ID2212 Network Programming with Java
Lecture 14

An Overview of the Android Programming

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HT 2015

References

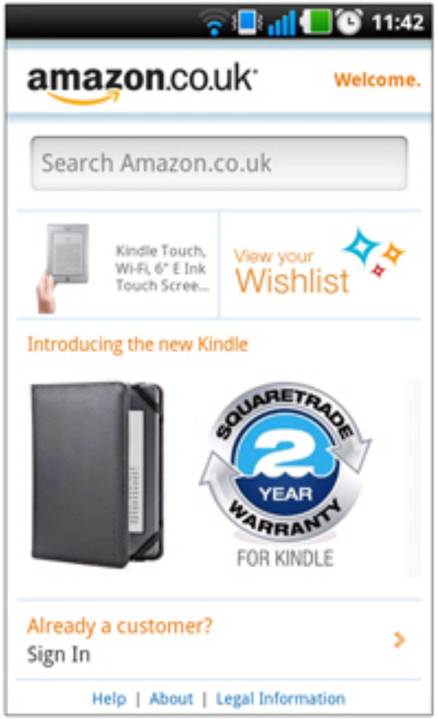
- http://developer.android.com/training/index.html
- **Course ID2216 Developing Mobile Applications**
  - **Offered by the Communication Systems department**
  - **Course responsible: Associate Professor Konrad Tollmar**

Outline

- **Mobile Web Apps vs. Native Apps**
- **Android Platform**
- **Android Programming**
- **User Experience**

Mobile Web App / Native App

Native App



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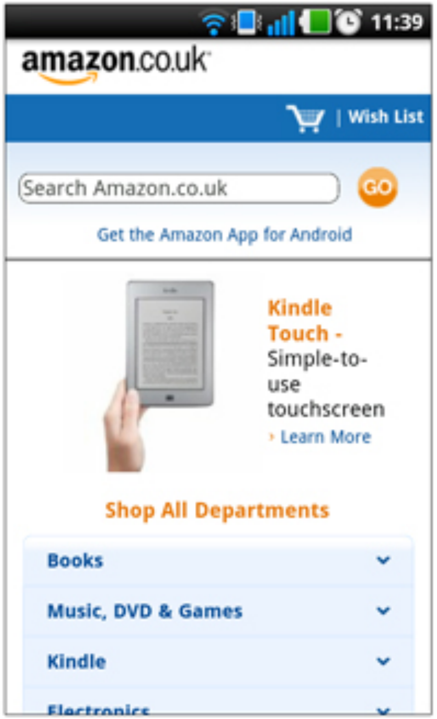
Web App



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Mobile Web Apps (1/2)

- Accessing **browser-based internet services** from a **handheld mobile device**

- **Core technologies**: HTML, CSS and JavaScript

Mobile Web Apps (2/2)

- **Advantages***:
  - Cross-platform compatibility
  - Cheaper and easier to maintain
  - Simple and ubiquitous access

- **Disadvantages**:
  - Requires customization across different browser versions
  - Limited access to mobile's hardware and software
  - Generally requires internet connection

