Security model

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Security model

Android OS is a multi-user Linux in which each application is a different user.

By default, the system assigns each application a unique Linux user ID (the ID is unknown to the application). The system sets permissions for all the files in an application so that only the user ID assigned to that application can access them.

Each process has its own virtual machine (VM), so an application's code runs in isolation from other applications.

By default, every application runs in its own Linux process.

Principle of least privilege

Principle of least privilege (or "need to know")

Each application, by default, has access only to the components that it requires to do its work and no more.

A variation of "information hiding", or "Parnas' principle".

Data sharing

It's possible to arrange for two applications to share the same Linux user ID, in which case they are able to access each other's files.

Applications with the same user ID can also arrange to run in the same Linux process and share the same VM (the applications must also be signed with the same certificate).

An application can request permission to access device data such as the user's contacts, SMS messages, the mountable storage (SD card), camera, Bluetooth, and more. All application permissions must be granted by the user at install time.

Process lifetime

Android

- starts the process when any of the application's components need to be executed,
- shuts down the process when
  - it's no longer needed
  - the system must recover memory for other applications.

Getting started: Installing IDE and SDK

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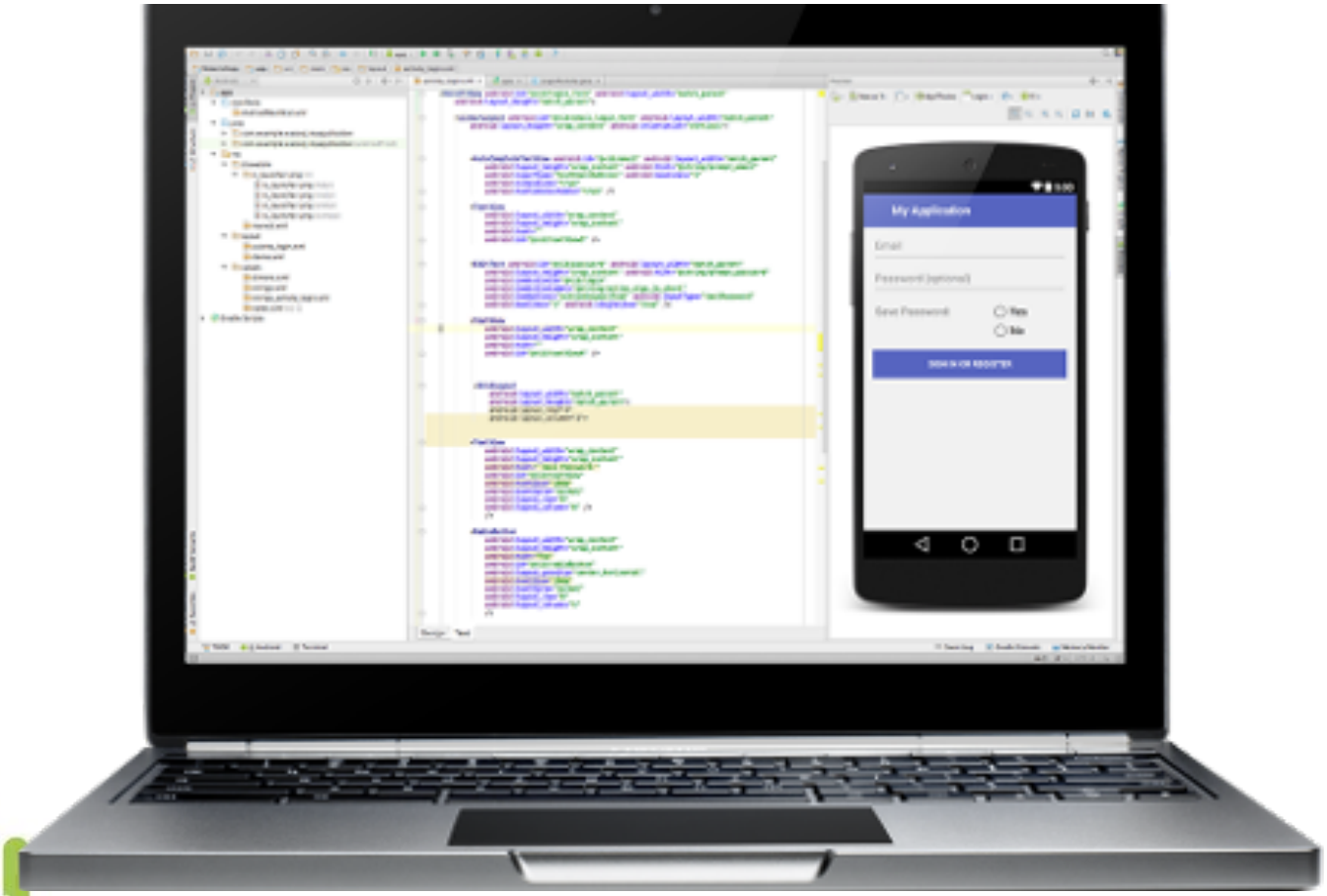
Alternative: Android Studio

http://developer.android.com/develop/index.html



Tools behind the scenes

dx

- allows to convert Java .class files into .dex (Dalvik Executable) files.

aapt (Android Asset Packaging Tool)

- packs Android applications into an .apk (Android Package) file.

adb (Android debug bridge)

ADT (Android Development Tools for Eclipse)

- A development tool provided by Google to perform automatic conversion from .class to .dex files and to create the apk during deployment. It also provides debugging tools, and an Android device emulator.

ADV - Android Virtual Device

An emulator configuration that lets you model an actual device by defining hardware and software options

An AVD consists of:

- A hardware profile
  - Defines the hardware features of the virtual device (whether it has has a camera, a physical QWERTY keyboard or a dialing pad, how much memory it has etc.
- A mapping to a system image:
  - You can define what version of the Android platform will run on the virtual device
- Other options: the emulator skin (screen dimensions, appearance, etc.), emulated SD card
- A dedicated storage area on your development machine:
  - the device's user data (installed applications, settings, and so on) and emulated SD card are stored in this area.

ADV - Android Virtual Device

You create an AVD:

- with the graphical **AVD Manager** in Eclipse
  - See http://developer.android.com/guide/developing/devices/managing-avds.html
- from the command line (**$ android create avd**),
  - see http://developer.android.com/guide/developing/devices/managing-avds-cmdline.html
- Using ADV Tool on Android studio

Getting started: Hello Android

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android.app.application

How shall we start?

First of all: there is no main…

But there is an ”application” class in the API.

(actually, android.app.application)

Probably we should subclass that, like we do with java.applet.Applet or with javax.servlet.http.HttpServlet?

NO!

Application is a base class ONLY for keeping a global application state.

We need to subclass another thing: Activity

HelloAndroid

```
package com.example.helloandroid;

import android.app.Activity;
import android.os.Bundle;

public class HelloAndroid extends Activity {
    /** Called when the activity is first created. */
    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.main);
    }
}
```


HelloAndroid

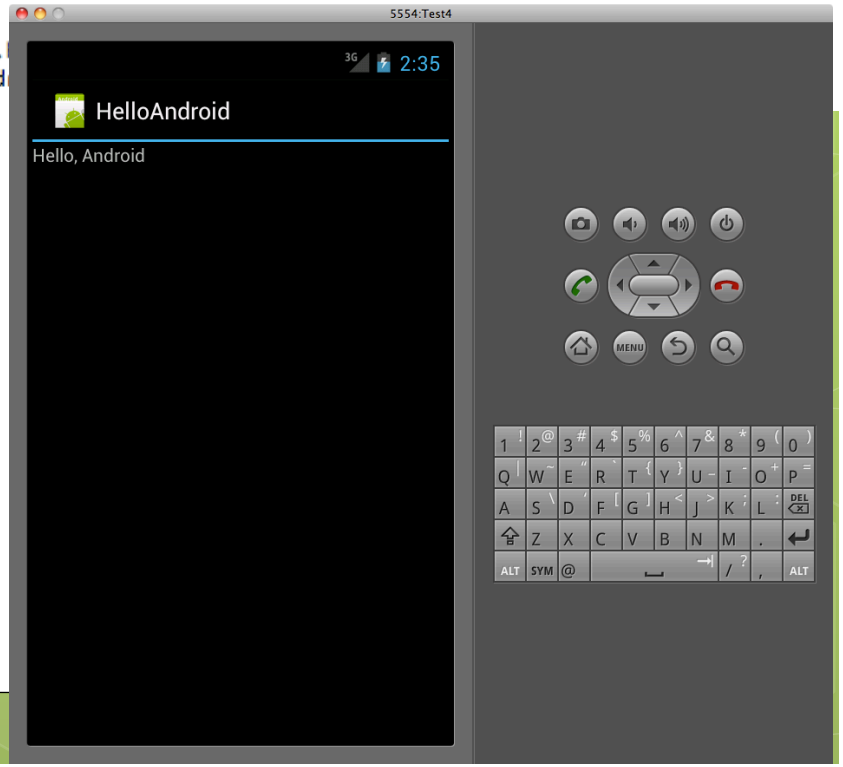
```
package com.example.helloandroid;

import android.app.Activity;
import android.os.Bundle;
import android.widget.TextView;

public class HelloAndroid extends Activity {
    /** Called when the activity is first created. */
    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        TextView tv = new TextView(this);
        tv.setText("Hello, Android");
        setContentView(tv);
    }
}
```


