Android Basics

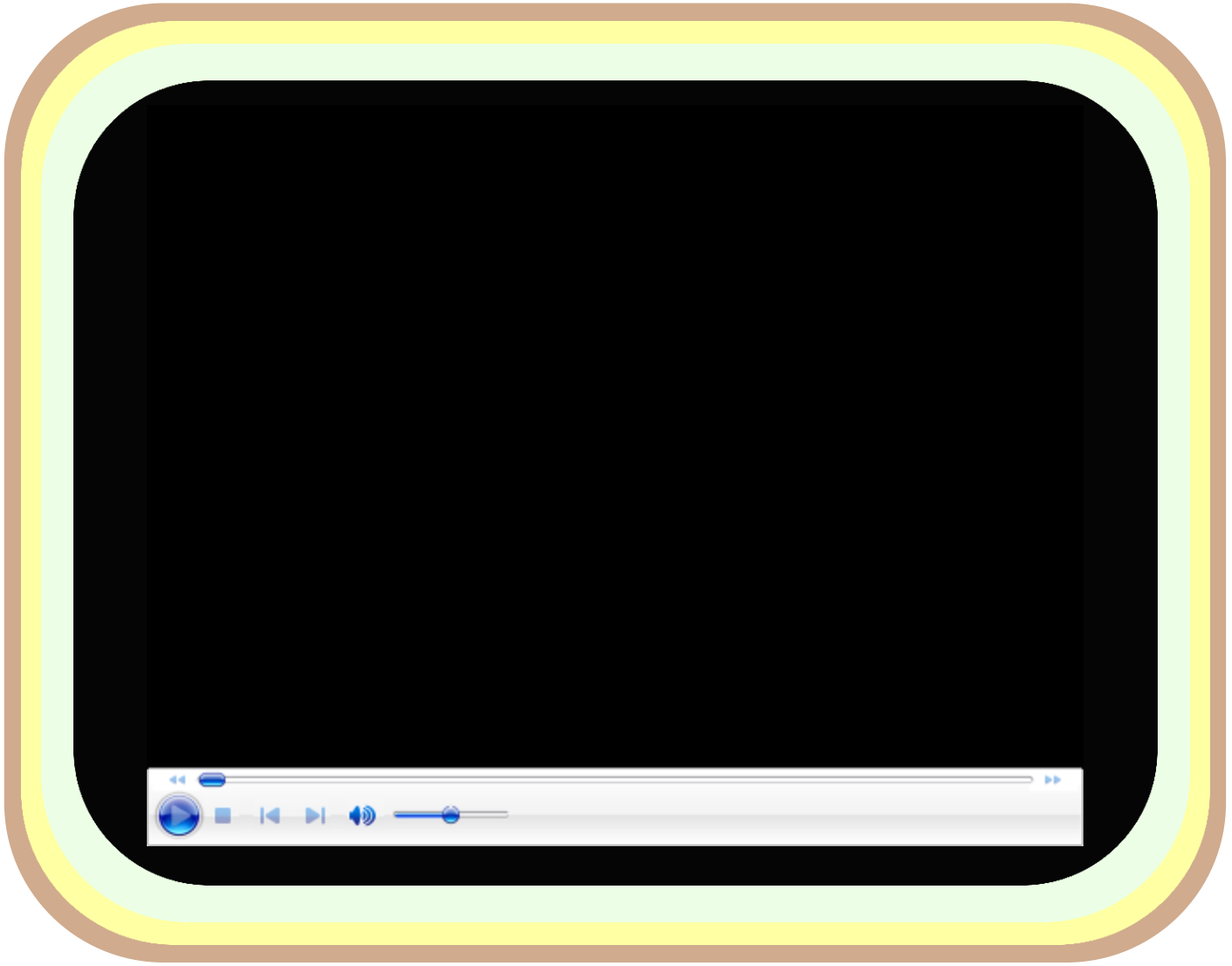
Xin Yang

2016-05-06

Outline of Lectures

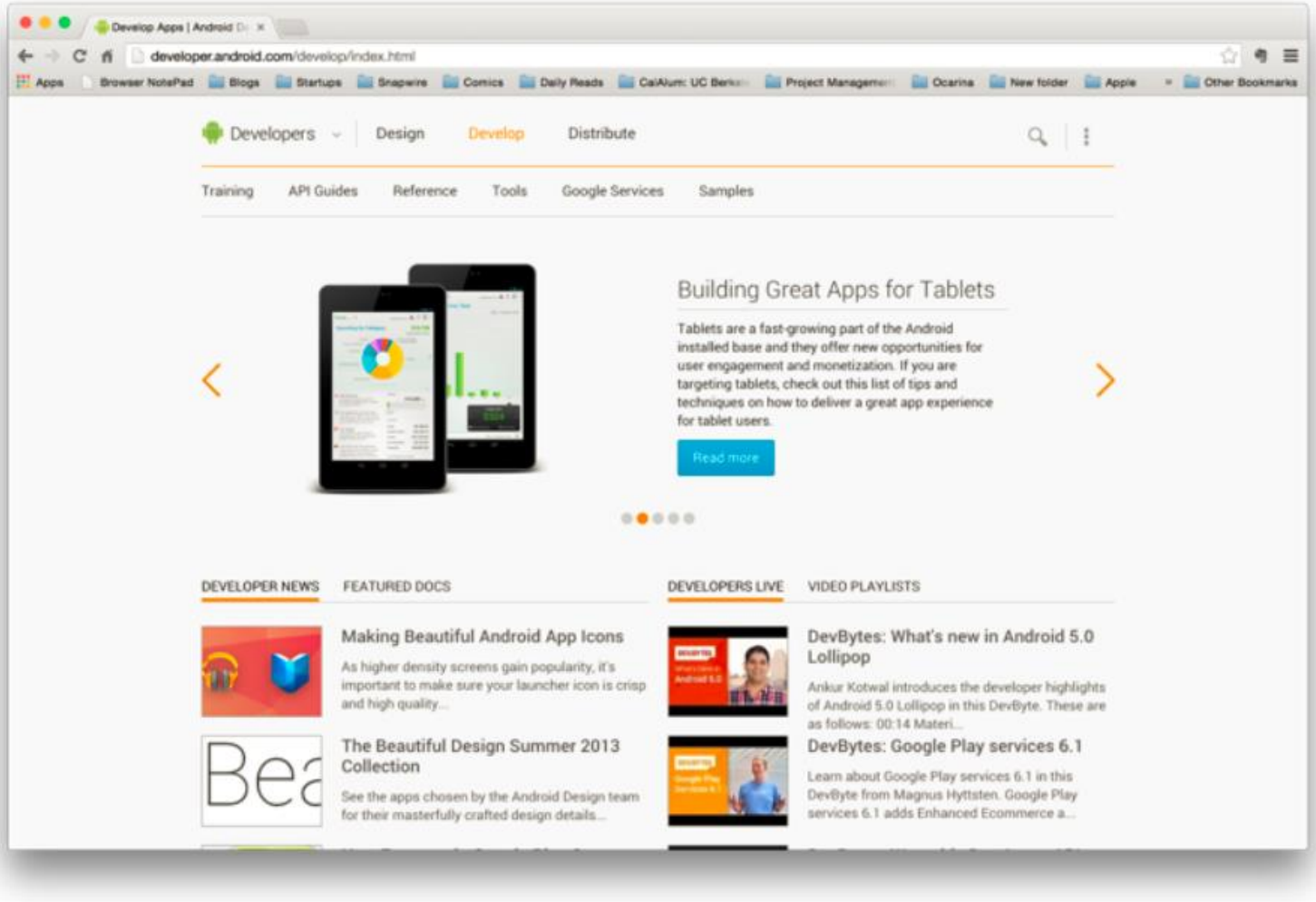
- Lecture 1 (45mins) – Android Basics
  - Programming environment
  - Components of an Android app
  - Activity, lifecycle, intent
  - Android anatomy
- Lecture 2 (45mins) – Intro to Android Programming
  - Camera
  - 2D graphics drawing
- Lecture 3 (45mins) – Advanced Topics in Android Programming
  - Interacting with native code via JNI
  - Using opencv library in and Android project
  - Intro to Qualcomm SDK
- Lecture 4 (45mins) – Intro to Google APIs
  - Sensors
  - Animations
  - GPS
  - Google Maps
  - Etc.

Application Example: PhotoTag



Outline - Lecture 1

- Android Programming Basics
  - Walk through app development process via an example
  - Activity, lifecycle and intent
- Android Anatomy
  - Five layers of Android: application, application framework, native libraries, Android runtime and Linux kernel



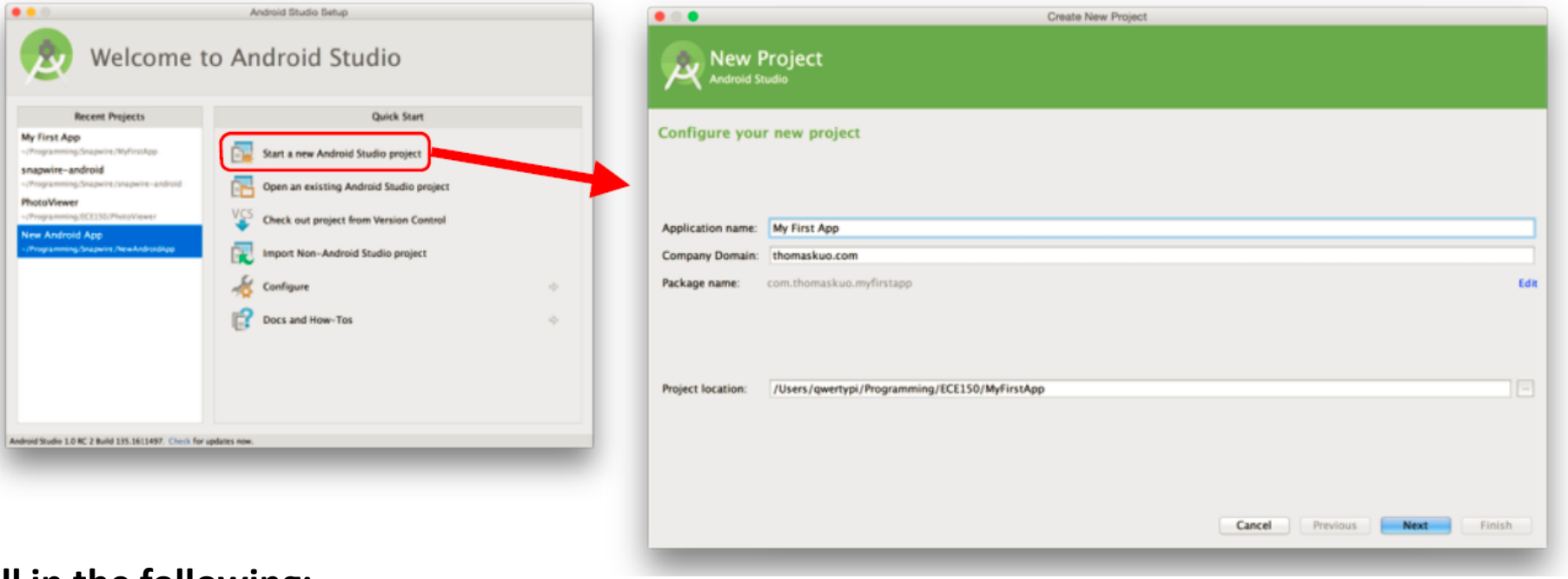
Developer Site

http://developer.android.com/develop

Development Environment

- Android Studio: IDE based on IntelliJ IDEA
- Android SDK Tools includes:
  - SDK Manager
    - separates the SDK tools, platforms, and other components into packages for easy access and management
    - Android SDK Manager for downloading platforms, Google APIs, etc.,
  - AVD(Android Virtual Devices) Manager
    - provides a graphical user interface in which you can create and manage AVDs, which are required by the Android Emulator.
  - Emulator
  - Dalvik Debug Monitor Server
- A version of the Android platform to compile your app
- A version of the Android system image to run your app in the emulator
  - Supports processor architectures, e.g. ARM EABI, Intel X86 or MIPS

Creating a New Project with Android Studio



Fill in the following:

Application name: app name that appears to users

Project name: name of your project directory in your computer

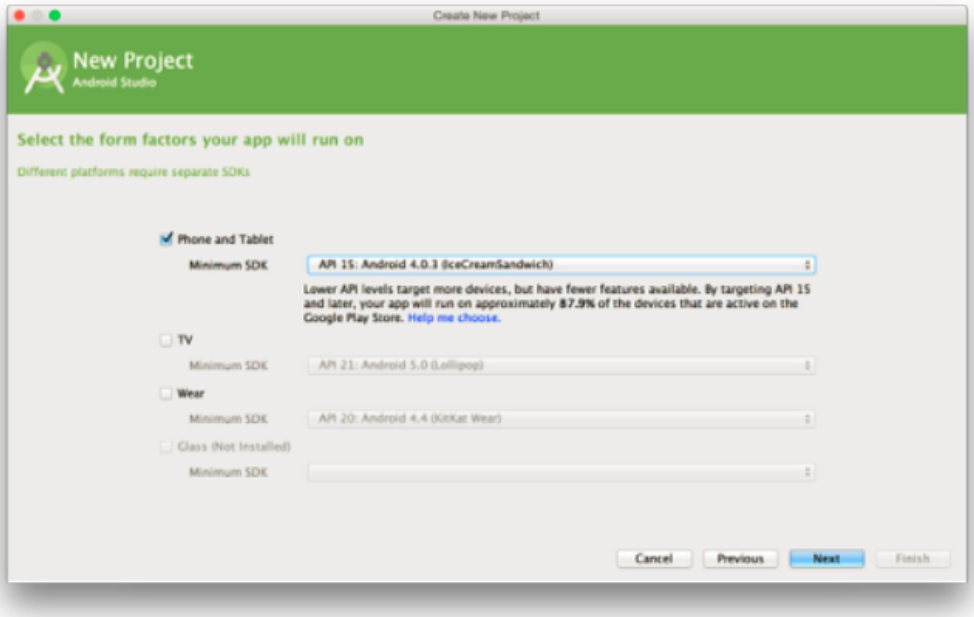
Package name: package namespace for your app, must be unique across all packages installed in Android system, same naming rules as packages in Java

Min SDK : lowest version of Android that your app supports

Target SDK: highest version of Android with which you have tested with your app

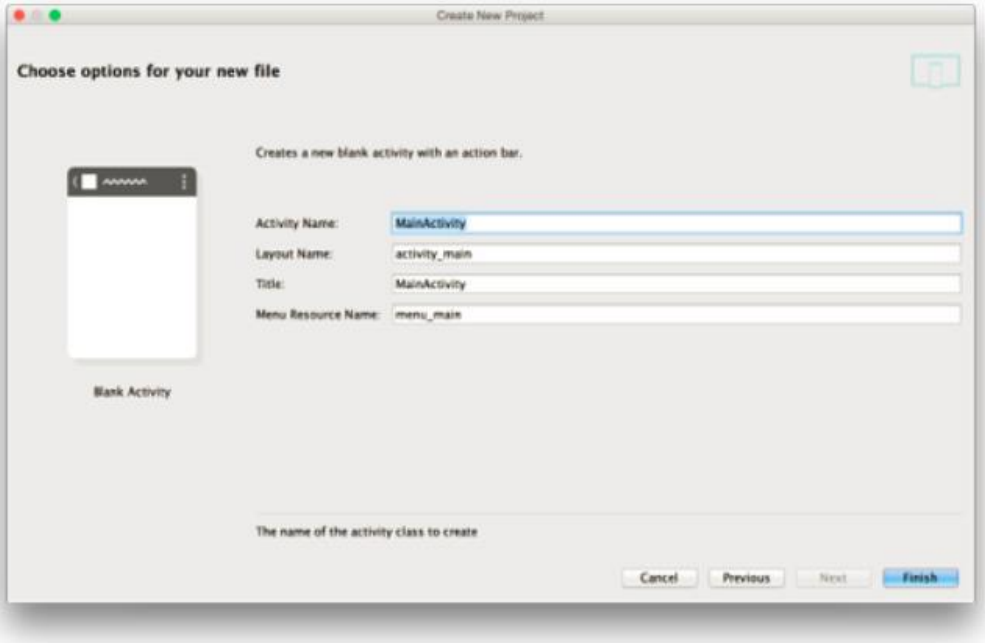
Creating a New Project with Android Studio

- Select: Minimum SDK (default)
- Android APIs can be referenced by:
  - Number: 1 - 21
  - Version: 1.0 - 5.0
  - Name: Cupcake - Lollipop



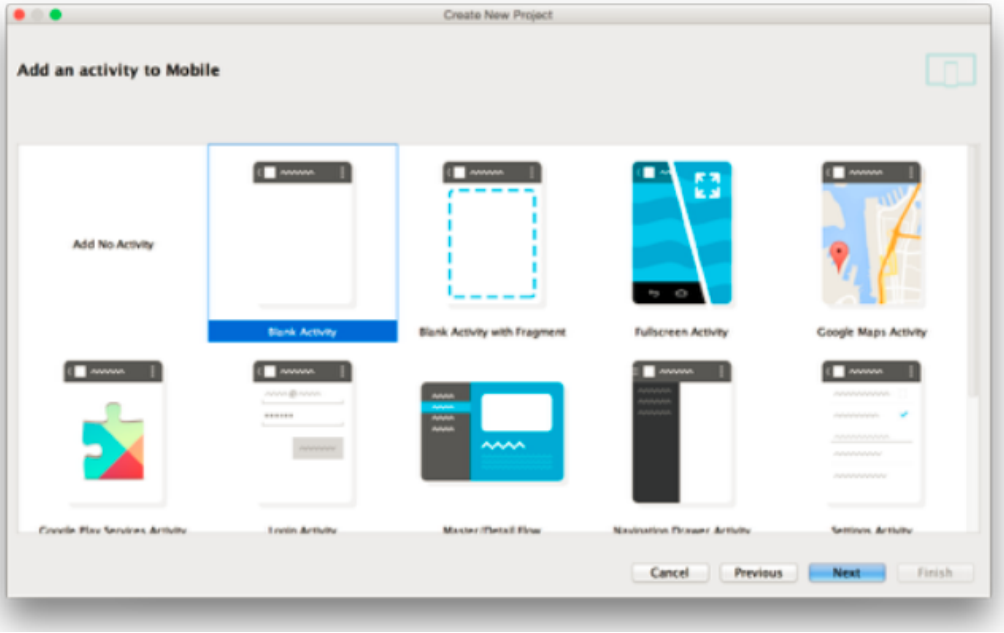
Creating a New Project with Android Studio

- Leave defaults: Activity Parameters

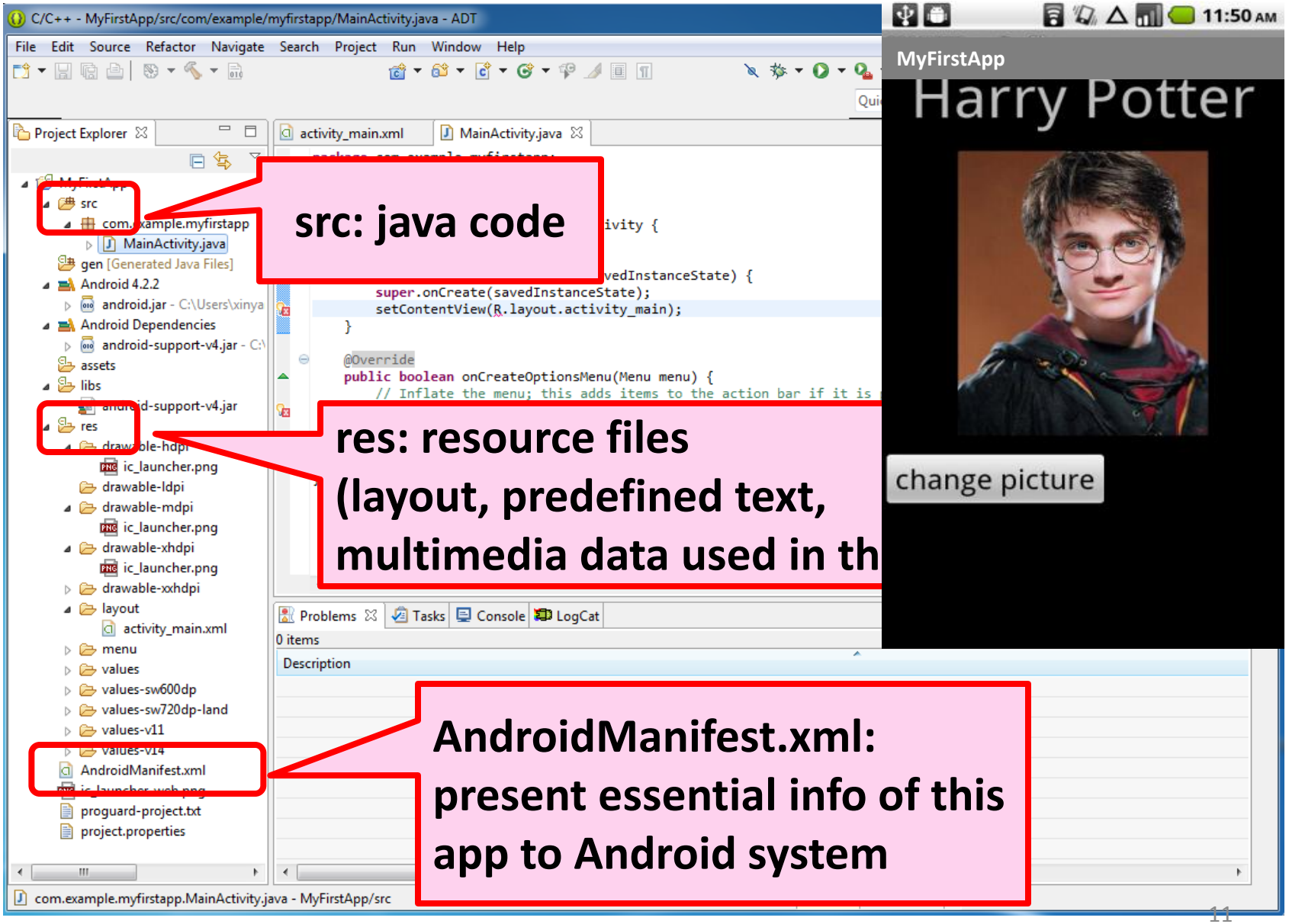


Creating a New Project with Android Studio

- Select: Initial Activity (Blank)
  - Activity: A screen with which users can interact in order to do something

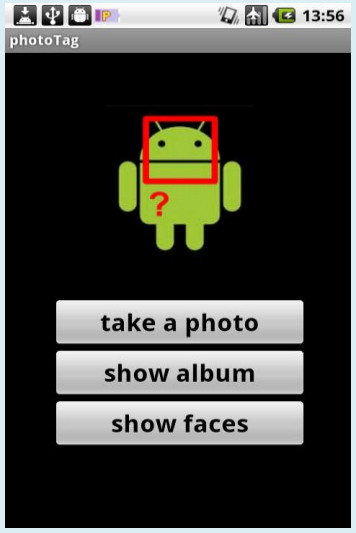


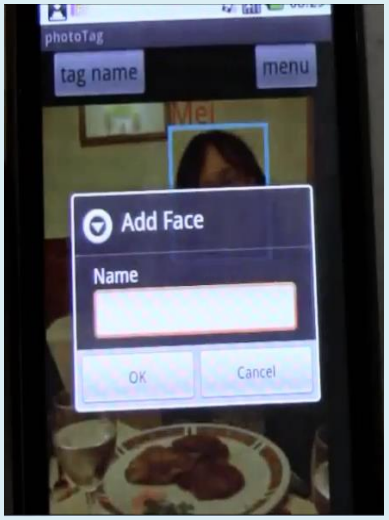
Project Directory Structure



Graphical User Interface (GUI)

- Android GUI is built using a hierarchy of **View** and **ViewGroup** objects
  - **View**: UI widgets (e.g. button, edit text fields)
  - **ViewGroup**: invisible view containers that define how the child views are laid out