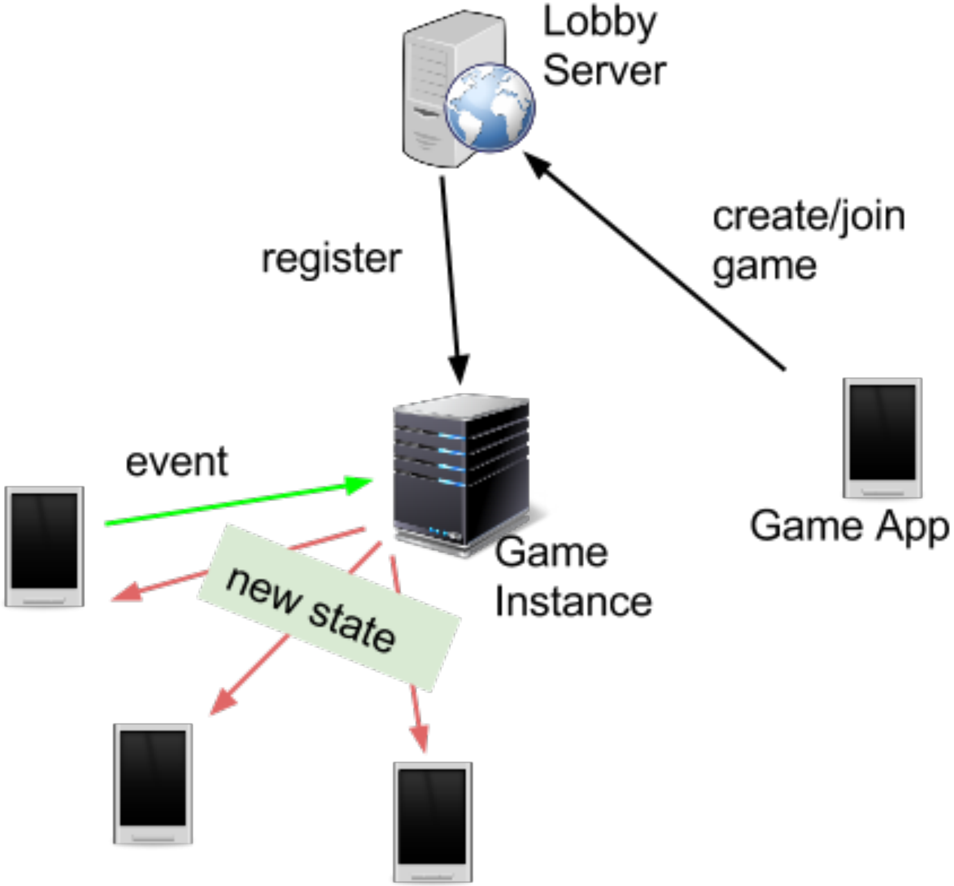
* www.lionbridge.com: Mobile Web Apps vs. Native Apps: How to Make the Right Choice

Mobile Native Apps

- Built specifically for a particular device and operating system

- **Advantages**:
  - Leverage the device specific hardware and software
  - Work offline
  - Better visibility in app stores, making money immediately
- **Disadvantages**:
  - Different versions of the app for different platforms
  - Keeping apps up to date is costly
  - Content publishers have to share information about their subscribers with the app store

A Sample Architecture of a Mobile Application



Overview of Android Platform

- **Android Operating System**
- **Dalvik Process Virtual Machine**
- **Application Lifecycle**

Android Operating System (1/2)

- **Google's Linux based open-source OS that includes:**
  - **Linux kernel** optimized for mobile and embedded devices
  - **Open-source application development libraries** such as SQLite, OpenGL, and a media manager
  - **A runtime** to host and execute Android applications, including **Dalvik virtual machine**
  - **An application framework** to expose system services to the application layer, including the window manager and location manager, databases, telephony and sensors
  - **A user interface framework** used to host and launch applications
  - A set of core **pre-installed applications**

Android Operating System (2/2)

Dalvik Virtual Machine (1/2)

- The **process virtual machine** (VM) in Google's Android operating system
- **Runs the apps** on Android devices.
- Programs are commonly written in **Java** and compiled to **bytecode**.

Dalvik Virtual Machine (2/2)

- Then converted from **Java Virtual Machine-compatible** .class files to **Dalvik-compatible** .dex (Dalvik Executable) files before installation on a device.

- In **Android 5,** a new virtual machine – **Android Runtime** (**ART**) – replaced Dalvik as the platform default.

Application Lifecycle (1/2)

- Android applications have **limited control over their own lifecycle**.
- Each application **runs in its own process**, each running in a **separate instance of Dalvik**.
- Applications have **different priorities**.

Application Lifecycle (2/2)

- Android can **kill applications without warning**, to free resources for higher-priority applications.

- An application's priority is equal to that of its **highest-priority component**.

- It's important to structure the application to ensure that it has the right priority for the work it's doing.