Launching the emulator…

Problems | Javadoc | Declaration | Console

Android

```
[2012-02-28 14:33:05 - HelloAndroid] ------------------------------
[2012-02-28 14:33:05 - HelloAndroid] Android Launch!
[2012-02-28 14:33:05 - HelloAndroid] adb is running normally.
[2012-02-28 14:33:05 - HelloAndroid] Performing com.example.helloandroid.HelloAndroidActivity activity launch
[2012-02-28 14:33:05 - HelloAndroid] Automatic Target Mode: launching new emulator with compatible AVD 'Test4'
[2012-02-28 14:33:05 - HelloAndroid] Launching a new emulator with Virtual Device 'Test4'
[2012-02-28 14:33:07 - Emulator] 2012-02-28 14:33:07.475 emulator-arm[3911:80b] Warning once: This application, or a library it uses, is using
[2012-02-28 14:33:07 - Emulator] emulator: WARNING: Unable to create sensors port: Connection refused
[2012-02-28 14:33:07 - HelloAndroid] New emulator found: emulator-5554
[2012-02-28 14:33:07 - HelloAndroid] Waiting for HOME ('android.process.acore') to be launched...
[2012-02-28 14:33:39 - HelloAndroid] HOME is up on device 'emulator-5554'
[2012-02-28 14:33:39 - HelloAndroid] Uploading HelloAndroid.apk onto device 'emulator-5554'
[2012-02-28 14:33:39 - HelloAndroid] Installing HelloAndroid.apk...
[2012-02-28 14:34:04 - HelloAndroid] Success!
[2012-02-28 14:34:04 - HelloAndroid] Starting activity com.example.helloandroid.
[2012-02-28 14:34:05 - HelloAndroid] ActivityManager: Starting: Intent { act=and
```



HelloAndroid: questions.

```
package com.example.helloandroid;

import android.app.Activity;
import android.os.Bundle;

public class HelloAndroid extends Activity {
    /** Called when the activity is first created. */
    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.main);
    }
}
```

- What is an Activity?
- What is onCreate?
- What is a Bundle?
- What is R?

- What is a TextView??

```
TextView tv = new TextView(this);
```


Dissecting the HelloWorld

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Class Activity

android.app
Class Activity

java.lang.Object
  └ android.content.Context
    └ android.content.ContextWrapper
      └ android.view.ContextThemeWrapper
        └ **android.app.Activity**

All Implemented Interfaces:
ComponentCallbacks, KeyEvent.Callback, LayoutInflater.Factory, View.OnCreateContextMenuListener, Window.Callback

Direct Known Subclasses:
ActivityGroup, AliasActivity, ExpandableListActivity, ListActivity

An activity is a single, focused thing that the user can do.

Almost all activities interact with the user, so the Activity class takes care of creating a window for you in which you can place your UI with setContentView(int).

Doesn't it reminds you of "JFrame" and "setContentPane()?

Class Activity

android.app
Class Activity

java.lang.Object
  └ android.content.Context
    └ android.content.ContextWrapper
      └ android.view.ContextThemeWrapper
        └ **android.app.Activity**

Interface to global information about an application environment.

All Implemented Interfaces:
ComponentCallbacks, KeyEvent.Callback, LayoutInflater.Factory, View.OnCreateContextMenuListener, Window.Callback

Direct Known Subclasses:
ActivityGroup, AliasActivity, ExpandableListActivity, ListActivity

An activity is a single, focused thing that the user can do.

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Doesn't it reminds you of "JFrame" and "setContentPane()?

Class Activity

While activities are often presented to the user as full-screen windows, they can also be used in other ways: as floating windows (via a theme with R.attr.windowIsFloating set) or embedded inside of another activity (using ActivityGroup).

Resources

You should always externalize resources (e.g. images and strings) from your application code, so that you can:

- maintain them independently.
- provide alternative resources, e.g.:
  - different languages
  - different screen sizes

Resources must be organized in your project's res/ directory, with various sub-directories that group resources by type and configuration.

The R class

When your application is compiled, aapt generates the R class, which contains resource IDs for all the resources in your res/ directory.

For each type of resource, there is an R subclass (for example, R.layout for all layout resources) and for each resource of that type, there is a static integer (for example, R.layout.main). This integer is the resource ID that you can use to retrieve your resource.

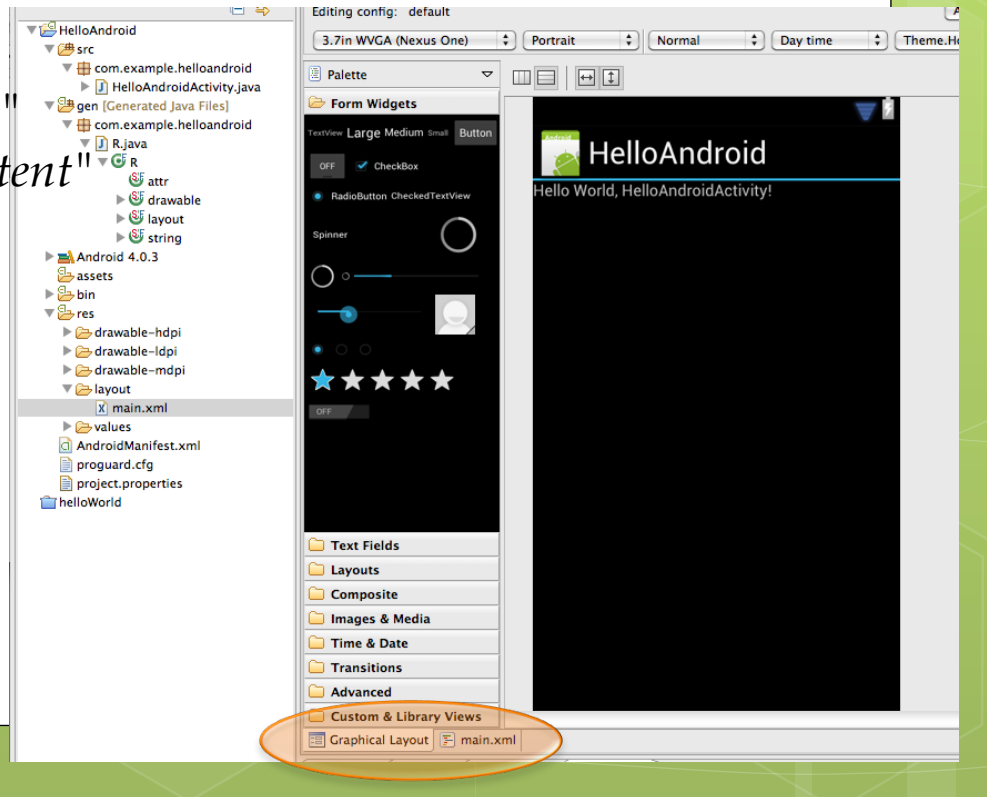
More about resources in future lectures.

R.Java in gen/

```
/* AUTO-GENERATED FILE.  DO NOT MODIFY.
 *
 * This class was automatically generated by the
 * aapt tool from the resource data it found.  It
 * should not be modified by hand.
 */

package com.example.helloandroid;
public final class R {
    public static final class attr {
    }
    public static final class drawable {
        public static final int ic_launcher=0x7f020000;
    }
    public static final class layout {
        public static final int main=0x7f030000;
    }
    public static final class string {
        public static final int app_name=0x7f040001;
        public static final int hello=0x7f040000;
    }
}
```


Res/layout/main.xml

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

    <TextView
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:text="@string/hello" />

</LinearLayout>
```



onCreate(Bundle b)

Callback invoked when the activity is starting.

This is where most initialization should go.

If the activity is being re-initialized after previously being shut down then this Bundle contains the data it most recently supplied in onSaveInstanceState(Bundle), otherwise it is null.

Note: a Bundle is a sort of container for serialized data.

TextView

Displays text to the user and optionally allows them to edit it. A TextView is a complete text editor, however the basic class is configured to not allow editing; see EditText for a subclass that configures the text view for editing.

This class represents the basic building block for user interface components. A View occupies a rectangular area on the screen and is responsible for drawing and event handling. View is the base class for widgets, which are used to create interactive UI components (buttons, text fields, etc.).

Doesn't it remind you the java.awt.Component?

android.widget
Class TextView