Exemplar View objects

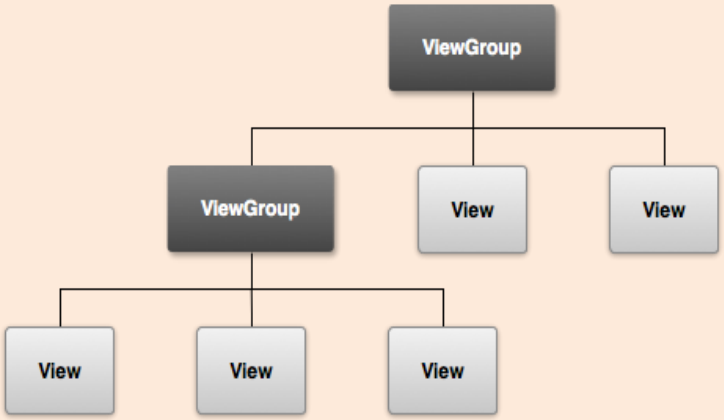
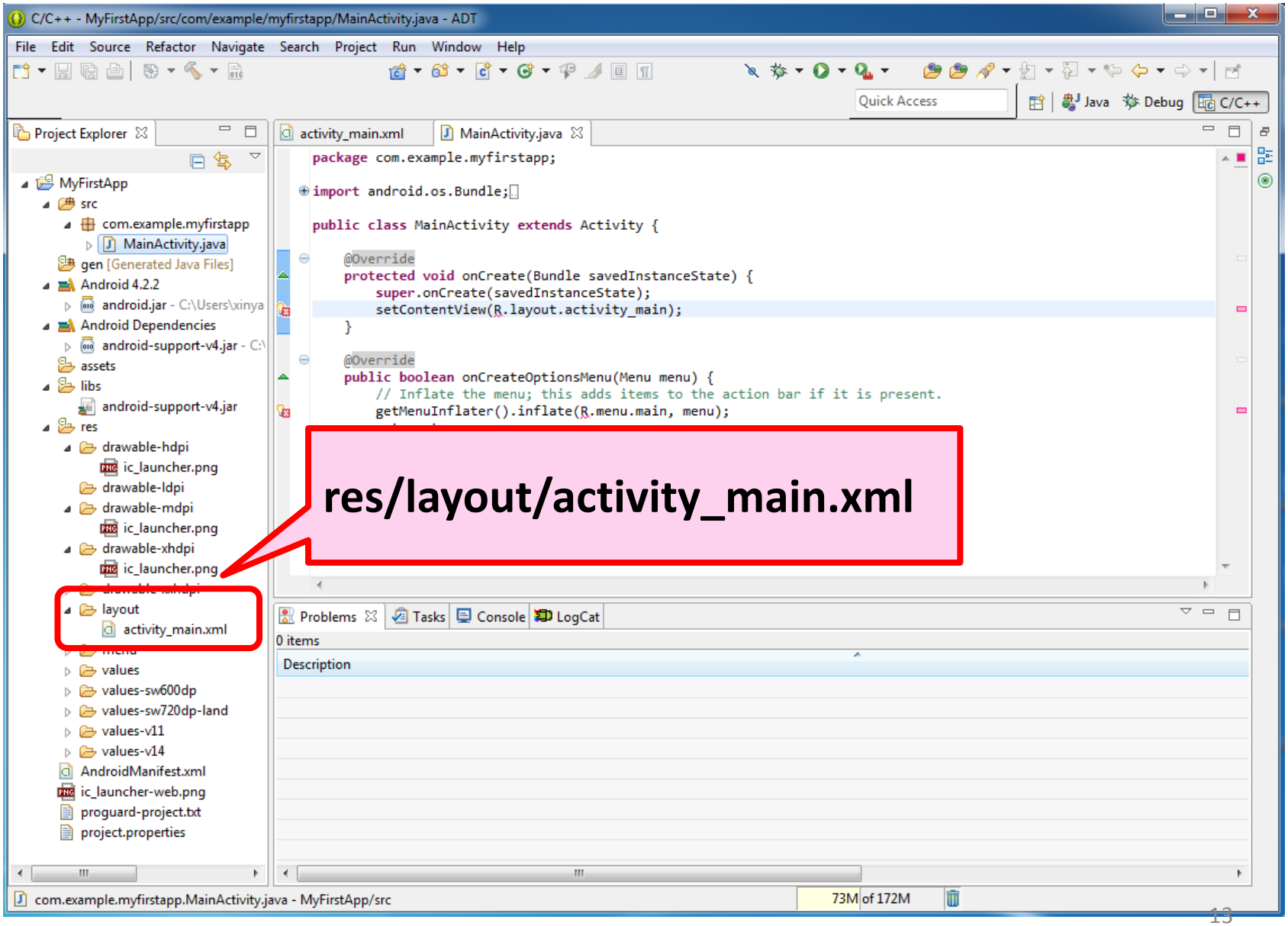


Illustration of how ViewGroup objects form branches in the layout


C/C++ - MyFirstApp/src/com/example/myfirstapp/MainActivity.java - ADT
File Edit Source Refactor Navigate Search Project Run Window Help
Quick Access
Java
Debug
C/C++
Project Explorer
MyFirstApp
src
com.example.myfirstapp
MainActivity.java
gen [Generated Java Files]
Android 4.2.2
android.jar - C:\Users\xinya
Android Dependencies
android-support-v4.jar - C:\
assets
libs
android-support-v4.jar
res
drawable-hdpi
ic_launcher.png
drawable-ldpi
drawable-mdpi
ic_launcher.png
drawable-xhdpi
ic_launcher.png
layout
activity_main.xml
values
values-sw600dp
values-sw720dp-land
values-v11
values-v14
AndroidManifest.xml
ic_launcher-web.png
proguard-project.txt
project.properties
activity_main.xml
MainActivity.java
package com.example.myfirstapp;
import android.os.Bundle;
public class MainActivity extends Activity {
@Override
protected void onCreate(Bundle savedInstanceState) {
super.onCreate(savedInstanceState);
setContentView(R.layout.activity_main);
}
@Override
public boolean onCreateOptionsMenu(Menu menu) {
// Inflate the menu; this adds items to the action bar if it is present.
getMenuInflater().inflate(R.menu.main, menu);
res/layout/activity_main.xml
Problems
Tasks
Console
LogCat
0 items
Description
com.example.myfirstapp.MainActivity.java - MyFirstApp/src
73M of 172M

Create a Layout in XML

activity_main.xml file from res/layout/ directory

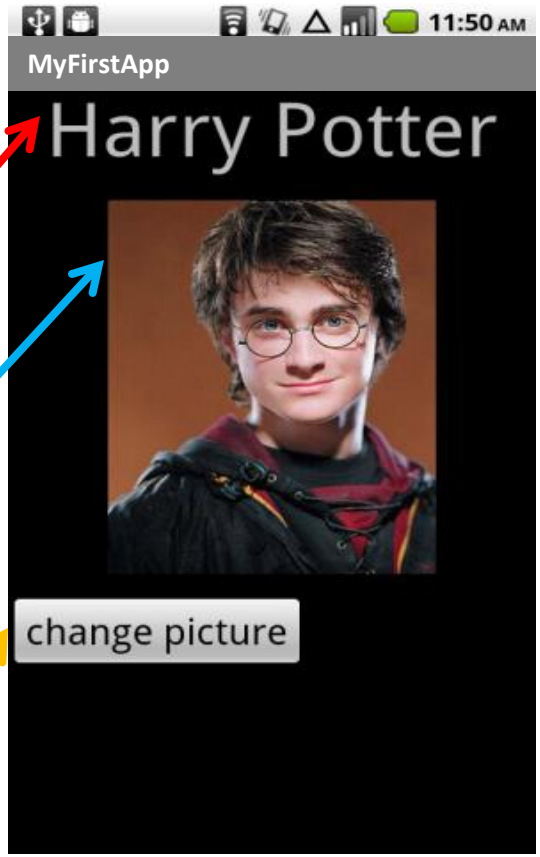
view group
```
<LinearLayout
    android:orientation="vertical“
    android:layout_width=“match_parent"
    android:layout_height=“match_parentt"
    >
```

view
```
    <TextView
      android:id="@+id/text1"
      android:text="@string/defaultText“/>
```

view
```
    <ImageView
    „ android:layout_width=" wrap_content"
    android:layout_height="wrap_content“
      android:src = “@drawable/photo”>
```

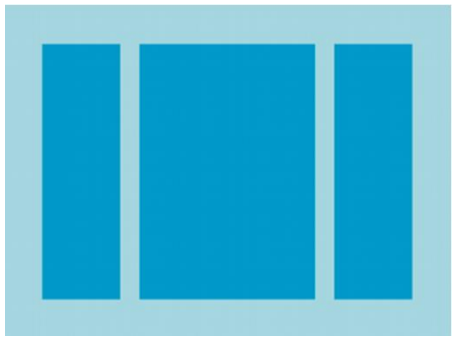
view
```
    <Button
      android:id="@+id/button"
      android:text="@string/buttonText“/>

</LinearLayout>
```



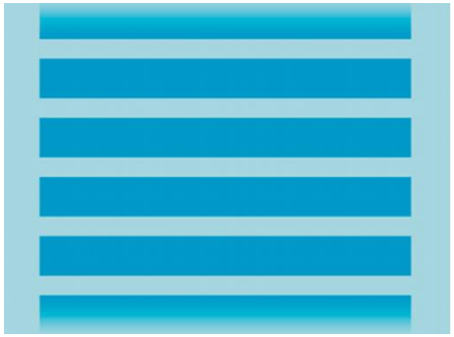
Common ViewGroup Subclasses

- **LinearLayout**: all children are aligned in a single direction, horizontally or vertically
- **RelativeLayout**: Child object relative to each other
- **ListView**: a list of **scrollable** items
- **GridView**: displays items in **two-dimensional**, **scrollable** grid

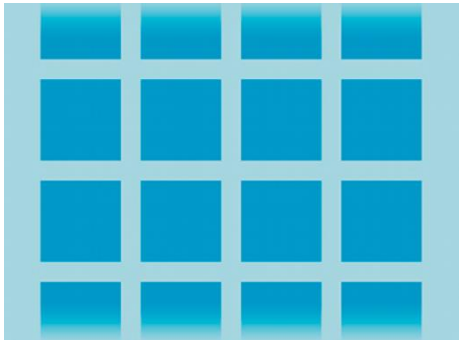


LinearLayout

RelativeLayout



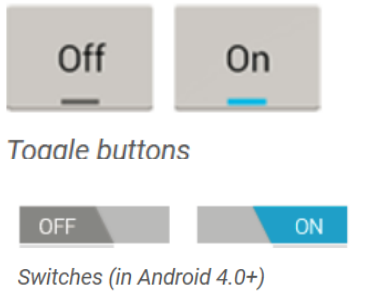
ListView



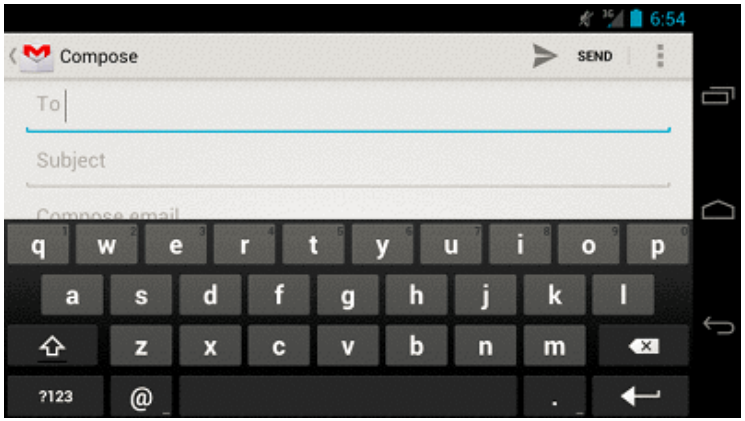
GridView

Common View Subclasses

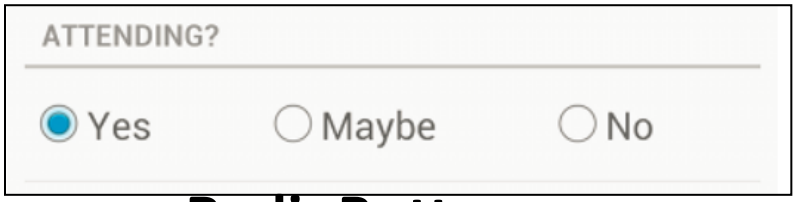
- TextView
- ImageView
- Button
- EditText
- Checkbox
- RadioGroup/RadioButton
- ToggleButton
- Spinner