Application Lifecycle: Application States (1/3)

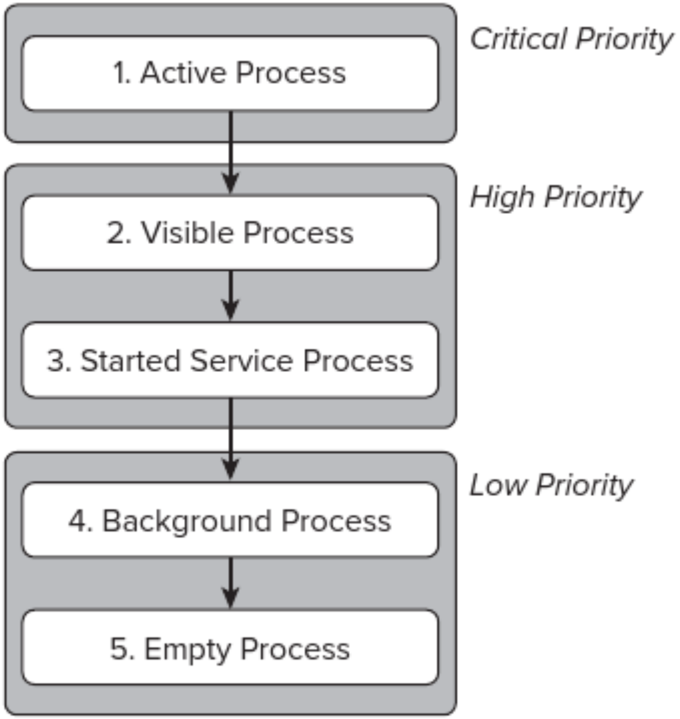


Figure taken from “Professional Android 4 Application Development (3rd Edition)”.

Application Lifecycle: Application States (2/3)

- **Active**: includes application components the user is interacting with.
- **Visible**: those activities which aren’t in the foreground but still can affect what the user sees on screen.
- **Started service**: processes hosting services.
- **Background**: processes hosting Activities which aren’t visible and don’t have any running services.
- **Empty**: a process having no active application component

Application Lifecycle: Application States (3/3)

And now let’s watch an example!

Android Programming

- **Android SDK**
- **Application Model and Components**
- **Processes and Threads**
- **Permissions**
- **Networking**
- **Location**

Development Environment

- First, **download Android Developer Tool (ADT).** It includes:
  - Eclipse + ADT plugin
  - Android SDK Tools
  - Android Platform-tools
  - The latest Android platform
  - The latest Android system image for the emulator

- Notice that, you need to have **JDK** installed beforehand.

Android SDK (1/3)

- Provides the **API libraries** and **developer tools** necessary to **build, test,** and **debug apps** for Android.

- Includes:
  - **Build Tools:** all the tools required to compile and build the app.
  - **SDK Tools:** Contains main tools for debugging and testing, plus other utilities that are required to develop an app.

Android SDK (2/3)

- **SDK Platform-tools:** Contains platform-dependent tools for developing and debugging your application.
- **Documentation:** the latest documentation for the Android platform APIs.
- **SDK Platform:** It includes an android.jar file with a fully compliant Android library.
- **System Images:** Required system images for the Android emulator.
- **Google APIs:** APIs which adds special Google features to your apps.

Android SDK (3/3)

- **Android support:** a set of code libraries that provide backward-compatible versions of Android framework APIs as well as features that are only available through the library APIs
- **Google Play Billing:** Provides the static libraries and samples that allow you to integrate billing services in your app with Google Play.
- **Google Play Licensing:** Provides the static libraries and samples that allow you to perform license verification for your app when distributing with Google Play.

Application Model and Components

- Every Android application consists of some **loosely coupled components** and the **application manifest**.

- The manifest defines **application's metadata** and the **components bindings**.

Application Components

- **Activities & UI design elements:** The application's presentation layer.
- **Services:** components that run in the background to perform long-running operations.
- **Intents:** a powerful inter-application message passing framework.
- **Broadcast Receivers:** Intent listeners *(not covered in this lecture)*
- ***Content Provider:*** manages a shared set of application data *(not covered in this lecture)*

Application Manifest

- Every Android project includes a **manifest file**.

- Defines **the structure and metadata** of the application, its **components** and **requirements**.