```
java.lang.Object
  └ android.view.View
      └ android.widget.TextView
```

All Implemented Interfaces:

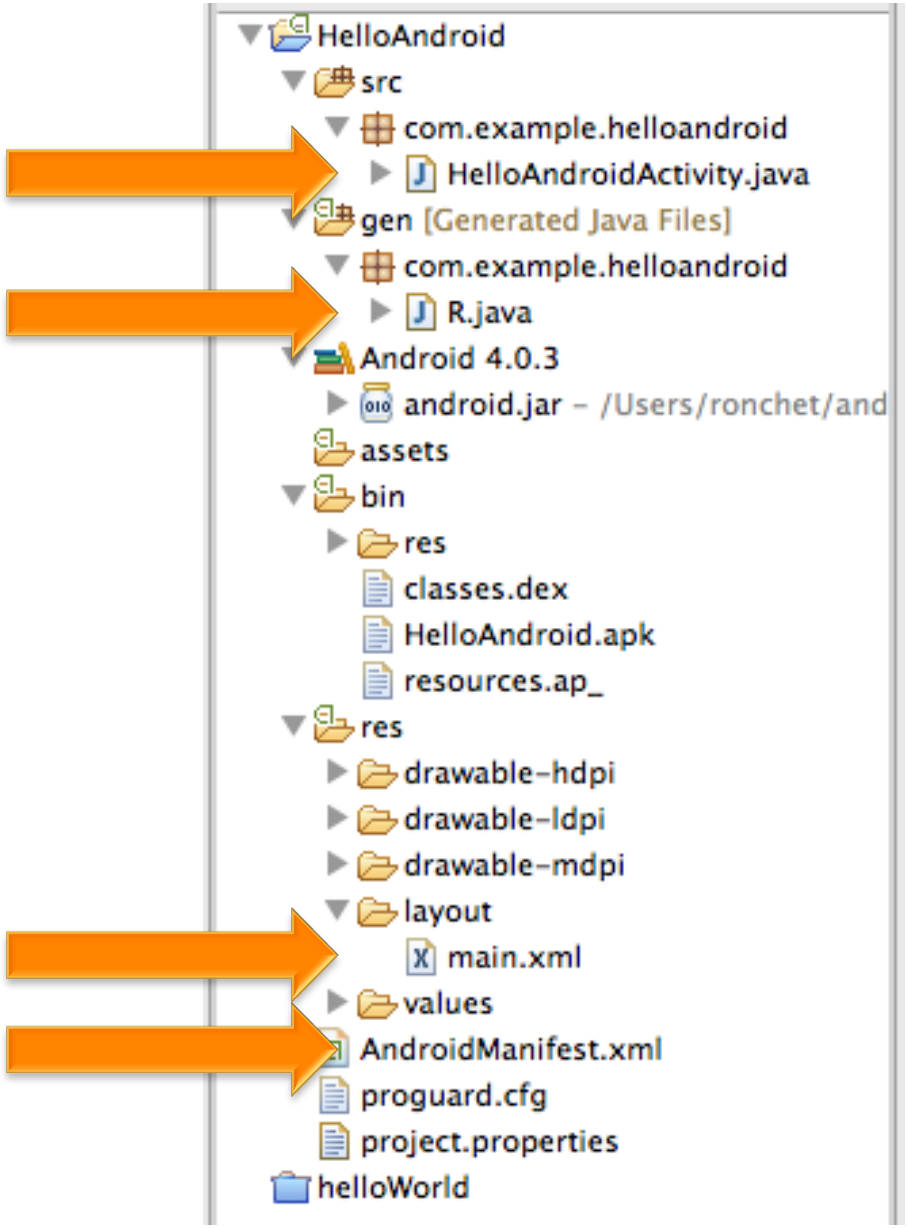
Drawable.Callback, AccessibilityEventSource, KeyEvent.Callback, ViewTreeObserver.OnPreDrawListener

Direct Known Subclasses:

Button, CheckedTextView, Chronometer, DigitalClock, EditText

```
public class TextView
extends View
implements ViewTreeObserver.OnPreDrawListener
```


The project


HelloAndroid
src
com.example.helloandroid
HelloAndroidActivity.java
gen [Generated Java Files]
com.example.helloandroid
R.java
Android 4.0.3
android.jar - /Users/ronchet/and
assets
bin
res
classes.dex
HelloAndroid.apk
resources.ap_
res
drawable-hdpi
drawable-ldpi
drawable-mdpi
layout
main.xml
values
AndroidManifest.xml
proguard.cfg
project.properties
helloWorld

AndroidManifest.xml

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.example.helloandroid"
    android:versionCode="1"
    android:versionName="1.0" >

    <uses-sdk android:minSdkVersion="15" />

    <application
        android:icon="@drawable/ic_launcher"
        android:label="@string/app_name" >
        <activity
            android:name=".HelloAndroidActivity"
            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>
```

Platform versions

Nov.2011

Feb 2011

Dic 2010

Mag 2010

Platform Version	API Level	VERSION_CODE
Android 4.0.3	15	ICE_CREAM_SANDWI
Android 4.0, 4.0.1, 4.0.2	14	ICE_CREAM_SANDWI
Android 3.2	13	HONEYCOMB_MR2
Android 3.1.x	12	HONEYCOMB_MR1
Android 3.0.x	11	HONEYCOMB
Android 2.3.4 Android 2.3.3	10	GINGERBREAD_MR1
Android 2.3.2 Android 2.3.1 Android 2.3	9	GINGERBREAD
Android 2.2.x	8	FROYO
Android 2.1.x	7	ECLAIR_MR1

project.properties

```
# This file is automatically generated by Android Tools.
# Do not modify this file -- YOUR CHANGES WILL BE ERASED!
#
# This file must be checked in Version Control Systems.
#
# To customize properties used by the Ant build system use,
# "ant.properties", and override values to adapt the script to your
# project structure.

# Project target.
target=android-15
```


The fundamental components

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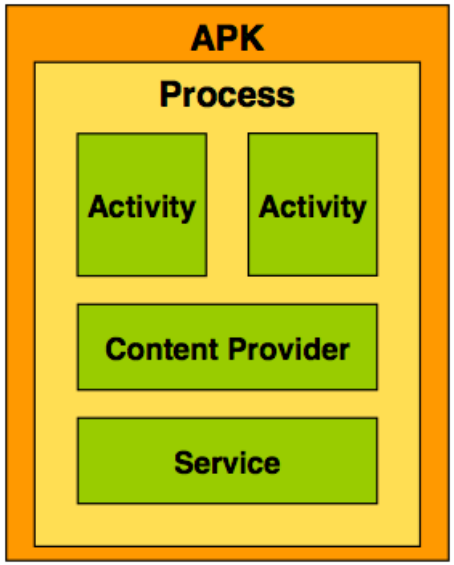
The fundamental components

- Activity
  - an application component that provides a screen with which users can interact in order to do something, such as dial the phone, take a photo, send an email, or view a map.
- Fragment (since 3.0)
  - a behavior or a portion of user interface in an Activity
- View
  - equivalent to Swing Component
- Service
  - an application component that can perform long-running operations in the background and does not provide a user interface
- Intent
  - a passive data structure holding an abstract description of an operation to be performed. It activates an activity or a service. It can also be (as often in the case of broadcasts) a description of something that has happened and is being announced.
- Broadcast receiver
  - component that enables an application to receive intents that are broadcast by the system or by other applications.
- Content Provider
  - component that manages access to a structured set of data.

Peeking into an application

Packaging: APK File (Android Package)
Collection of components



- Components share a set of resources
  - Preferences, Database, File space
- Components share a Linux process
  - By default, one process per APK
- APKs are isolated
  - Communication via Intents or AIDL (Android Interface Definition Language)
- Every component has a managed lifecycle

ONE APPLICATION, ONE PROCESS, MANY ACTIVITIES

Slide borrowed from Dominik Gruntz (and modified)

Activity

Not exactly what you might imagine…

Wordnet definitions:

- something that people do or cause to happen
- a process occurring in living organisms
- a process existing in or produced by nature (rather than by the intent of human beings)

Activity

From Wikipedia, the free encyclopedia

Activity may mean:

- Action (philosophy), in general
- The Aristotelian concept of energeia, Latinized as *actus*
- Physical exercise
- Activity (UML), a major task in Unified Modeling Language
- Activity diagram, a diagram representing activities in Unified Modeling Language
- *Activity*, an alternative name for the game charades
- *Activity*, the rate of catalytic activity, such as enzyme activity (enzyme assay), in physical chemistry and enzymology
- Activity (chemistry), the effective concentration of a solute for the purposes of mass action
- Activity (project management)
- Activity (radioactivity), radioactive decay#Radioactive decay rates, the number of radioactive decays per second
- Activity (software engineering)
- Activity (soil mechanics)
- *HMS Activity (D94)*, an aircraft carrier of the Royal Navy
- in military parlance, a military agency or unit (e.g. Intelligence Support Activity)
- Activity Theory , social constructivism (learning theory), Education