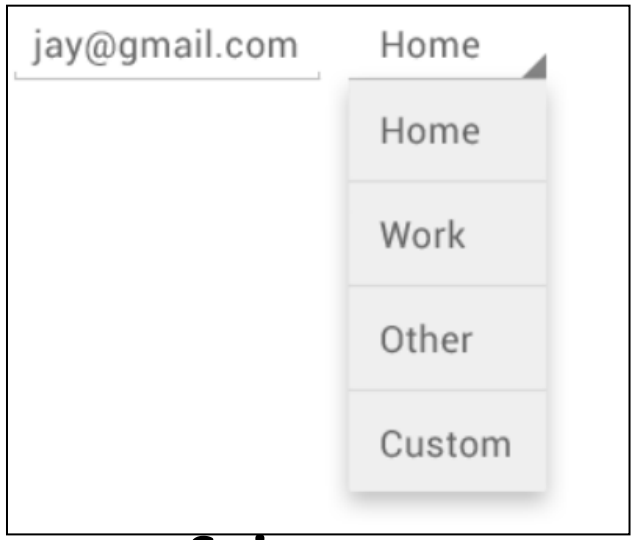
ToggleButton



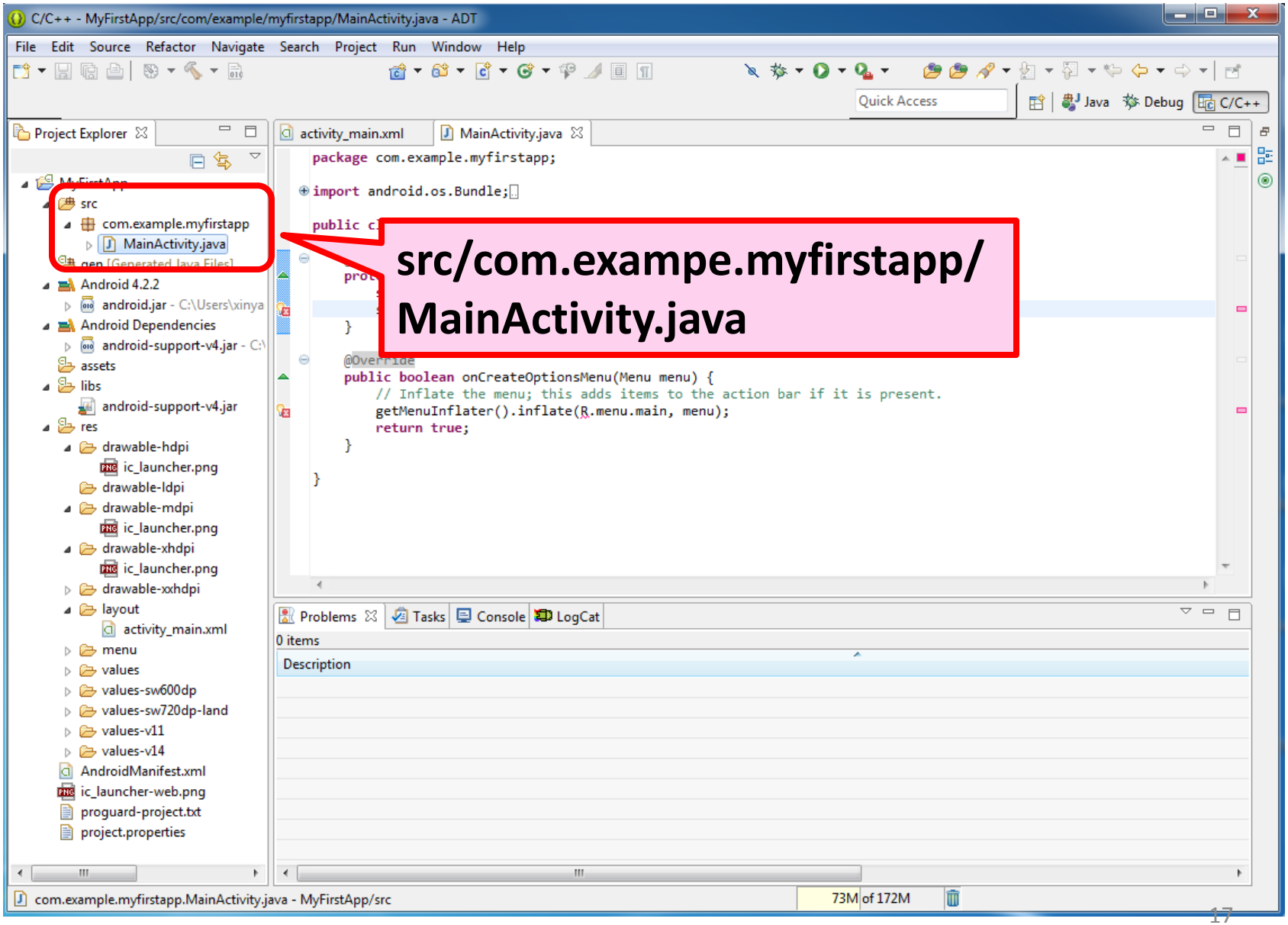
EditText



RadioButton



Spinner


C/C++ - MyFirstApp/src/com/example/myfirstapp/MainActivity.java - ADT
File Edit Source Refactor Navigate Search Project Run Window Help
Quick Access
Java
Debug
C/C++
Project Explorer
activity_main.xml
MainActivity.java
src
com.example.myfirstapp
MainActivity.java
Android 4.2.2
android.jar - C:\Users\xinya
Android Dependencies
android-support-v4.jar - C:\
assets
libs
android-support-v4.jar
res
drawable-hdpi
ic_launcher.png
drawable-ldpi
drawable-mdpi
ic_launcher.png
drawable-xhdpi
ic_launcher.png
drawable-xxhdpi
layout
activity_main.xml
menu
values
values-sw600dp
values-sw720dp-land
values-v11
values-v14
AndroidManifest.xml
ic_launcher-web.png
proguard-project.txt
project.properties
package com.example.myfirstapp;
import android.os.Bundle;
@Override
public boolean onCreateOptionsMenu(Menu menu) {
// Inflate the menu; this adds items to the action bar if it is present.
getMenuInflater().inflate(R.menu.main, menu);
return true;
}
Problems
Tasks
Console
LogCat
0 items
Description
com.example.myfirstapp.MainActivity.java - MyFirstApp/src
73M of 172M
src/com.exampe.myfirstapp/
MainActivity.java

Java Code

MainActivity.java file from src/com.example.myfirstapp/ directory

```
package com.example.myfirstapp;
import android.os.Bundle;
import android.app.Activity;
import android.view.Menu;

public class MainActivity extends Activity {
    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
    }
}
```

Package name

Set this layout as UI

Android Manifest*

- Present essential information to Android system
  - Application package name
  - Components of the application
  - Which permissions the application requires
    - ex: camera, write to SDCard
  - Which permissions other applications required to interact with the app's components
  - Minimum level of Android API
  - Required libraries

* http://developer.android.com/guide/topics/manifest/manifest-intro.html

Android Manifest*

```
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.example.android.camera2video"
    android:versionCode="1"
    android:versionName="1.0">

    <!-- Min/target SDK versions (<uses-sdk>) managed by build.gradle -->

    <uses-permission android:name="android.permission.CAMERA"/>
    <uses-permission android:name="android.permission.RECORD_AUDIO"/>

    <application android:allowBackup="true"
        android:label="@string/app_name"
        android:icon="@drawable/ic_launcher"
        android:theme="@style/MaterialTheme">

        <activity android:name=".CameraActivity"
                  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>
```

Unique Package ID

Uses Permissions

Components & their permissions

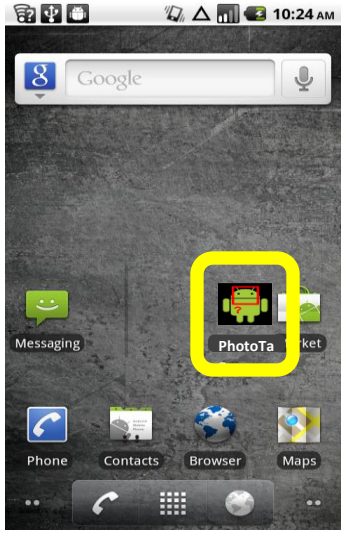
3. Run

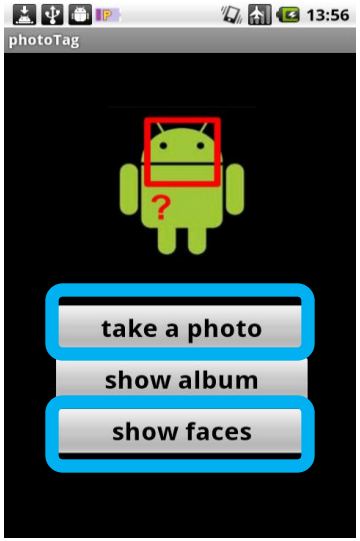
- Run
  - On emulator
    - Create Android Virtual Device (AVD) first
    - AVD is a device configuration for Android emulator to model different devices

  - On devices
    - Connect your device to host machine through USB cable

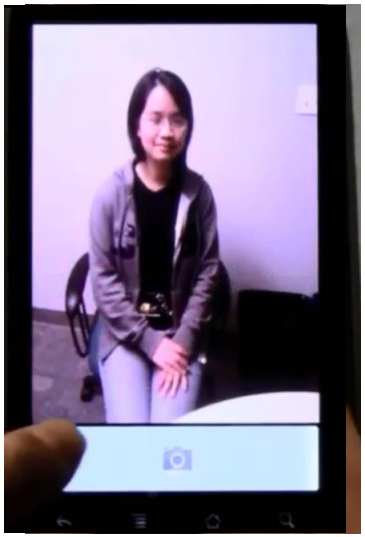
Activity

- Activity
  - A screen that user sees on the device at one time
  - An app typically has multiple activities and the user flips back and forth among them
  - Each activity is given a window to draw its user interface