- **AndroidManifest.xml**

Manifest Example (2/2)

```
<application
        android:allowBackup="true"
        android:icon="@drawable/ic_launcher"
        android:label="@string/app_name"
        android:theme="@style/AppTheme" >
        <activity
            android:name=".MainActivity"
            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>
```

Activities

- Each activity represents a **screen** that an application can present to its users.
- To create an activity, you must create a **subclass of Activity**.
- **Implement callback methods** inherited from Activity class.
- Two important callback methods:
  - **onCreate**(): called when creating the activity.
  - **onPause**(): indicates that the user might be leaving.

Activities: Example

```
public class MainActivity extends Activity {

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

Activity Lifecycle

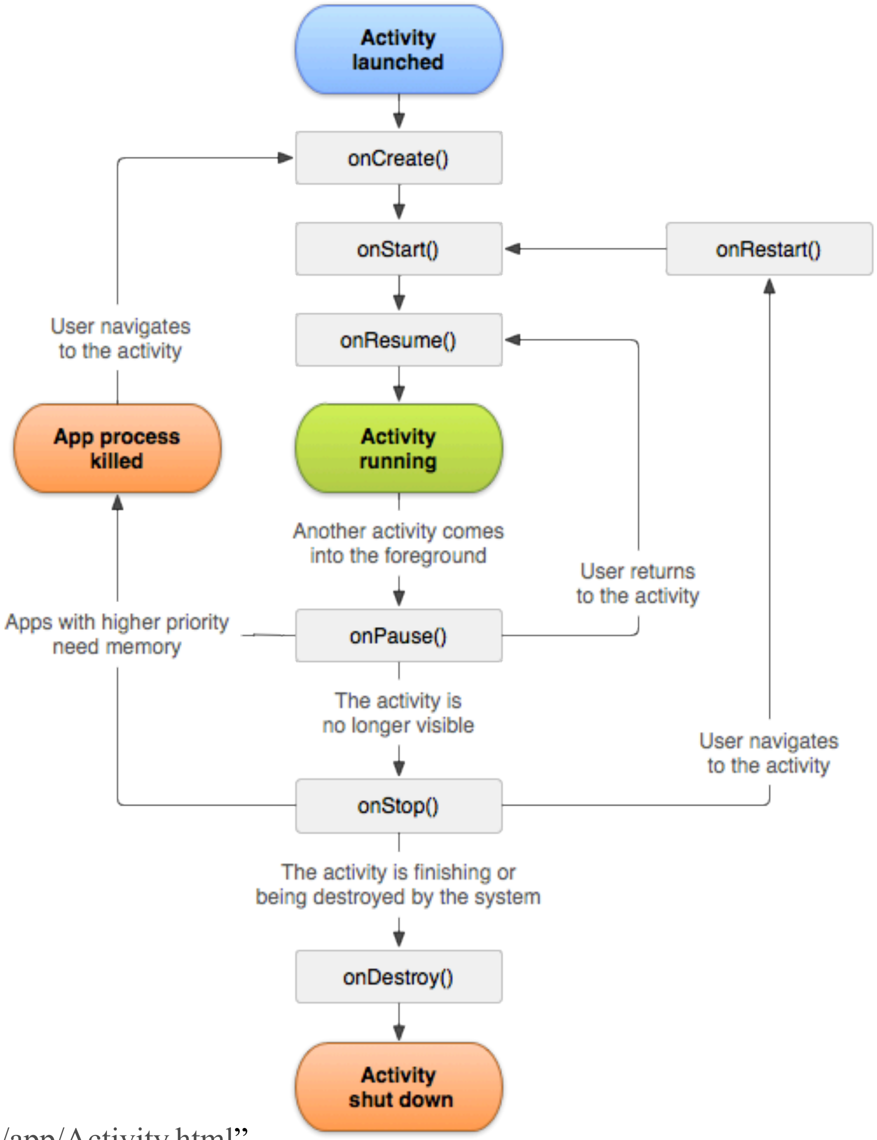

Activity launched
onCreate()
onStart()
onRestart()
User navigates to the activity