Activities

A rather misleading term… it's not a "computer activity", like a process.
It's rather an environment where a "user activity" is performed

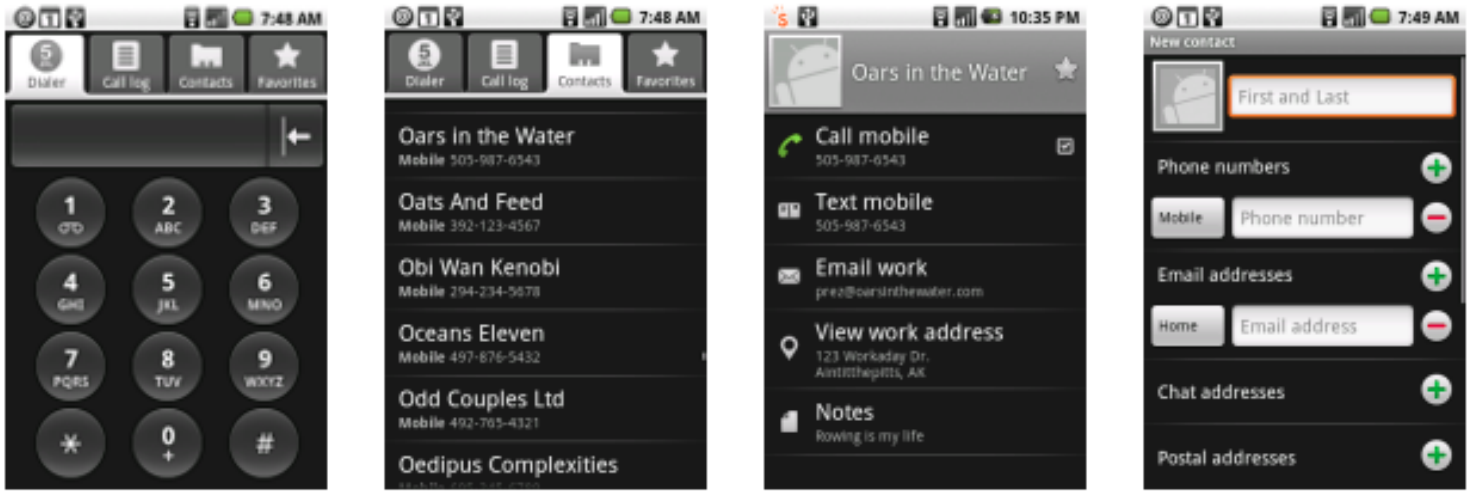
- "single" UI screens
- One visible at the time (Well. Almost…)
- One active at the time
- Stacked like a deck of cards

Activity

An application component that provides a screen with which users can interact in order to do something, such as dial the phone, take a photo, send an email, or view a map.

Each activity is given a window in which to draw its user interface. The window typically fills the screen, but may be smaller than the screen and float on top of other windows, or be embedded in another activity (activityGroup).

Activities of the dialer application

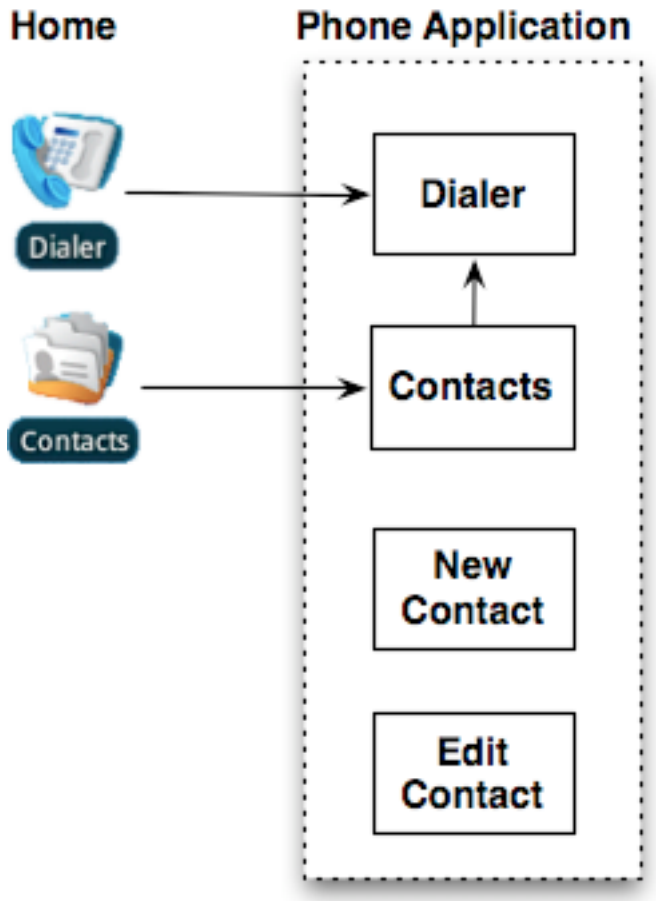


Multiple entry-point for an app

Typically, one activity in an application is specified as the "main" activity, which is presented to the user when launching the application for the first time.

BUT

An application can have multiple entry points



Activity

Each activity can start another activity in order to perform different actions.

Each time a new activity starts, the previous activity is stopped.

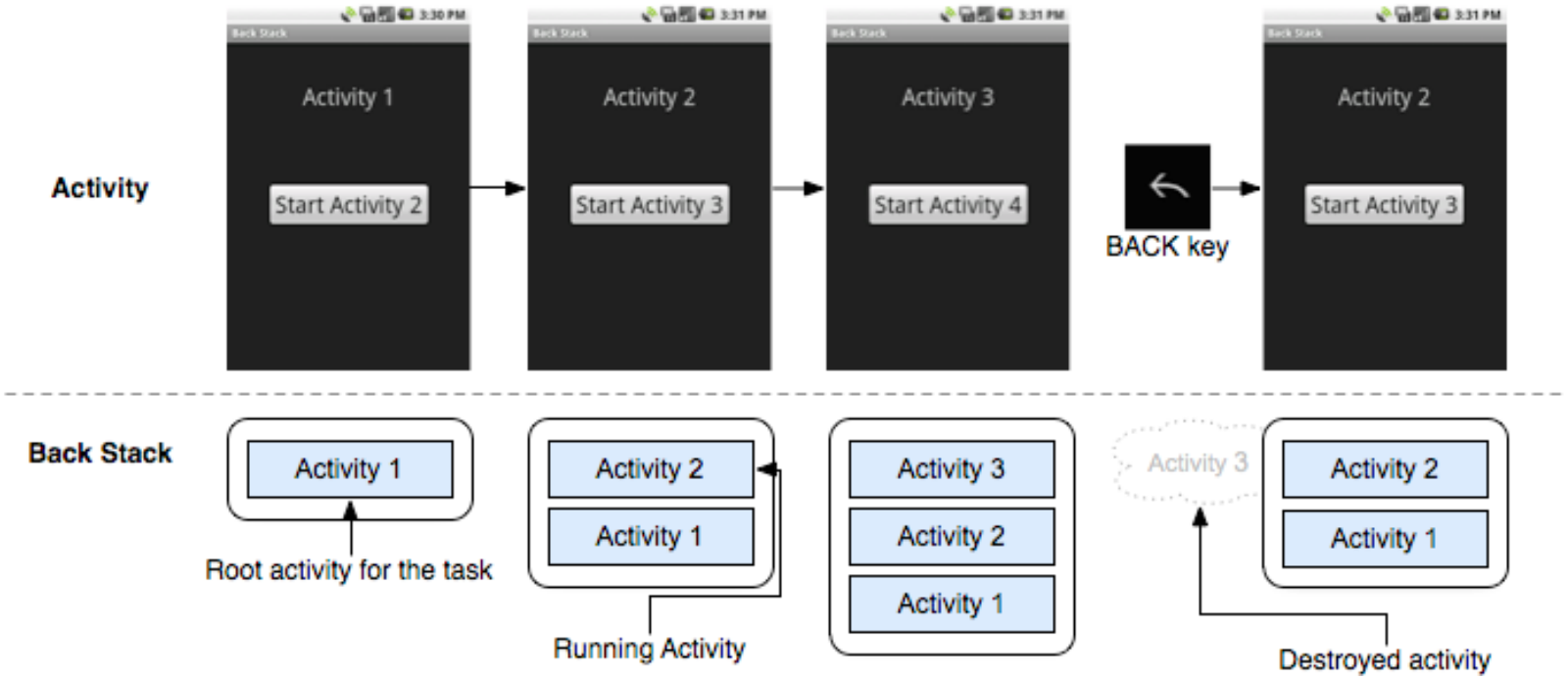
The system preserves the activity in a LIFO stack (the "activity stack" or "back stack").

The new activity it is pushed on top of the back stack and takes user focus.

When the user is done with the current activity and presses the BACK button, the current activity is popped from the stack (and destroyed) and the previous activity resumes.