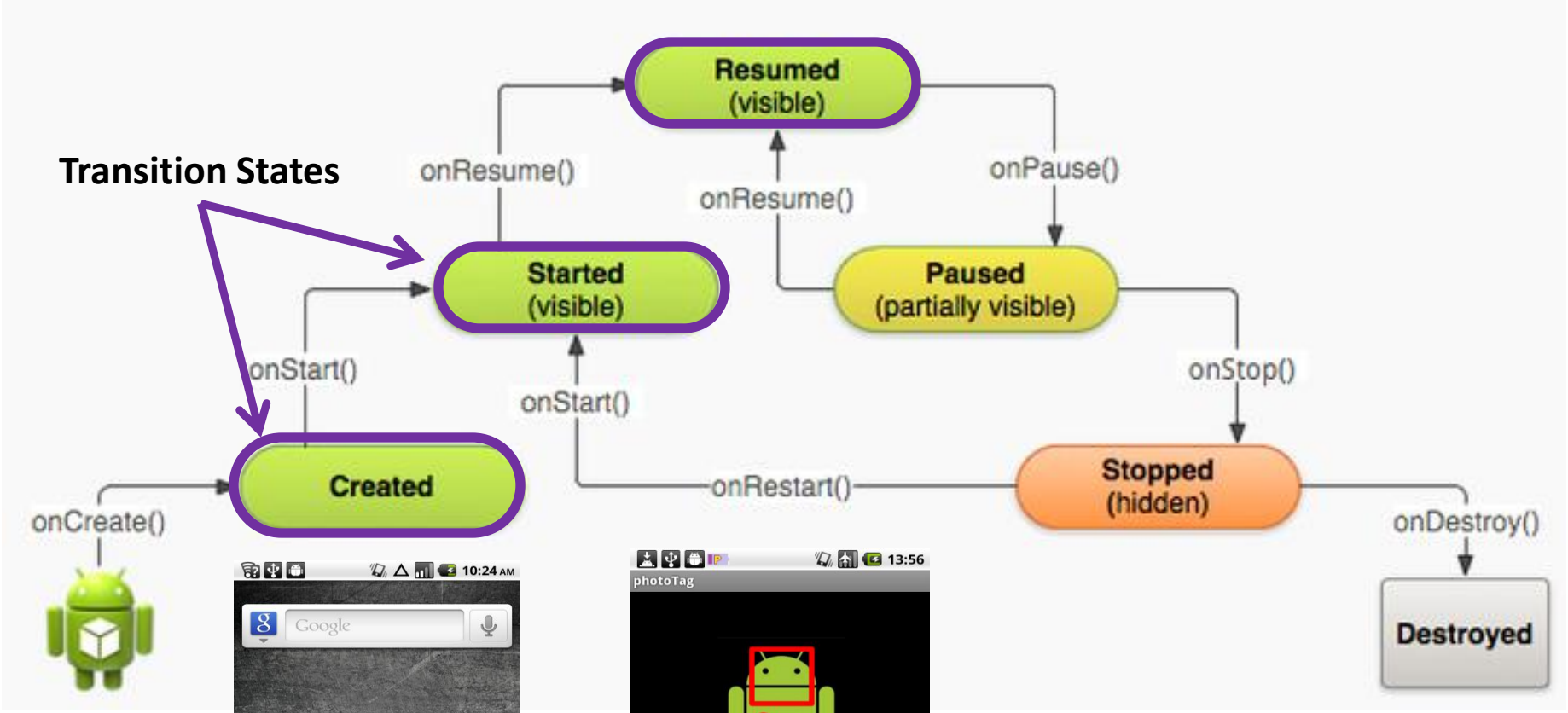


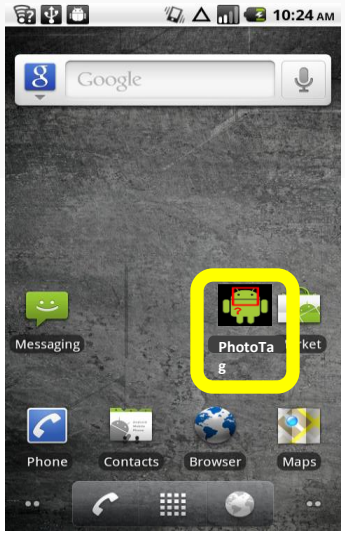
Main Activity



Activity

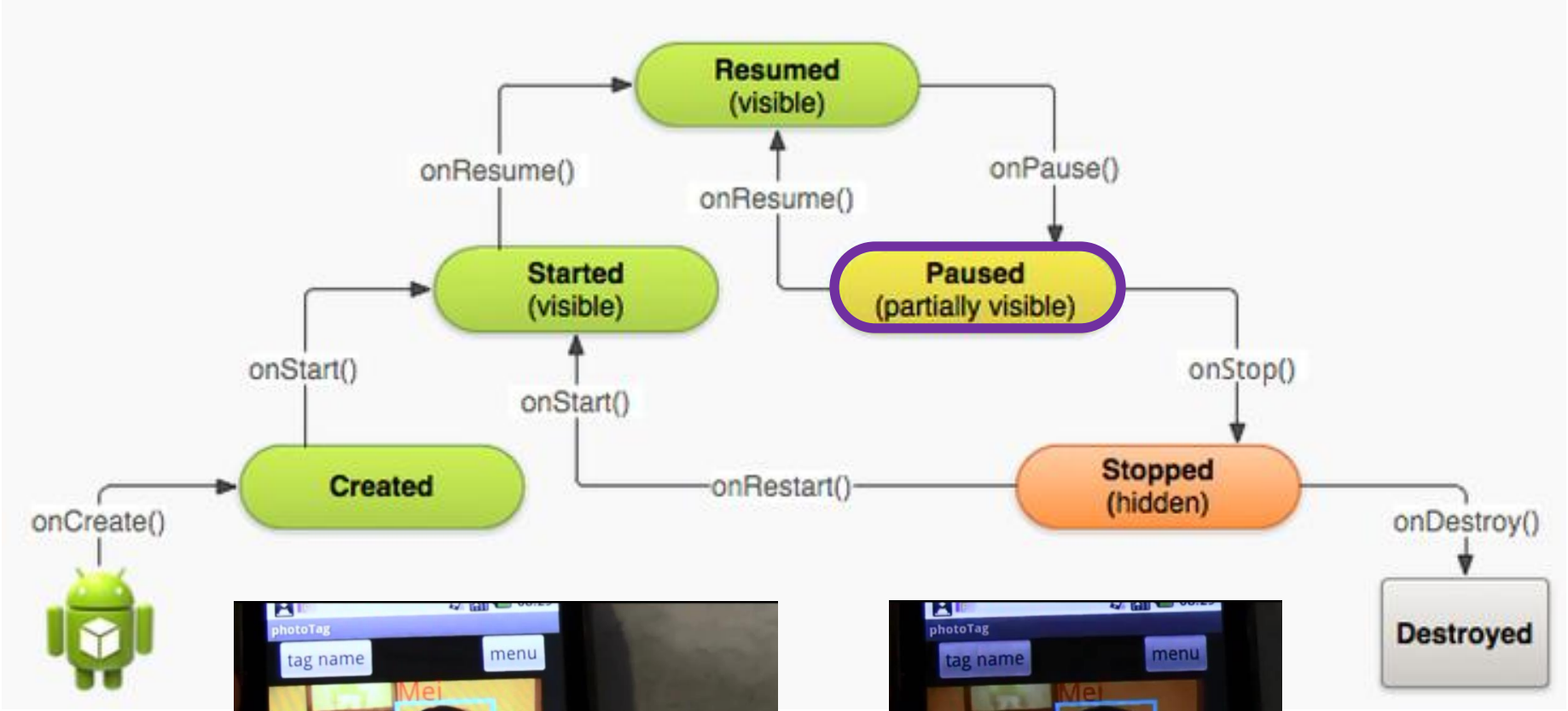
Activity Lifecycle

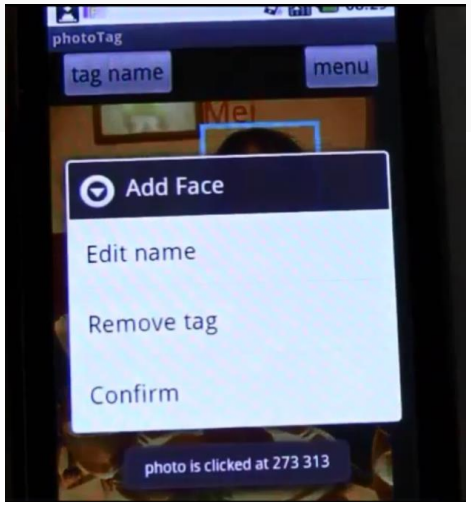




Main Activity

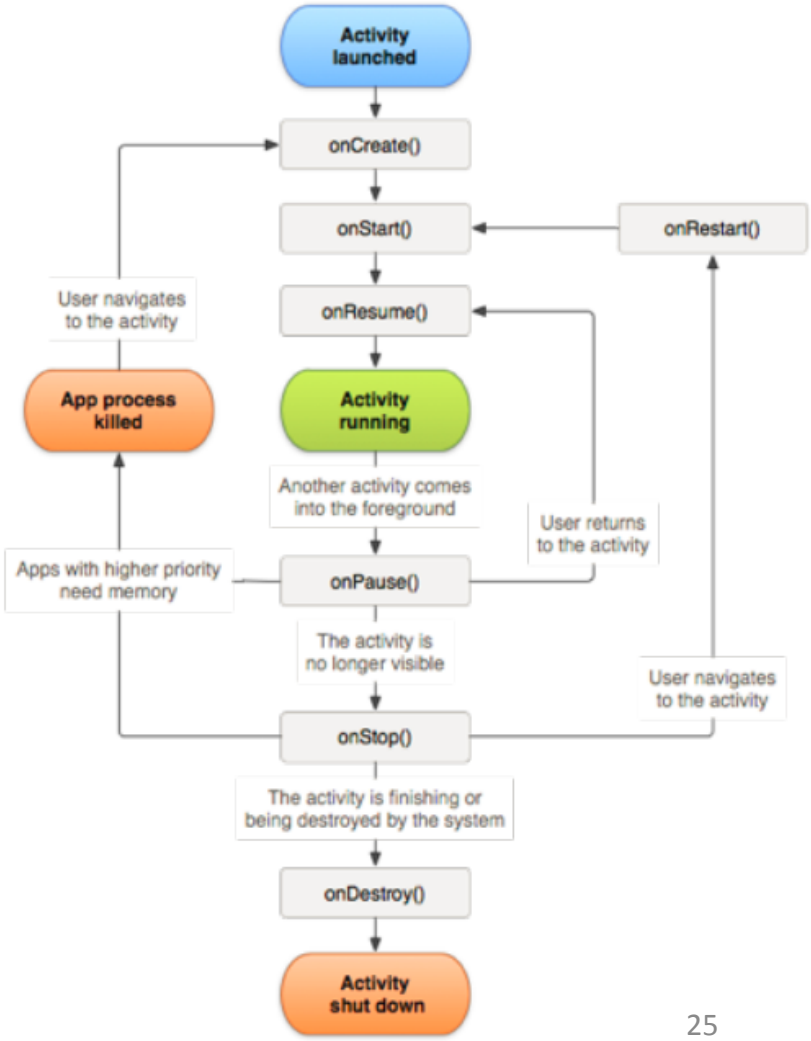
Activity Lifecycle





Lifecycle

- 3 States
  - Resumed: Activity running with user focus
  - Paused: Another activity in foreground, but this is still visible
  - Stopped: Activity complete obscured and in the “background”
- In pause or stopped, activity is retained in memory
- But, the system can drop it from memory, if necessary



Callback Functions

- Android system creates new Activity instance by calling its **onCreate()** method
- You must implement **onCreate()** method to perform basic application startup logic

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

    // Set the user interface layout for this Activity
    // The layout file is defined in the project res/layout/main_activity.xml file
    setContentView(R.layout.main_activity);

    // Initialize member TextView so we can manipulate it later
    mTextView = (TextView) findViewById(R.id.text_message);

    // Make sure we're running on Honeycomb or higher to use ActionBar APIs
    if (Build.VERSION.SDK_INT >= Build.VERSION_CODES.HONEYCOMB) {
        // For the main activity, make sure the app icon in the action bar
        // does not behave as a button
        ActionBar actionBar = getActionBar();
        actionBar.setHomeButtonEnabled(false);
    }
}
```

Callback Functions

- **onResume()** method is called every time when your activity comes into the foreground

```
@Override
public void onResume() {
    super.onResume();  // Always call the superclass method first

    // Get the Camera instance as the activity achieves full user focus
    if (mCamera == null) {
        initializeCamera(); // Local method to handle camera init
    }
}
```

Callback Functions

- **onPause()** method is usually used for
  - Stopping animations or other ongoing actions that could consume CPU
  - Committing unsaved changes
  - Release system resources, such as sensors, cameras, etc.

```
@Override
public void onPause() {
    super.onPause();  // Always call the superclass method first

    // Release the Camera because we don't need it when paused
    // and other activities might need to use it.
    if (mCamera != null) {
        mCamera.release()
        mCamera = null;
    }
}
```

Callback Functions

- When the activity receives a call to **onStop()** method, it is no longer visible and should release almost all unnecessary resources
- Compared to **onPause()**, **onStop()** performs larger, more CPU intensive shut-down operations, e.g. writing information to a database

Eg. saves the contents of a draft note to persistent storage

```
@Override
protected void onStop() {
    super.onStop();  // Always call the superclass method first

    // Save the note's current draft, because the activity is stopping
    // and we want to be sure the current note progress isn't lost.
    ContentValues values = new ContentValues();
    values.put(NotePad.Notes.COLUMN_NAME_NOTE, getCurrentNoteText());
    values.put(NotePad.Notes.COLUMN_NAME_TITLE, getCurrentNoteTitle());

    getContentResolver().update(
            mUri,    // The URI for the note to update.
            values,  // The map of column names and new values to apply to them.
            null,    // No SELECT criteria are used.
            null     // No WHERE columns are used.
            );
}
```

Callback Functions

- **onStart()** is called every time your activity becomes visible
  - It is a good place to verify required system features are enabled

```
@Override
protected void onStart() {
    super.onStart();  // Always call the superclass method first

    // The activity is either being restarted or started for the first time
    // so this is where we should make sure that GPS is enabled
    LocationManager locationManager =
            (LocationManager) getSystemService(Context.LOCATION_SERVICE);
    boolean gpsEnabled = locationManager.isProviderEnabled(LocationManager.GPS_PROVIDER);

