration, through the algorithm shown in the Figure.**



# Resources Alternatives Matching



\* If the qualifier is screen density, the system selects the "best match" and the process is done

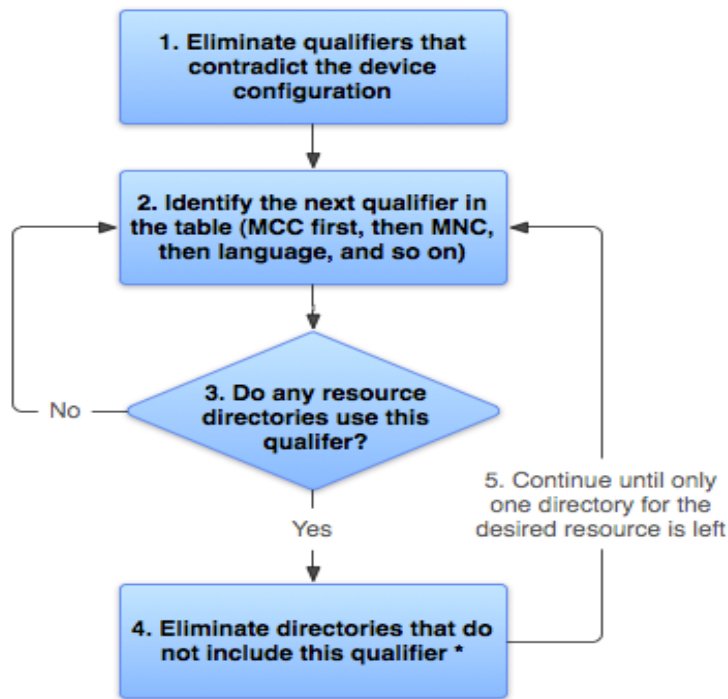
## DEVICE CONFIGURATION

Locale = it  
Screen orientation = port  
Screen pixel density = hdpi  
Touchscreen type = notouch  
Primary text input method = 12key

drawable/  
drawable-it/  
drawable-fr-rCA/  
drawable-it-port/  
drawable-it-notouch-12key/  
drawable-port-ldpi/  
drawable-port-notouch-12key/



# Resources Alternatives Matching



\* If the qualifier is screen density, the system selects the "best match" and the process is done

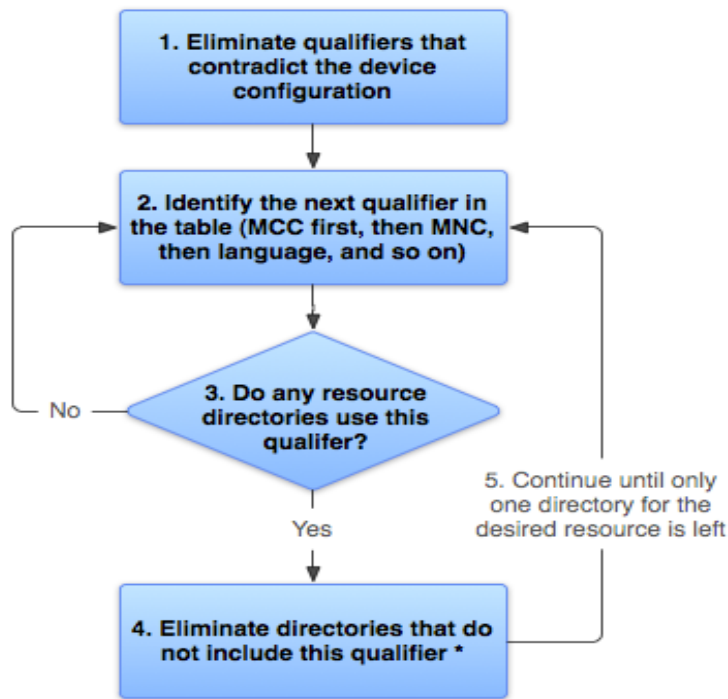
## DEVICE CONFIGURATION

Locale = it  
Screen orientation = port  
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Primary text input method = 12key

~~drawable/~~  
~~drawable-it/~~  
~~drawable-fr-rCA/~~  
~~drawable-it-port/~~  
~~drawable-it-notouch-12key/~~  
~~drawable-port-ldpi/~~  
~~drawable-port-notouch-12key/~~



# Resources Alternatives Matching



\* If the qualifier is screen density, the system selects the "best match" and the process is done

## DEVICE CONFIGURATION

Locale = it  
Screen orientation = port  
Screen pixel density = hdpi  
Touchscreen type = notouch  
Primary text input method = 12key

~~drawable/~~  
~~drawable-it/~~  
~~drawable-fr-rCA/~~  
**drawable-it-port/**  
~~drawable-it-notouch-12key/~~  
~~drawable-port-ldpi/~~  
~~drawable-port-notouch-12key/~~