onResume()
App process killed
Activity running
Another activity comes into the foreground
User returns to the activity
Apps with higher priority need memory
onPause()
The activity is no longer visible
User navigates to the activity
onStop()
The activity is finishing or being destroyed by the system
onDestroy()
Activity shut down

Figure taken from “http://developer.android.com/reference/android/app/Activity.html”.

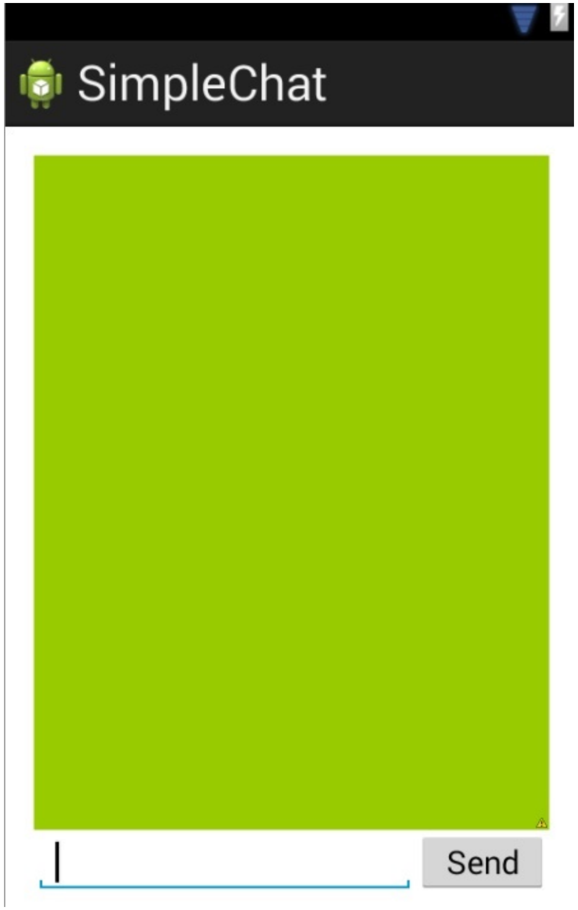
User Interface Design

Some UI terminologies in Android:

- **Views:** the base class for all visual interface elements.
- **View Groups:** extensions of the View class that can contain multiple child Views.
- **Fragments:** A Fragment represents a behavior or a portion of user interface in an Activity. Fragments have their own lifecycle, state, and back stack.
- **Activities:** represents the window or screen being displayed. To display a UI, you assign a View to an Activity.

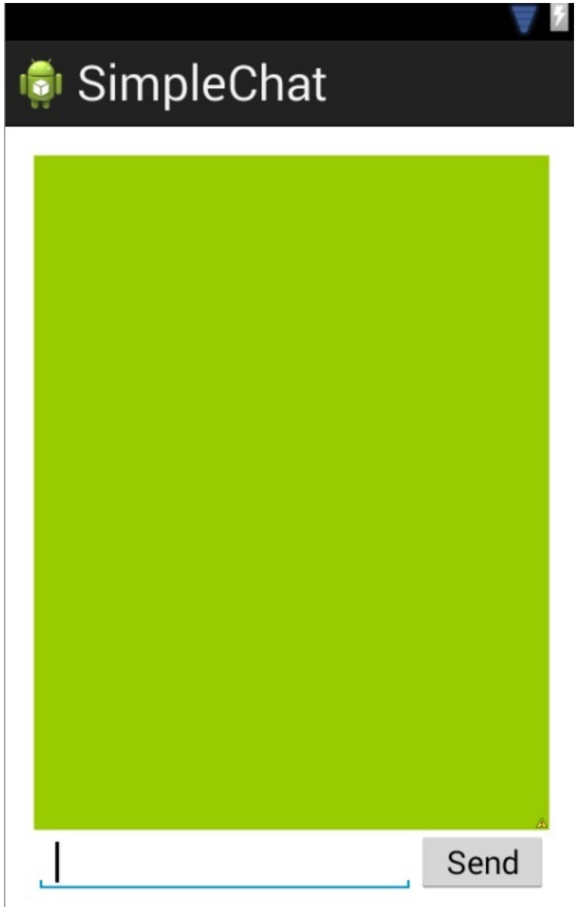
User Interface: Example (1/2)