    if (!gpsEnabled) {
        // Create a dialog here that requests the user to enable GPS, and use an intent
        // with the android.provider.Settings.ACTION_LOCATION_SOURCE_SETTINGS action
        // to take the user to the Settings screen to enable GPS when they click "OK"
    }
}
```

Activity Manager

- Launching an activity is quite expensive
  - Creating new Linux process
  - Allocating resources and memory for UI objects
  - Setting up the whole screen
  - Etc.
- It is wasteful to toss an activity out once user leaves that screen
- Activity manager manages activity lifecycle to avoid waste

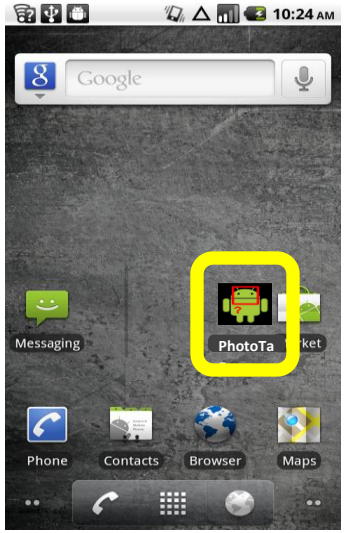
Activity Manager: An Example

Activity Manager

↓

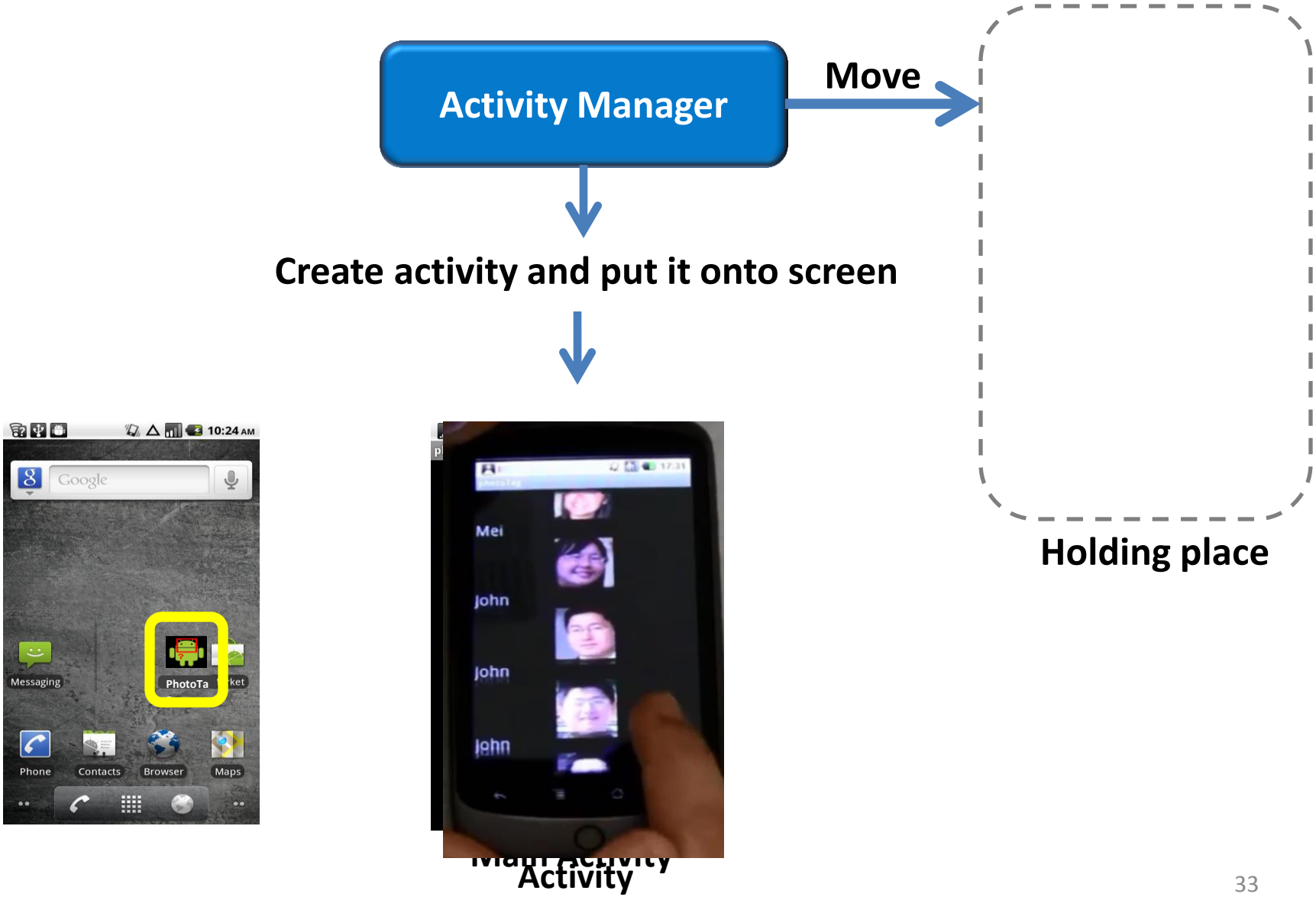
Create activity and put it onto screen

↓



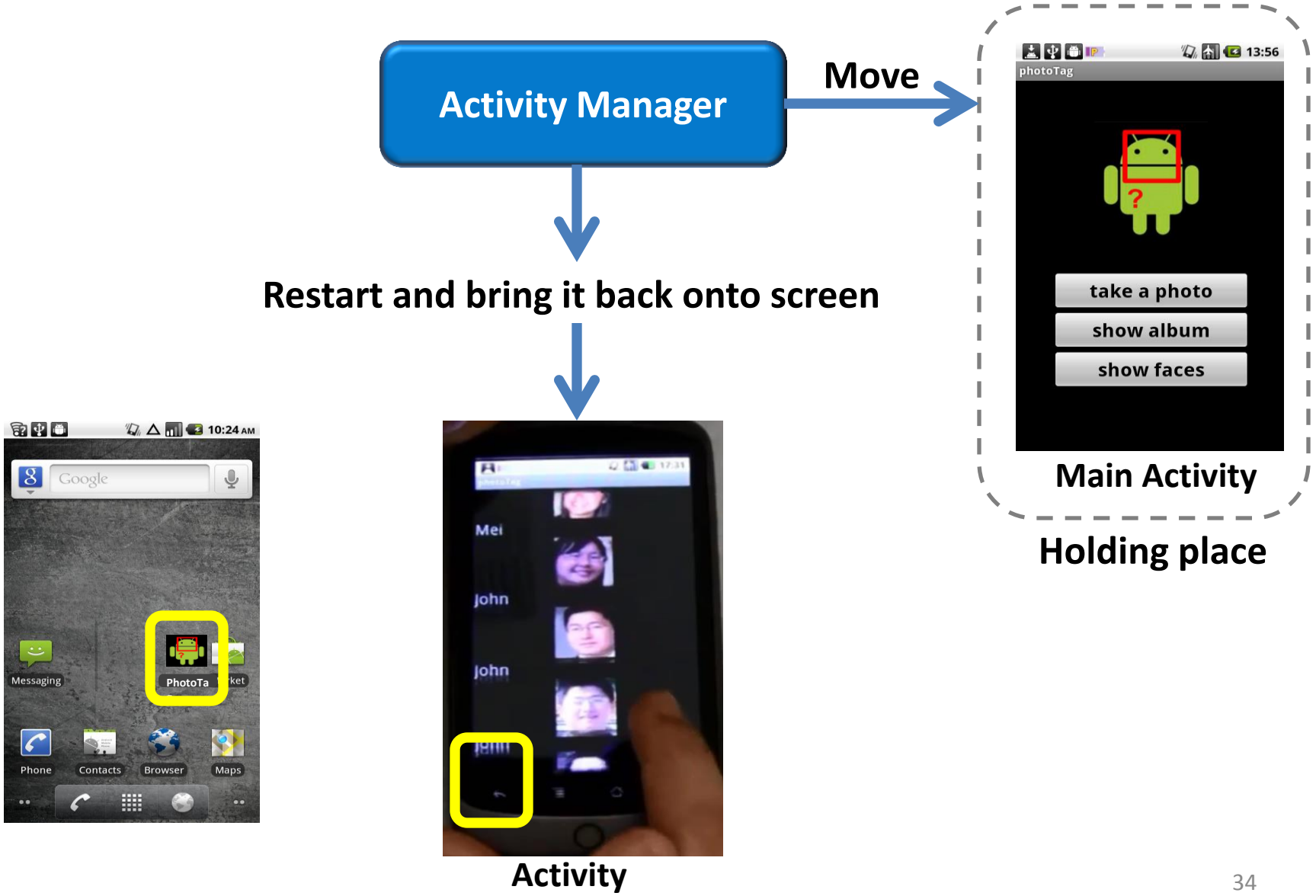
Main Activity

Activity Manager: An Example

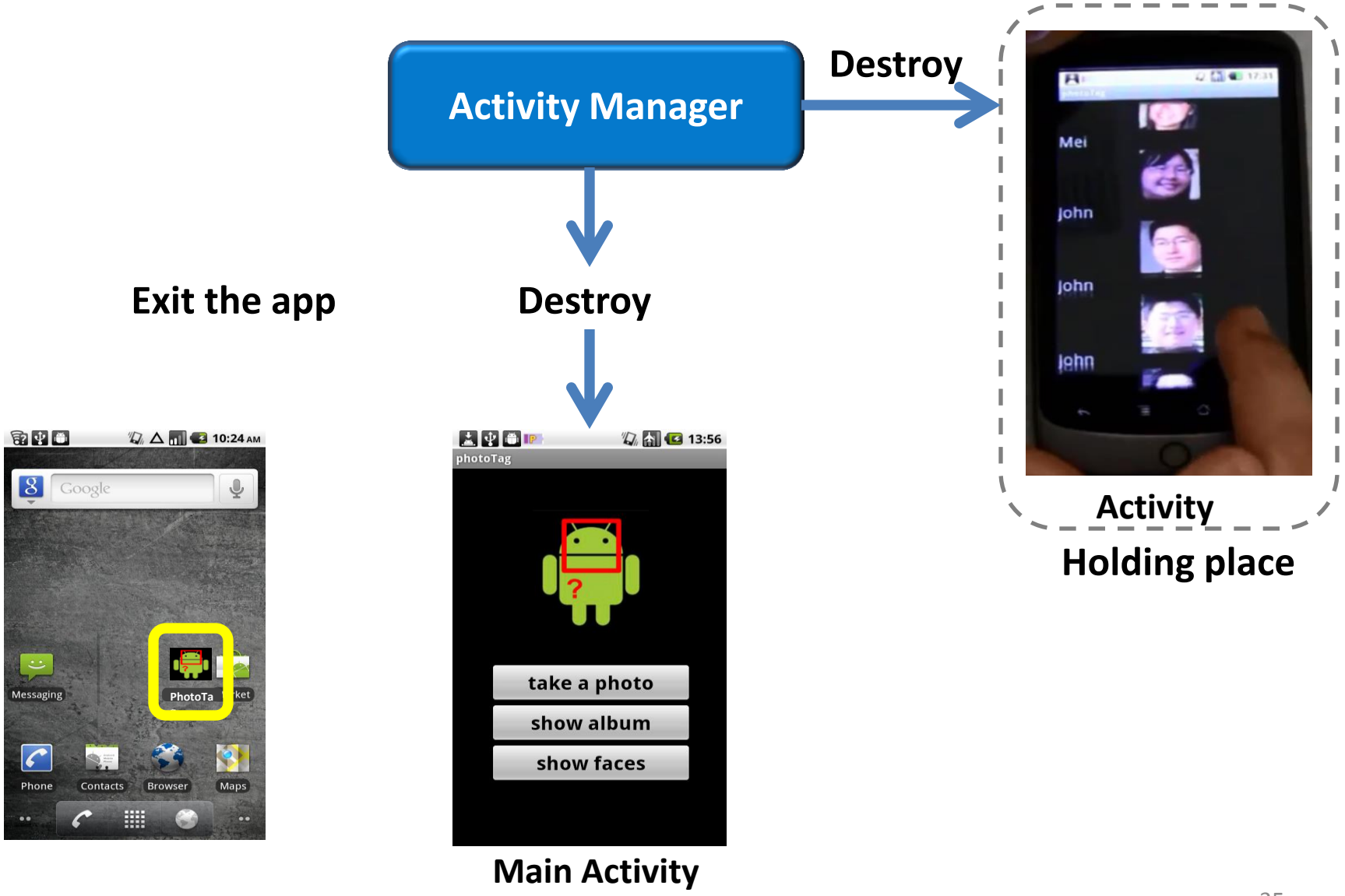


Activity

Activity Manager: An Example

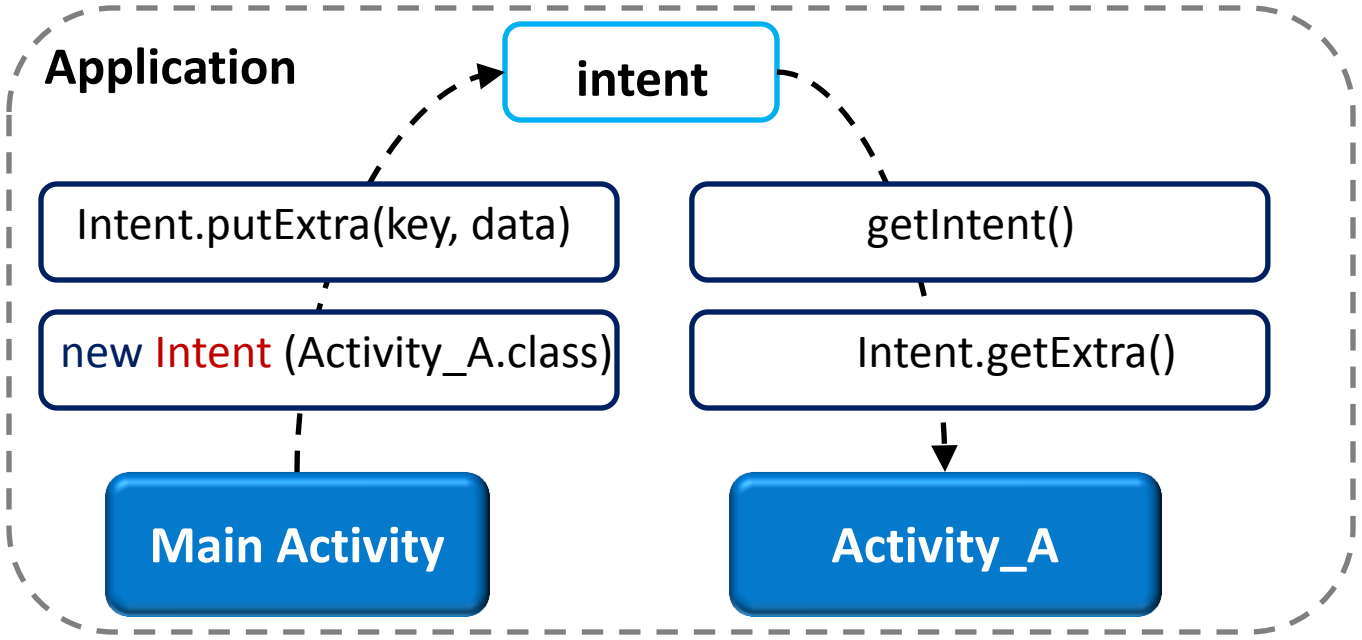


Activity Manager: An Example



Intent

- A messaging object which facilitates communication between activities



http://developer.android.com/guide/components/intents-filters.html

Intent

- Intent Types
  - **Explicit intents**: specify component to start by name. It is used to start component in your own
  - **Implicit intents**: specify component neral action to perform.