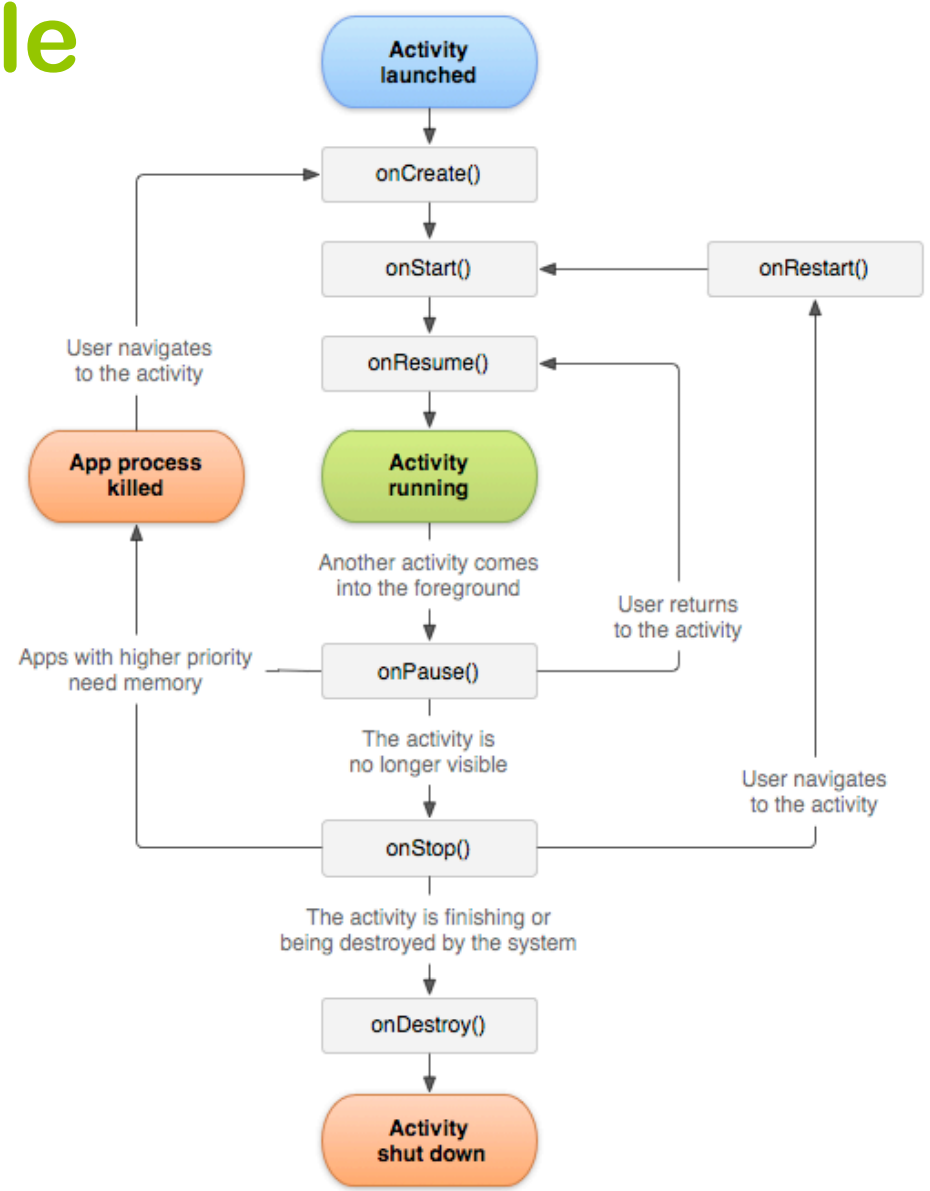
The activity stack

It's similar to the function stack in ordinary programming, with some difference



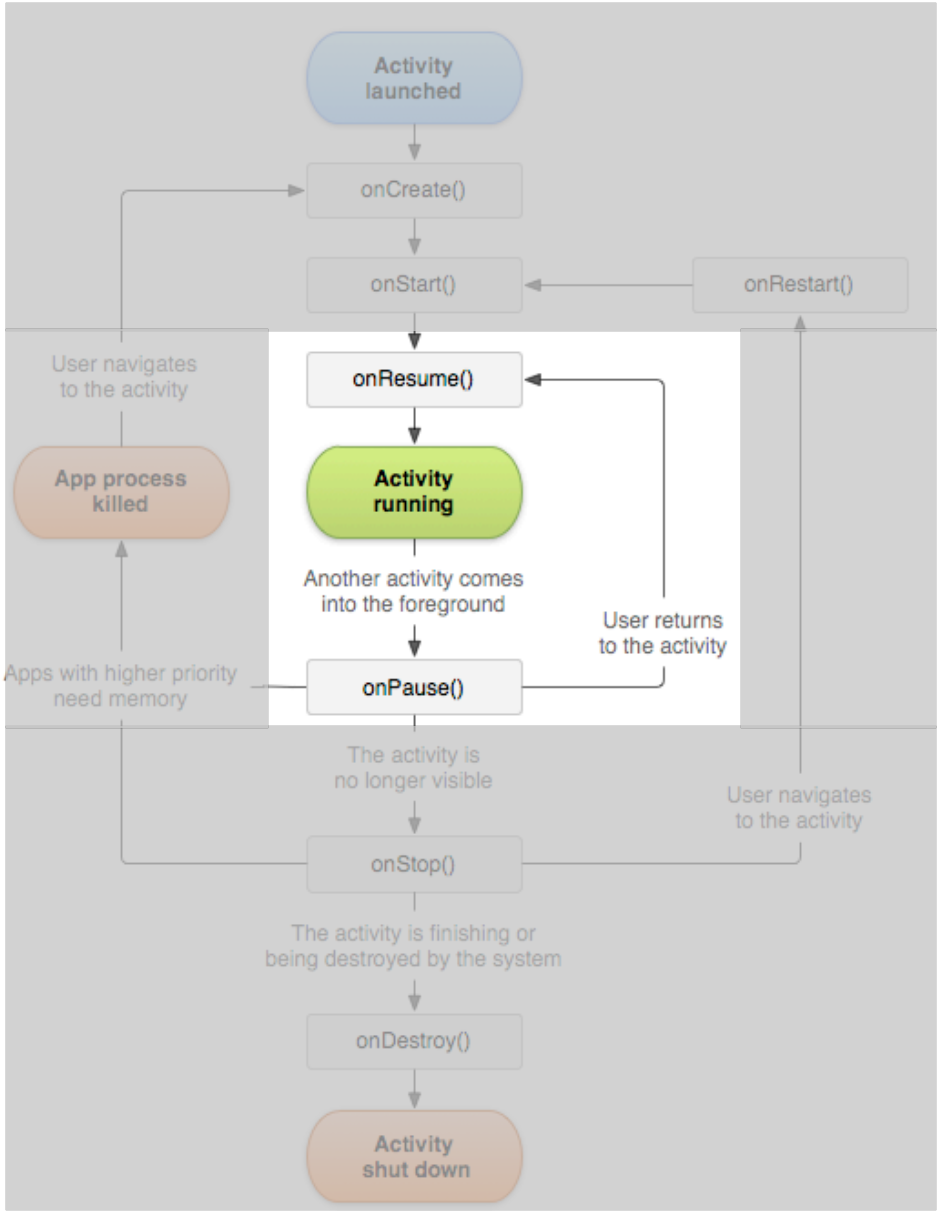
Activity lifecycle

States (colored),
and
Callbacks (gray)