```
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:gravity="top"
    android:orientation="vertical"
    android:paddingBottom="@dimen/activity_vertical_margin"
    android:paddingLeft="@dimen/activity_horizontal_margin"
    android:paddingRight="@dimen/activity_horizontal_margin"
    android:paddingTop="@dimen/activity_vertical_margin"
    tools:context=".MainActivity" >

    <TextView
        android:id="@+id/chatTextView"
        android:layout_width="match_parent"
        android:layout_height="match_parent"
        android:layout_above="@+id/sendButton"
        android:layout_alignParentTop="true"
        android:layout_gravity="top"
        android:background="@android:color/holo_green_light" />
```



User Interface: Example (2/2)

```
 <Button
        android:id="@+id/sendButton"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_alignBottom="@+id/chatTextInput"
        android:layout_alignRight="@+id/chatTextView"
        android:layout_alignTop="@+id/chatTextInput"
        android:layout_toRightOf="@+id/chatTextInput"
        android:text="@string/send" />

    <EditText
        android:id="@+id/chatTextInput"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_alignLeft="@+id/chatTextView"
        android:layout_alignParentBottom="true"
        android:layout_marginBottom="16dp"
        android:ems="10"
        android:inputType="textMultiLine" >

        <requestFocus />
    </EditText>

</RelativeLayout>
```



Intent

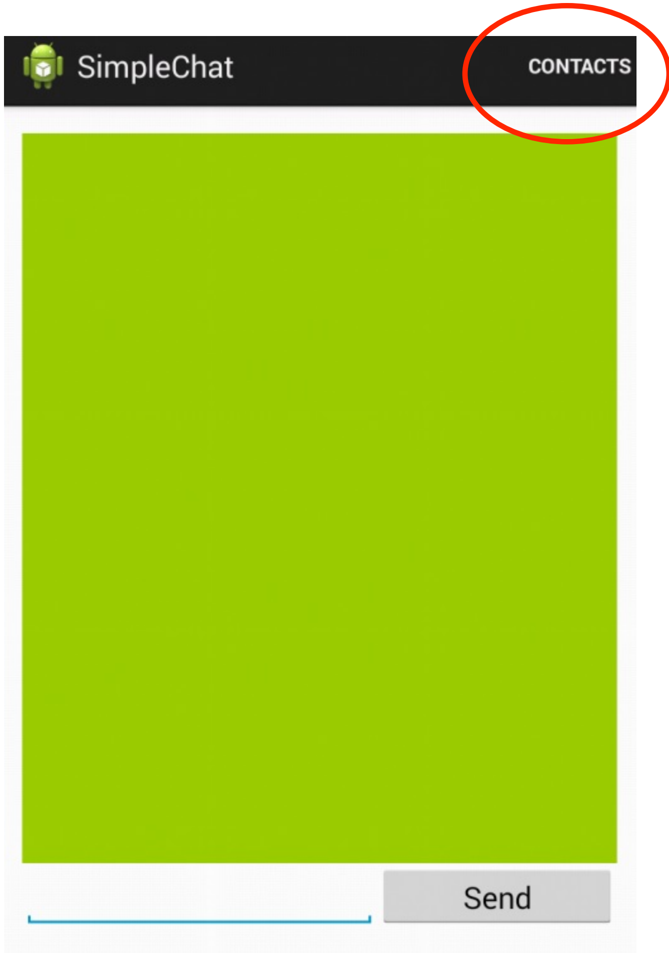
Intents work as **a message-passing** mechanism both **within and between applications**.

Using Intents you can:

- **Explicitly**, start a particular Service or Activity using its class name
- **Implicitly**, start an Activity or Service by requesting an action on a piece of data
- Broadcast the occurrence of an event

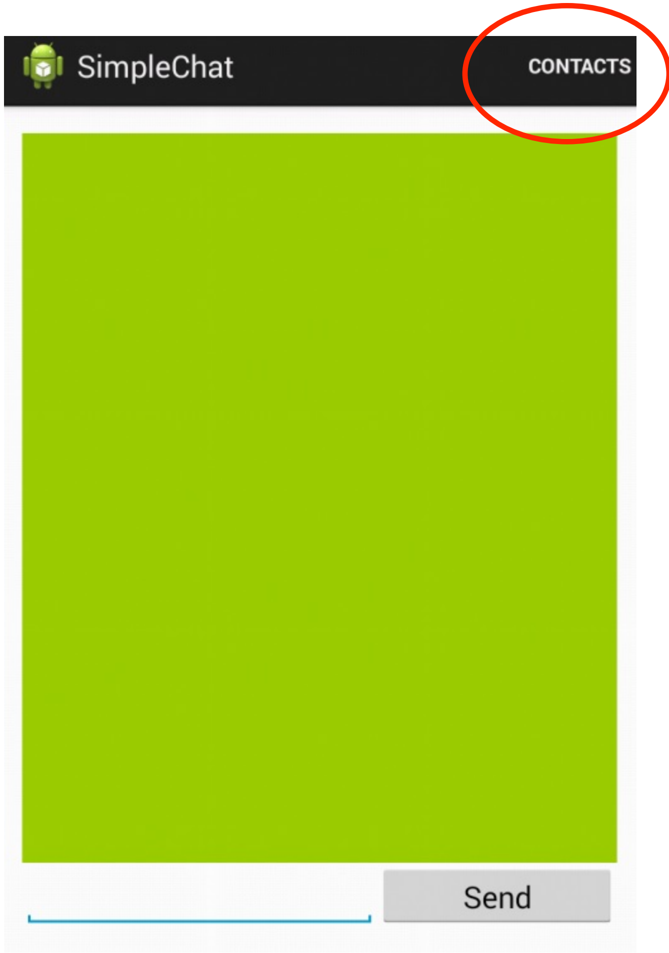
Explicit Start of a New Activity