```
intent.setAction(Intent.ACTION_VIEW);
```

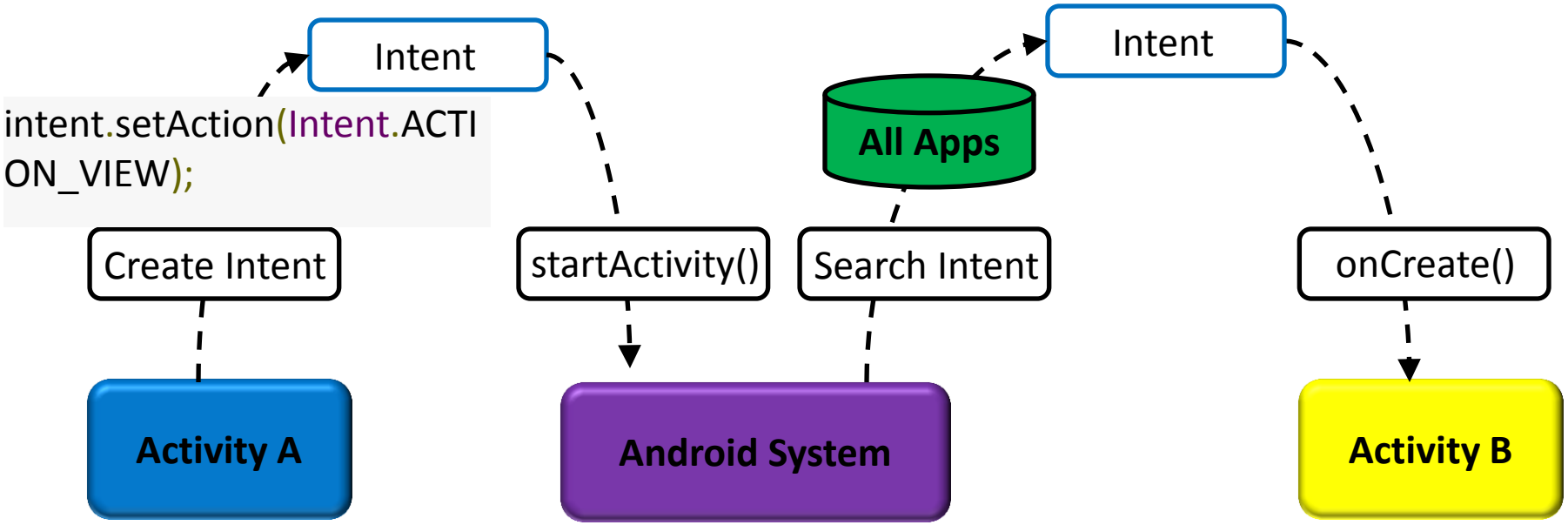


Fig. Illustration of how an implicit intent is delivered to start another activity

Starting Activities in App

```
public void sendMessage(View view)
{
    Intent intent = new Intent(this, DisplayMessageActivity.class);

    EditText editText = (EditText) findViewById(R.id.edit_message);
    String message = editText.getText().toString();
    intent.putExtra(EXTRA_MESSAGE, message);
    startActivity(intent);
}
```

public **Intent** (Context packageContext, Class<?> cls)

Added in API level 1

Create an intent for a specific component. All other fields (action, data, type, class) are null, though they can be modified later with explicit calls. This provides a convenient way to create an intent that is intended to execute a hard-coded class name, rather than relying on the system to find an appropriate class for you; see `setComponent(ComponentName)` for more information on the repercussions of this.

Parameters

packageContext	A Context of the application package implementing this class.
cls	The component class that is to be used for the intent.

See Also

`setClass(Context, Class)`

`setComponent(ComponentName)`

`Intent(String, android.net.Uri, Context, Class)`

Starting Activities in App

```
public static final String EXTRA_MESSAGE = "com.example.myfirstapp.MESSAGE";

public void sendMessage(View view)
{
    Intent intent = new Intent(this, DisplayMessageActivity.class);

    EditText editText = (EditText) findViewById(R.id.edit_message);
    String message = editText.getText().toString();
    intent.putExtra(EXTRA_MESSAGE, message);
    startActivity(intent);
}
```

public Intent **putExtra** (String name, String value) Added in API level 1

Add extended data to the intent. The name must include a package prefix, for example the app com.android.contacts would use names like "com.android.contacts.ShowAll".

Parameters

name	The name of the extra data, with package prefix.
value	The String data value.

Returns

Returns the same Intent object, for chaining multiple calls into a single statement.

- name: many standardized types, but if defining own, include app's package name as prefix

Starting Activities in App

```
public void sendMessage(View view)
{
    Intent intent = new Intent(this, DisplayMessageActivity.class);

    EditText editText = (EditText) findViewById(R.id.edit_message);
    String message = editText.getText().toString();
    intent.putExtra(EXTRA_MESSAGE, message);
    startActivity(intent);
}
```

- Starts Activity based on Intent Parameters

Getting Intent Extra

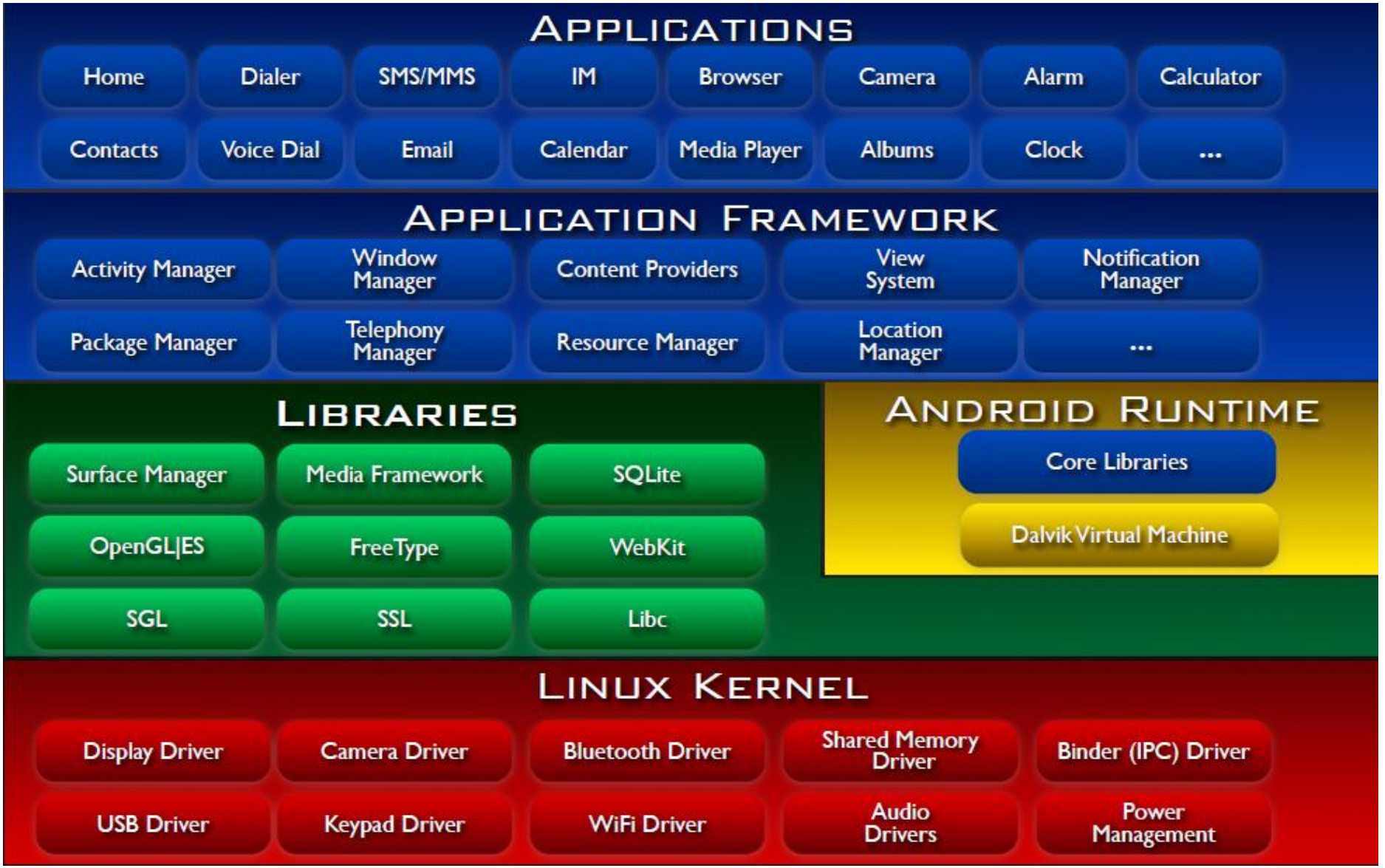
```
@Override
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);

    // Get Intent
    Intent intent = getIntent();
    String message = intent.getStringExtra(MainActivity.EXTRA_MESSAGE);

    // Create the text view
    TextView textView = new TextView(this);
    textView.setTextSize(40);
    textView.setText(message);