Activity lifecycle

The FOREGROUND lifetime

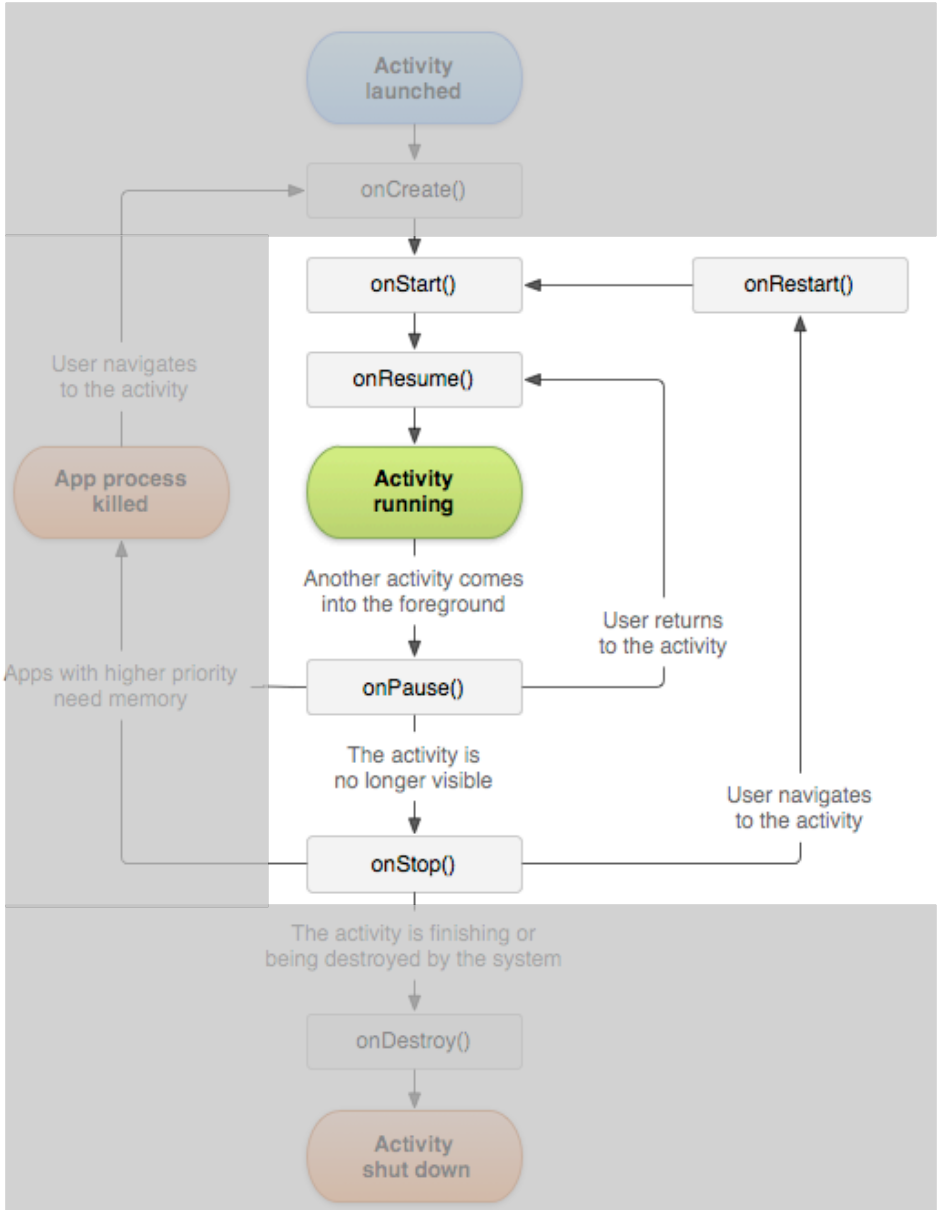


Activity lifecycle

The VISIBLE lifetime

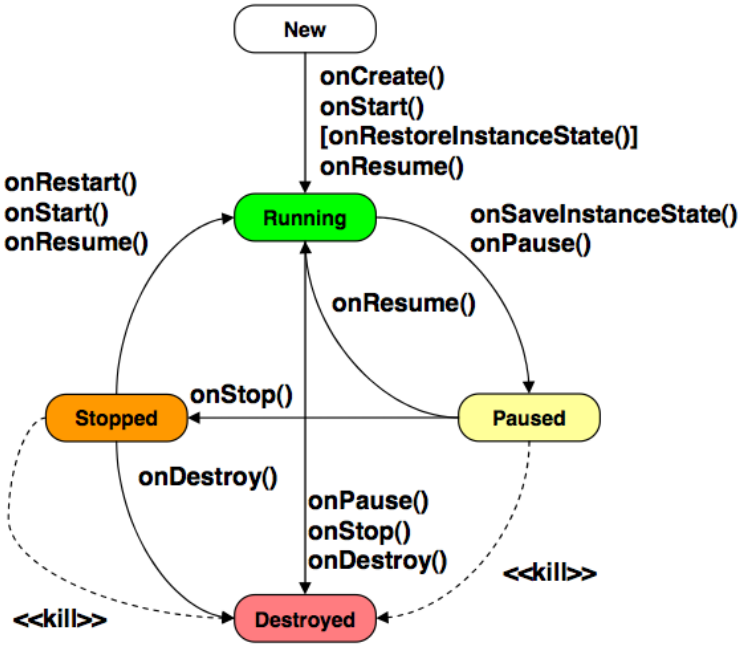
When stopped, your activity should release costly resources, such as network or database connections.

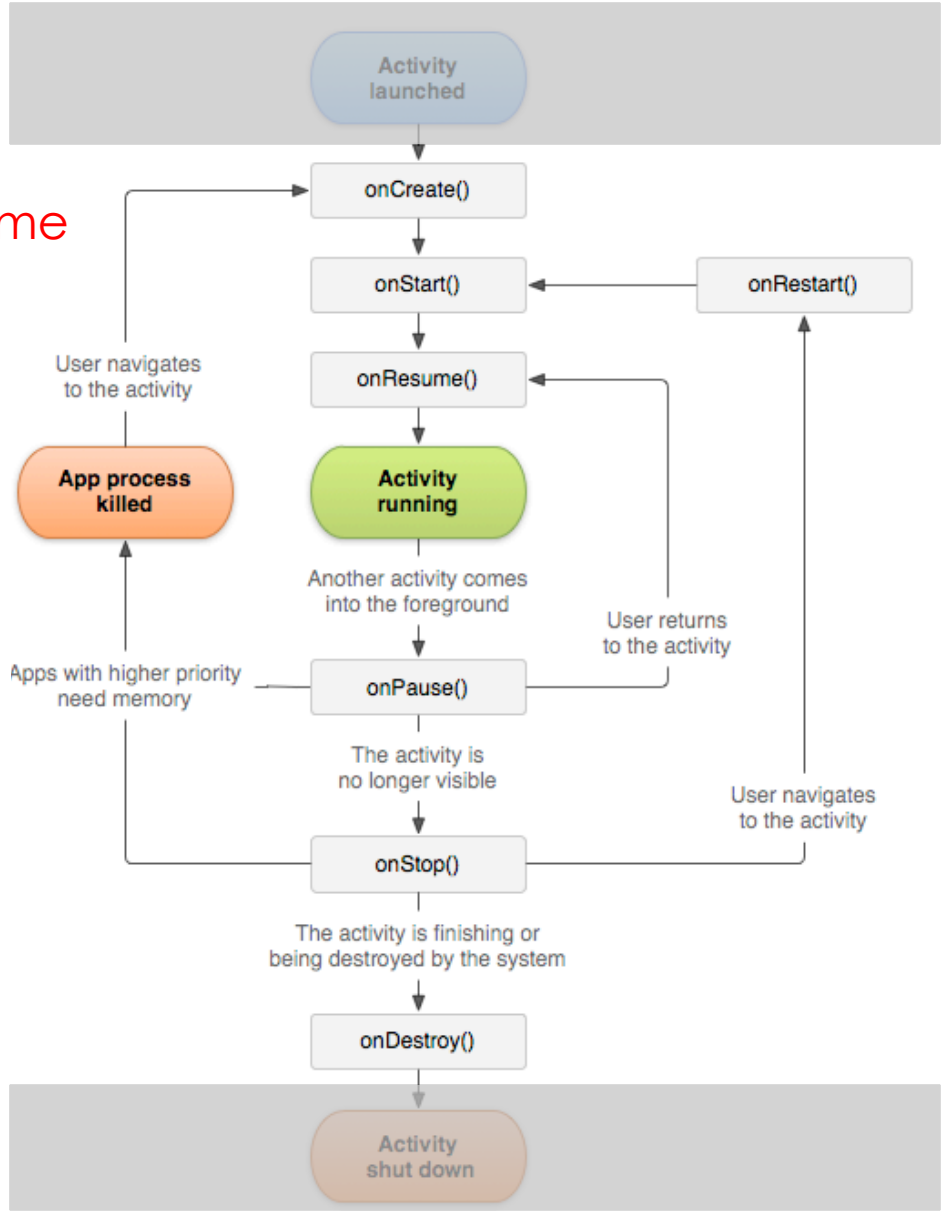
When the activity resumes, you can reacquire the necessary resources and resume actions that were interrupted.



Activity lifecycle

The ENTIRE lifetime



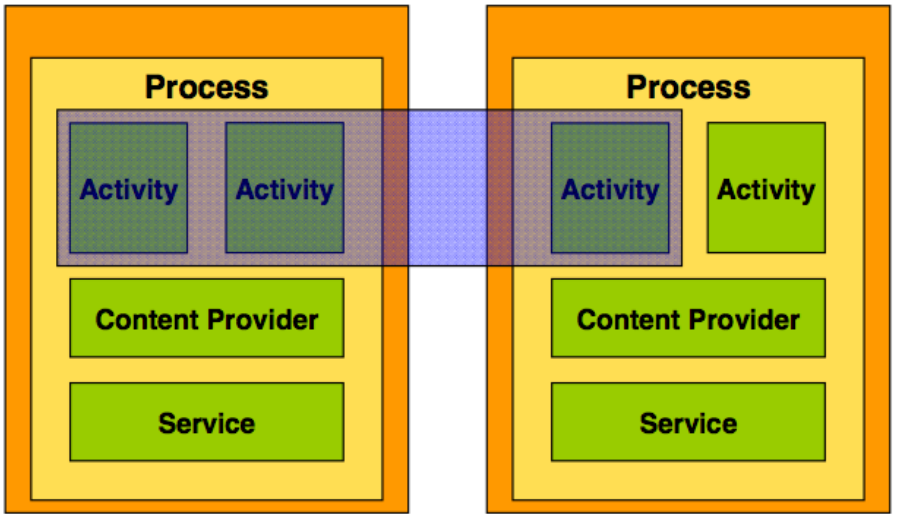


The shocking news…

An activity can start
a second activity in
a DIFFERENT application!
(and hence in a different process…)

We need a name
for this "thing":

We'll call it
"a task"



Task

Not exactly what you might imagine…

Wordnet definitions:

- activity directed toward making or doing something
- work that you are obliged to perform for moral or legal reasons

Task (computing)

From Wikipedia, the free encyclopedia

This article **needs additional cita**
reliable sources. Unsourced mate

A **task** is an execution path through address space.[1] In other words, a set of program instructions that are loaded in memory. The address registers have been loaded with the initial address of the program. At the next clock cycle, the CPU will start execution, in accord with the program. The sense is that some part of 'a plan is being accomplished'. As long as the program remains in this part of the address space, the task can continue, in principle, indefinitely, unless the program instructions contain a `halt`, `exit`, or `return`.

- In the computer field, "task" has the sense of a real-time application, as distinguished from **process**, which takes up space (memory), and execution time. See operating system.
  - Both "task" and "process" should be distinguished from event, which takes place at a **specific** time and **place**, and which can be planned for in a computer program.
    - In a computer graphical user interface (GUI), an event can be as simple as a mouse click or keystroke.

See also [edit]

- Thread
- Process states
- Process
- Computer multitasking

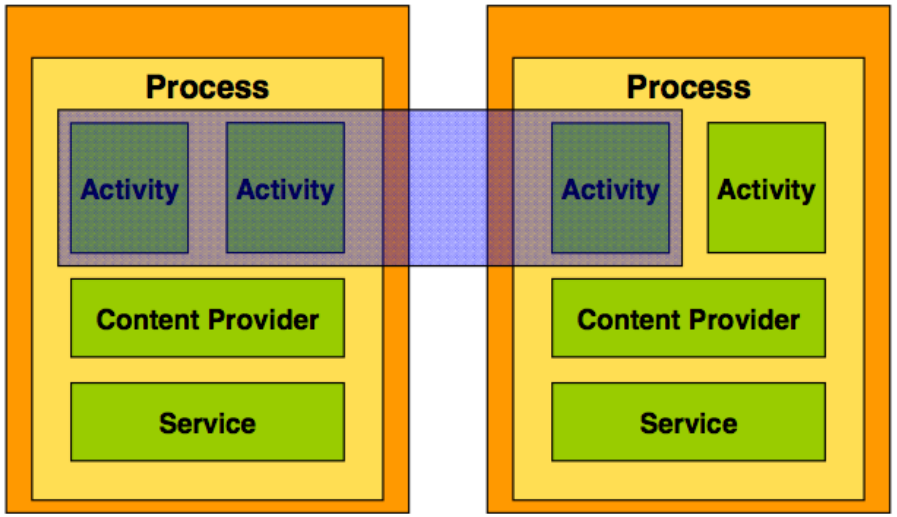
Notes [edit]

1. ^ Data General, *RDOS Reference Manual*

Tasks

Task (what users view as application)

- Collection of related activities
- Capable of spanning multiple processes
- Associated with its own UI history stack



Slide borrowed from Dominik Gruntz

Tasks

An App defines at least one task, may define more.

Activities may come from different applications (favoring reuse).

Android maintains a seamless user experience by keeping the activities in the same task.

Tasks may be moved in the background.

Tasks

The Home screen is the starting place for most tasks.

When the user touches an icon in the application launcher (or a shortcut on the Home screen), that application's task comes to the foreground.

If no task exists for the application (the application has not been used recently), then a new task is created and the "main" activity for that application opens as the root activity in the stack.

If the application has been used recently, its task is resumed (in general with its state preserved: more on this in the next lecture).

Switching among apps

To switching among apps:

long press the home button and you'll see a window of the 6 most recently used apps.

Tap the app you want to switch to.

Task Management

Default behavior:

New activity is added to the same task stack.

NOTE: Activity can have multiple instances, in different tasks or in the same task!

Google recommends:

"Let Android manage it for you. You do not need to bother with multitasking management!"

Process priorities

Active process	Critical priority
Visible process Started service process	High Priority
Background process Empty process	Low Priority

Task Managers ?

Several apps on the store offer a task manager functionality (to kill inactive apps). Are they needed?

Lots of services and applications constantly run in the background just like they do on Windows. However, and this is important, they do not have to use up a ton of resources. A service or app can be loaded, yet use almost no additional memory, and 0% CPU until it actually has to do something.

In general, killing off stuff is a waste of time. Android automatically asks apps to close when it needs more memory. Killing off processes also means it'll slow your phone down, as when you do need them again the system will need to reload them.

Fragment

A Fragment represents a behavior or a portion of user interface in an Activity.

You can combine multiple fragments in a single activity to build a multi-pane UI and reuse a fragment in multiple activities.

You can think of a fragment as a modular section of an activity, which has its own lifecycle, receives its own input events, and which you can add or remove while the activity is running (sort of like a "sub activity" that you can reuse in different activities).

View

the basic building block for user interface components, similar to the Java AWT Component.

A View occupies a rectangular area on the screen and is responsible for drawing and event handling. View is the base class for *widgets*, which are used to create interactive UI components (buttons, text fields, etc.)

Service

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

Another application component can start a service and it will continue to run in the background even if the user switches to another application.

Additionally, a component can bind to a service to interact with it and even perform interprocess communication (IPC). For example, a service might handle network transactions, play music, perform file I/O, or interact with a content provider, all from the background.

Service

A service can essentially take two forms:

Started

A service is "started" when an application component (such as an activity) starts it by calling startService(). Once started, a service can run in the background indefinitely, even if the component that started it is destroyed.

For example, it might download or upload a file over the network. When the operation is done, the service should stop itself.

Bound

A service is "bound" when an application component binds to it by calling bindService(). A bound service offers a client-server interface that allows components to interact with the service, send requests, get results, and even do so across processes with interprocess communication (IPC).

A bound service runs only as long as another application component is bound to it.

Multiple components can bind to the service at once, but when all of them unbind, the service is destroyed.

dedicated to user interaction with your activities.

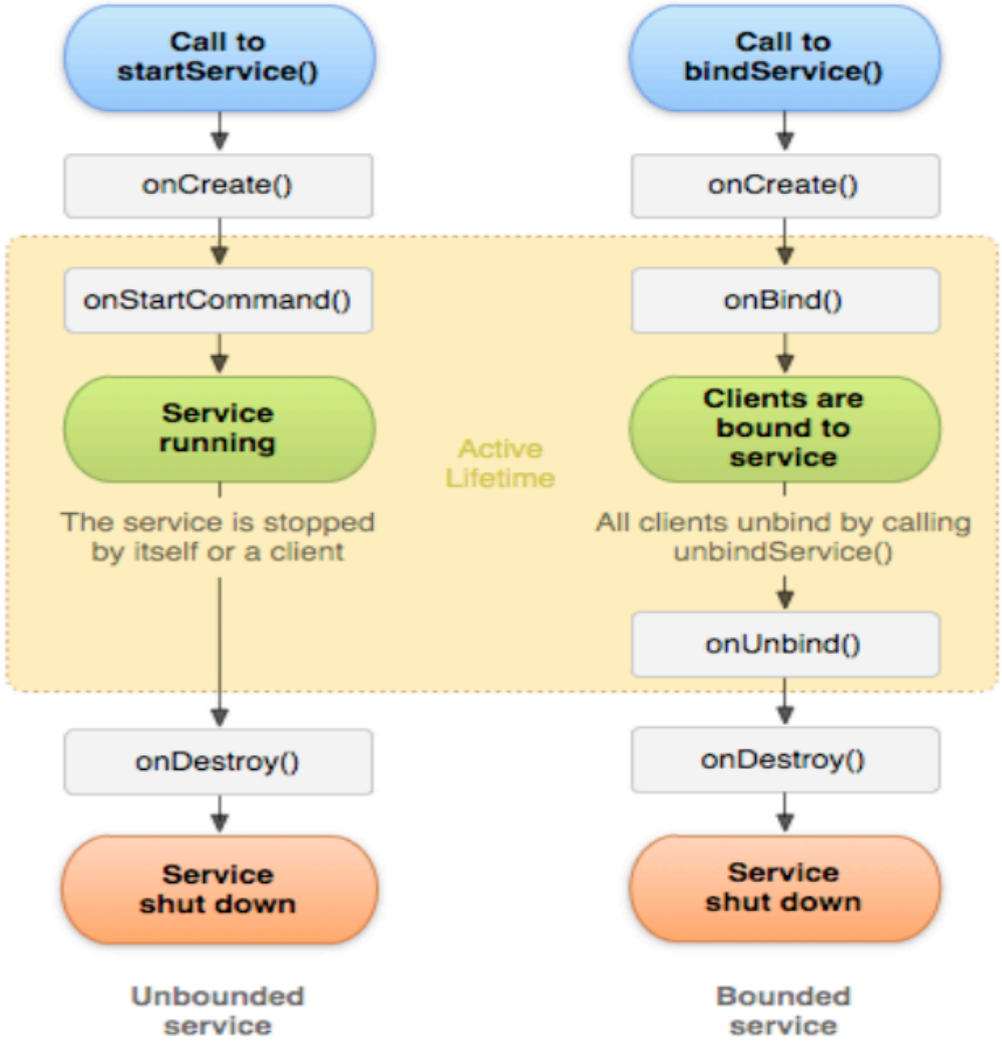
Service

You can declare the service as private, in the manifest file, and block access from other applications.