    // Set the text view as the activity layout
    setContentView(textView);
}
```

Android Anatomy*

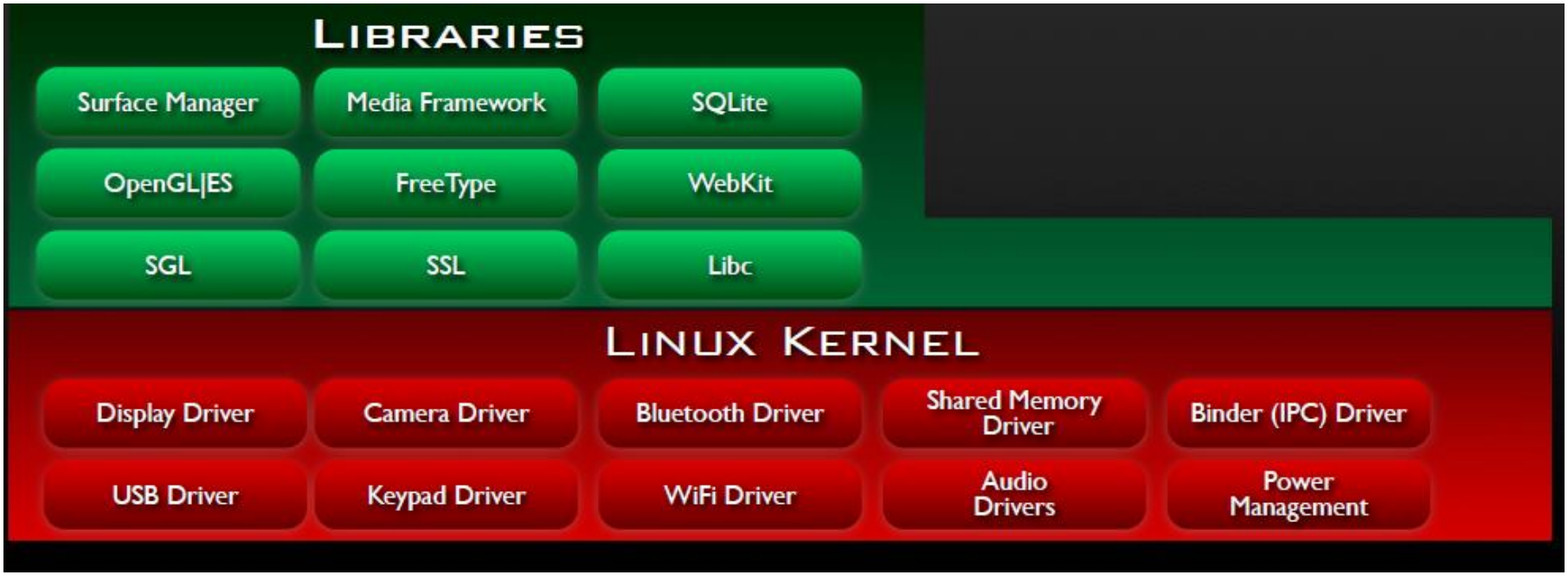


* http://sites.google.com/site/io/anatomy--physiology-of-an-android

Linux Kernel

- Android is built on the Linux kernel, but Android is not Linux
  - No glibc support
  - Does not include full set of standard Linux utilities
  - Android relies on Linux version 2.6 for core system services such as security, memory management, process management, etc.
- Kernel acts as an abstraction layer between hardware and the rest of the software stack

Android Anatomy*



Native Libraries

- Categorization
  - Bionic Libc
    - Custom libc implementation, optimized for embedded use
    - Small size and very fast

Native Libraries

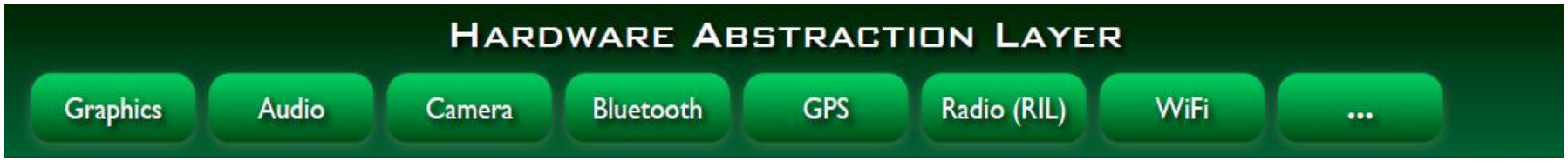
- Categorization
  - Bionic Libc
  - Function Libraries
    - WebKit: web browser engine to render web pages
    - Media Framework: supports standard video, audio, still-frame formats
    - SQLite: light-weight transactional data store

Native Libraries

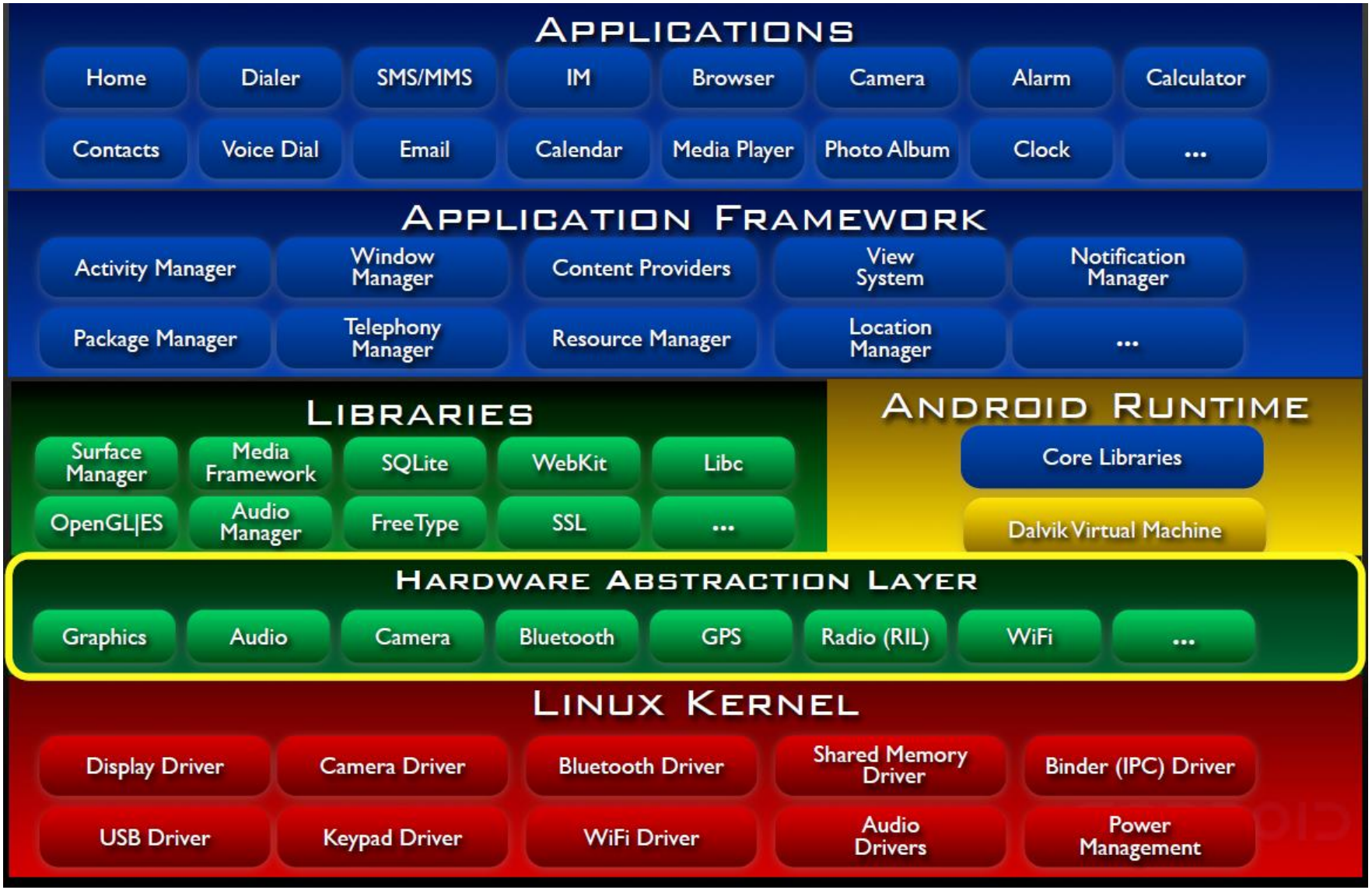
- Categorization
  - Bionic Libc
  - Function Libraries
  - Native Servers
    - Surface Manager: composes surfaces and hands surfaces to frame buffer devices
    - Audio Manager: manages all audio output devices

Native Libraries

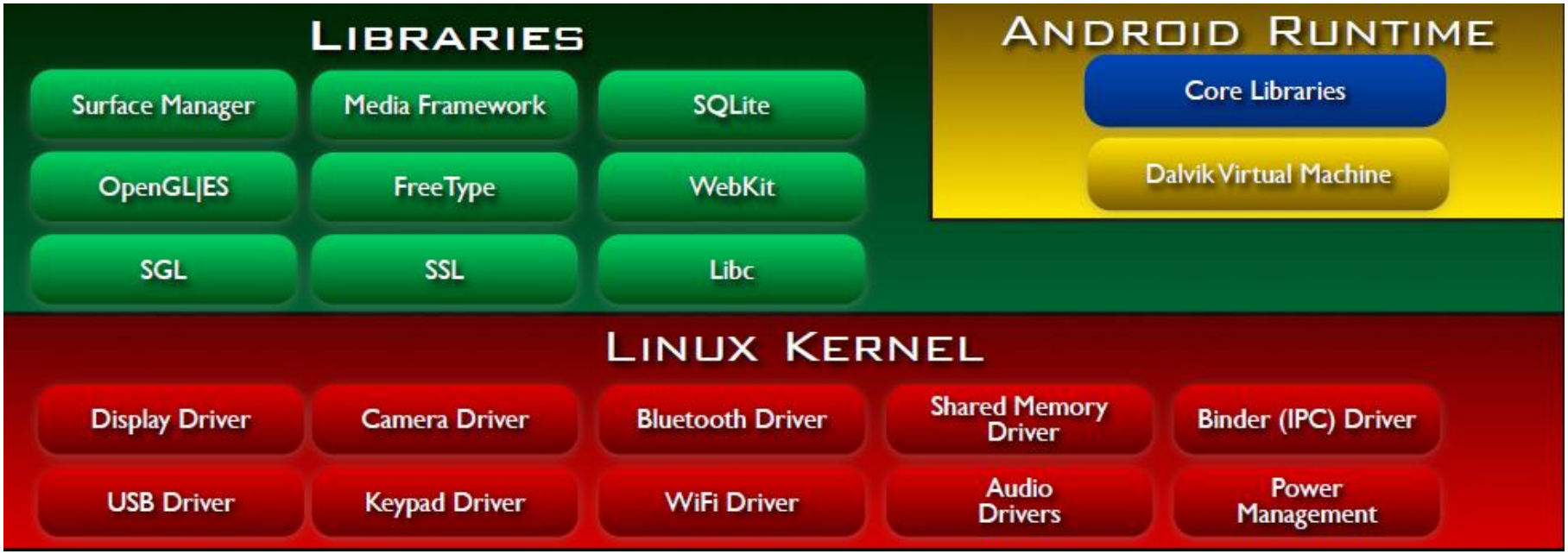
- Categorization
  - Bionic Libc
  - Function Libraries
  - Native Servers
  - Hardware Abstraction Layer
    - Defines interface that Android requires hardware “drivers” to implement
    - Why it is needed?
      - Not all components have standardized kernel driver interfaces
      - Android has specific requirements for hardware drivers



Android Anatomy



Android Runtime

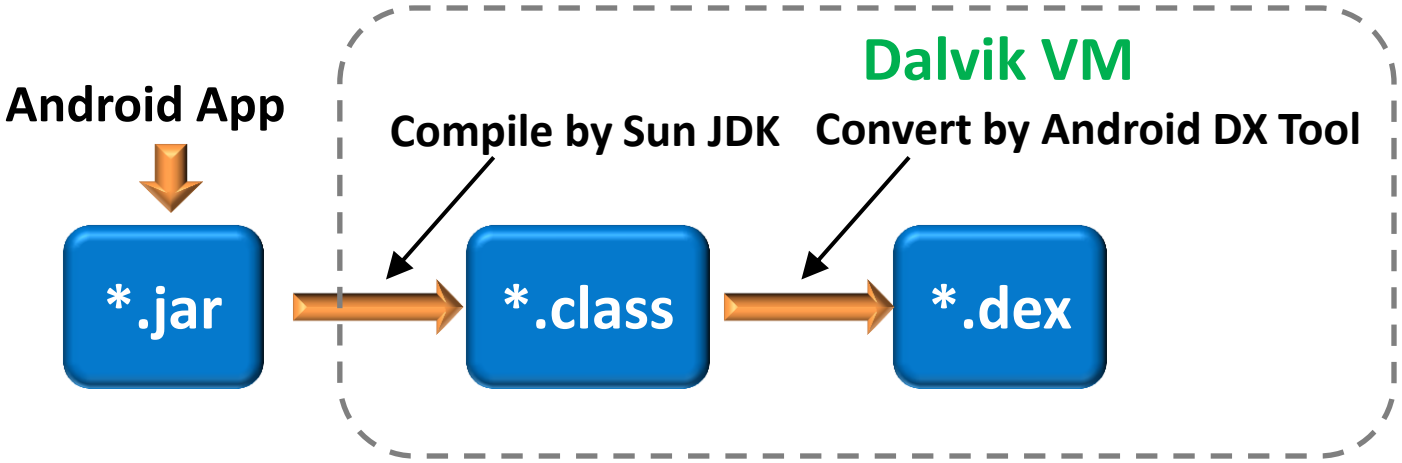


Android Runtime

- Core Libraries
  - Provide most of the functionalities available in the core libraries of Java language → powerful, simple and familiar development platform
    - Data Structure
    - Utilities
    - File Access
    - Network Access
    - Graphics
    - …

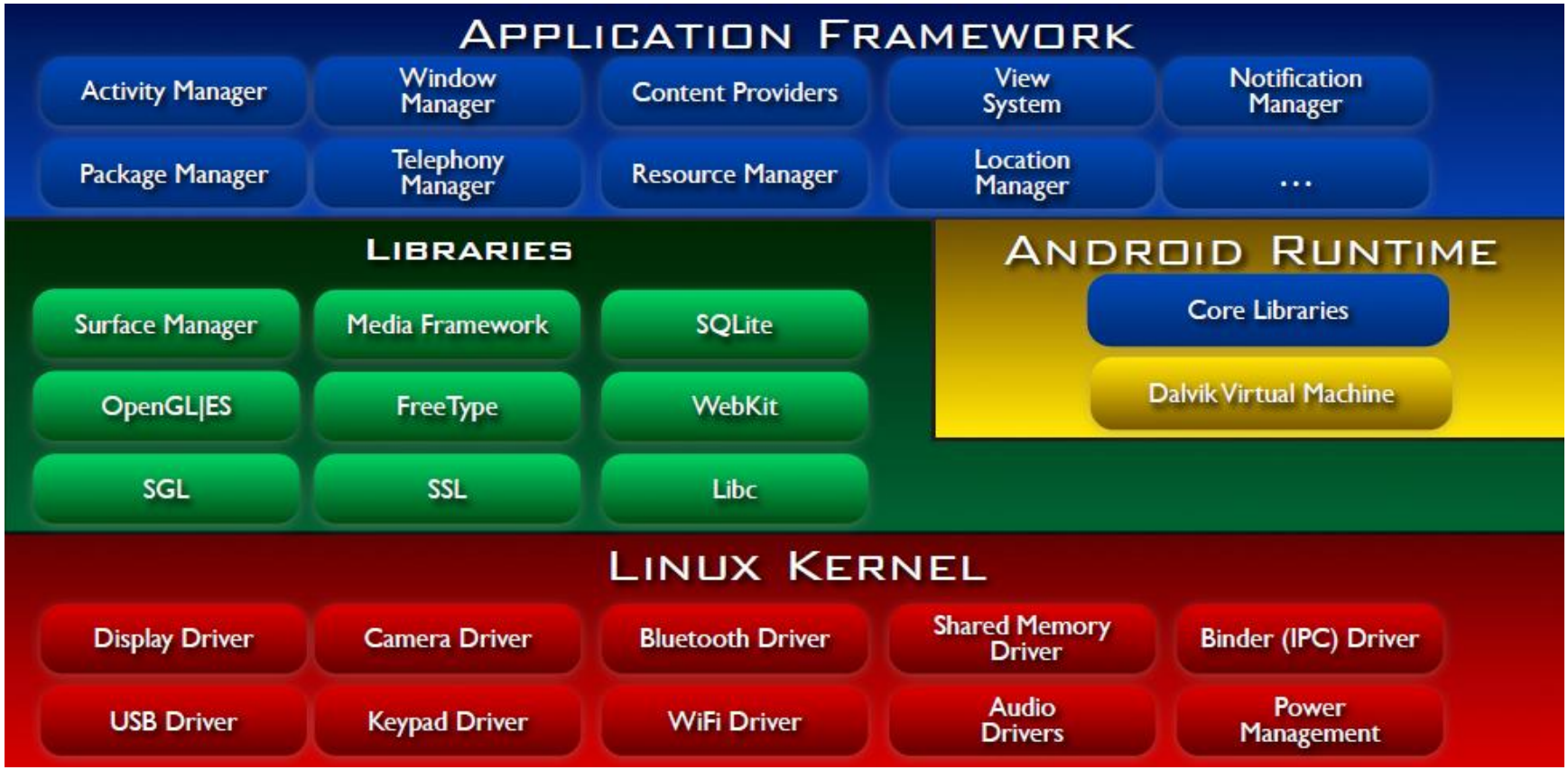
Android Runtime

- Dalvik Virtual Machine*
  - Provides Android apps portability and runtime consistency
  - Designed for embedded environment, uses runtime memory very efficiently
  - Convert Java .class/.jar files to .dex (Dalvik executable) at build time



*http://davidehringer.com/software/android/The_Dalvik_Virtual_Machine.pdf

Application Framework



Application Framework

- Contains all classes, cores and services that are used to build Android apps
- Categorization
  - Core platform services
  - Hardware services

Core Platform Services

- Services that are essential to the Android platform, e.g.
  - Manage application lifecycle, manage package, load resources
- Working behind the scenes
  - Applications don't access/interrupt them directly
- Core platform services
  - Activity Manager
  - Package Manager
  - Window Manager
  - Resource Manager
  - Content Providers
  - View System

At Google I/O "Inside the Android Application Framework"

Hardware Services

- Telephony Service
- Location Service
- Bluetooth Service
- WiFi Service
- USB Service
- Sensor Service

More information

- At Google I/O
  - "Inside the Android Application Framework"

Hardware Services

- Provide access to lower-level hardware APIs
- Typically accessed through local Manager object

```
LocationManager lm = (LocationManager)
                    Context.getSystemService(Context.LOCATION_SERVICE)
```