Caution: A service runs in the main thread of its hosting process—the service does not create its own thread and does not run in a separate process (unless you specify otherwise). This means that, if your service is going to do any CPU intensive work or blocking operations (such as MP3 playback or networking), you should create a new thread within the service to do that work.

By using a separate thread, you will reduce the risk of Application Not Responding (ANR) errors and the application's main thread can remain dedicated to user interaction with your activities.

Service lifecycle



Intents

Three of the core components of an application — activities, services, and broadcast receivers — are activated through messages, called intents.

Intent messaging is a facility for late run-time binding between components in the same or different applications. The intent itself, an Intent object, is a passive data structure holding an abstract description of an operation to be performed — or, often in the case of broadcasts, a description of something that has happened and is being announced.

In each case, the Android system finds the appropriate activity, service, or set of broadcast receivers to respond to the intent, instantiating them if necessary.

There is no overlap within these messaging systems:

- Broadcast intents are delivered only to broadcast receivers, never to activities or services.
- An intent passed to startActivity() is delivered only to an activity, never to a service or broadcast receiver, and so on.

Broadcast receiver

A broadcast receiver is a component that responds to system-wide broadcast announcements.

Many broadcasts originate from the system—for example, a broadcast announcing that the screen has turned off, the battery is low, or a picture was captured. Applications can also initiate broadcasts—for example, to let other applications know that some data has been downloaded to the device and is available for them to use.

Although broadcast receivers don't display a user interface, they may create a status bar notification to alert the user when a broadcast event occurs.

Content Provider

Content providers manage access to a structured set of data. They encapsulate the data, and provide mechanisms for defining data security. Content providers are the standard interface that connects data in one process with code running in another process.

Android itself includes content providers that manage data such as audio, video, images, and personal contact information.

You can see some of them listed in the reference documentation for the android.provider package.

Screen properties

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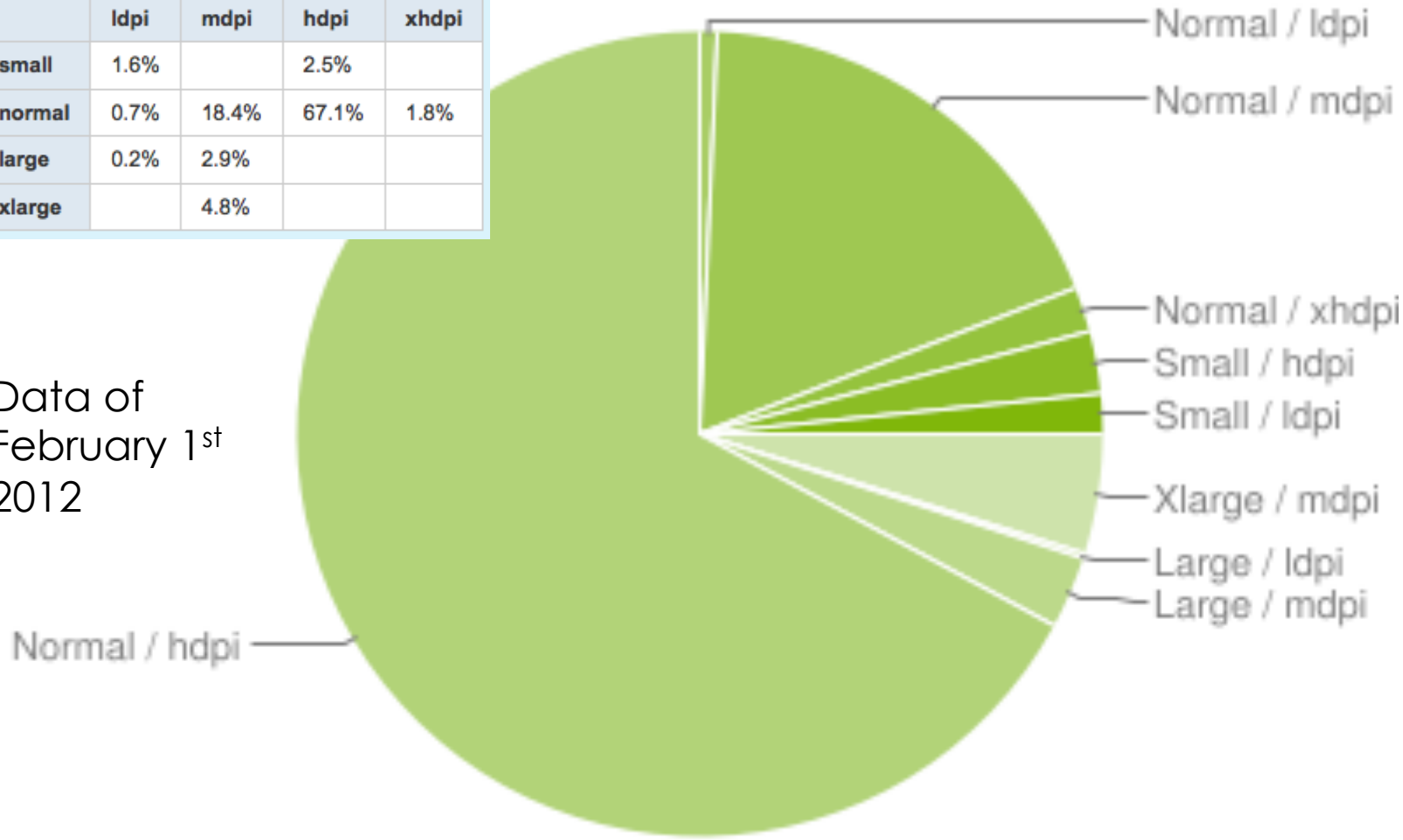
Screen Sizes and Densities

	ldpi	mdpi	hdpi	xhdpi
small	1.6%		2.5%	
normal	0.7%	18.4%	67.1%	1.8%
large	0.2%	2.9%		
xlarge		4.8%		



Data of February 1st 2012

http://developer.android.com/resources/dashboard/screens.html

Screen related terms and concepts

Resolution The total number of physical pixels on a screen. When adding support for multiple screens, applications do not work directly with resolution; applications should be concerned only with screen size and density, as specified by the generalized size and density groups.

Screen size Actual physical size, measured as the screen's diagonal.

Screen density The quantity of pixels within a physical area of the screen; usually referred to as dpi (dots per inch).

Orientation The orientation of the screen from the user's point of view. This is either landscape or portrait, meaning that the screen's aspect ratio is either wide or tall, respectively. Not only do different devices operate in different orientations by default, but the orientation can change at runtime when the user rotates the device.

Density-independent pixel

Density-independent pixel (dp) A virtual pixel unit that you should use when defining UI layout, to express layout dimensions or position in a density-independent way. The density-independent pixel is equivalent to one physical pixel on a 160 dpi screen, which is the baseline density assumed by the system for a "medium" density screen. At runtime, the system transparently handles any scaling of the dp units, as necessary, based on the actual density of the screen in use. The conversion of dp units to screen pixels is simple: px = dp * (dpi / 160). For example, on a 240 dpi screen, 1 dp equals 1.5 physical pixels. You should always use dp units when defining your application's UI, to ensure proper display of your UI on screens with different densities.

xlarge screens are at least 960dp x 720dp

large screens are at least 640dp x 480dp

normal screens are at least 470dp x 320dp

small screens are at least 426dp x 320dp

Screen Sizes and Densities

Android divides the range of actual screen sizes and densities into:

A set of four generalized **sizes**:

small, *normal*, *large*, and *xlarge*

A set of four generalized **densities**:

ldpi (low), *mdpi* (medium), *hdpi* (high), and *xhdpi* (extra high)

Una lettura consigliata…

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Android design

http://developer.android.com/design/index.html