```
Intent intent = new Intent(MainActivity.this,
                           MyContactsActivity.class);


startActivityForResult(intent, PICK_CONTACT);
```



Implicit Start of a New Activity

```
Intent intent = new Intent(Intent.ACTION_PICK,
                    Contacts.CONTENT_URI);


startActivityForResult(intent, PICK_CONTACT);
```



Service (1/3)

- A Service is an application component that can perform **long-running operations** in the **background** and does not provide a user interface.
- A service can run in the background to perform work even while the user is in a different application.
- A component **can bind to a service to interact with it** and even perform inter-process communication (IPC).
- A service might handle **network transactions, play music, perform file I/O**

Service (2/3)

- To create a service, you must create **a subclass of Service.**
- You need to **override the callback methods** to control the behavior of the service:
  - **onStartCommand**(): when another component requests the service to start.
  - **onBind**(): when another component wants to bind with the service
  - **onCreate**(): when the service is first created.
  - **onDestroy**(): when the service is no longer used and is being destroyed.

Service (3/3)

Declare the service in the manifest

```
<manifest ... >
  ...
  <application ... >
      <service android:name=".ExampleService" />
      ...
  </application>
</manifest>
```

Processes

- By default, **all components** of the same application run in **the same process**.
- You can define **in the manifest,** that **different components** of the same application are to be run in **different processes**.

```
android:process="string"
```

Threads (1/2)

- When an application is launched, the system creates a **thread of execution for the application,** called **"main.“**
- The **main thread** is called **UI thread** because: it interacts the **Android UI components**.
- **Performing long operations** such as network access or database queries will **block the whole UI.**

Threads (2/2)

- The **Andoid UI toolkit** is **not thread-safe**, so do not manipulate your UI from a worker thread.
- **Remember these two rules:**
  1. Do not block the UI thread
  2. Do not access the Android UI toolkit from outside the UI thread

Threads: Example (1/3)

An example of **wrong implementation**:

```
public void onClick(View v) {
   new Thread(new Runnable() {
      public void run() {
         Bitmap b = loadImageFromNetwork("http://example.com/image.png");
         mImageView.setImageBitmap(b);
      }
   }).start();
}
```

Worker thread is updating ImageView which is not thread-safe.

Threads : Example (2/3)

- Correct implementation using **AsyncTask**
- AsyncTask performs the **blocking operations in a worker thread** and then **publishes the results on the UI thread**.
- you must **subclass AsyncTask** and implement the **doInBackground**() callback method.
- To **update the UI**, you should implement **onPostExecute()**

Threads : Example (3/3)

```
public void onClick(View v) {

    new DownloadImageTask().execute("http://example.com/image.png");

}

private class DownloadImageTask extends AsyncTask<String, Void, Bitmap> {

    protected Bitmap doInBackground(String... urls) {
        return loadImageFromNetwork(urls[0]);
    }

    protected void onPostExecute(Bitmap result) {
        mImageView.setImageBitmap(result);
    }
}
```

Permissions

- A basic Android application has no permission associated with it by default, so it cannot access data on the device.
- To make use of protected features of the device, you must give the related to permissions to your application.
- Permissions must be added to **AndroidManifest.xml**. Example:

```
<uses-permission android:name="android.permission.READ_CONTACTS" />
```

Network and Internet Connectivity (1/4)

- There are **different network technologies** with different speed, reliability and cost:
  - **Wi-Fi, GPRS, 3G, LTE** and so on
- Application can manage these connections to ensure the **efficiency** and **responsiveness**
- Networking in Android is handled via **ConnectivityManager**.
- Changes in network connectivity are broadcasted by Android to Intents.

Network and Internet Connectivity (2/4)

To utilize the network connectivity, following **user permissions** are required:

•**INTERNET**: Allows applications to open network sockets.

•**ACCESS_NETWORK_STATE**: Allows applications to access information about networks.

Network and Internet Connectivity (3/4)

To check if the network is connected:

```
ConnectivityManager connMgr = (ConnectivityManager)
            getSystemService(Context.CONNECTIVITY_SERVICE);
  NetworkInfo networkInfo = connMgr.getActiveNetworkInfo();
  if (networkInfo != null && networkInfo.isConnected()) {
    // do network operations
  } else {
    // display error
  }
```

Network and Internet Connectivity (4/4)

- The **NetworkInfo** object includes the type of the network connection which is available.

- **getType**() returns the network connection type:

  - **TYPE_MOBILE**
  - **TYPE_WIFI**
  - **TYPE_WIMAX**
  - **TYPE_ETHERNET**
  - **TYPE_BLUETOOTH**

Location (1/4)

- The central component of the location framework is the **LocationManager** system service.
- Using **Google Maps Android API**, you can add maps to your app based on Google Maps data.
- The application can acquire the user location utilizing **GPS** and Android's **Network Location Provider**.

Location (2/4)

- **Network Location Provider:**
  - Determines location through cell tower and Wi-Fi signals
  - Works indoors and outdoors
  - Responds faster
  - Less battery power
- **GPS:**
  - Most accurate
  - Only works outdoor
  - Consumes battery quickly
  - Slow

Location (3/4)

You need to request user permission for either:

•**ACCESS_FINE_LOCATION**: Allows an app to access precise location from location sources such as GPS, cell towers, and Wi-Fi.

•**ACCESS_COARSE_LOCATION**: Allows an app to access approximate location derived from network location sources such as cell towers and Wi-Fi.

Location (4/4)

- Getting user location in Android works by means of **callback**.
- First, acquire a reference to the system Location Manager

```
LocationManager locationManager =
       (LocationManager)this.getSystemService(
                           Context.LOCATION_SERVICE);
```

Location: Define a Listener

- Define a listener that responds to location updates

```
LocationListener locationListener = new LocationListener() {

   public void onLocationChanged(Location location) {
    makeUseOfNewLocation(location);
   }

   public void onStatusChanged(String provider, int status,
                                      Bundle extras) {}

   public void onProviderEnabled(String provider) {}

   public void onProviderDisabled(String provider) {}
  };
```

Location : Register the Listener

- Register the listener with the Location Manager to receive location updates

```
locationManager.requestLocationUpdates(
       LocationManager.NETWORK_PROVIDER, 0,
       0, locationListener);
```

Location: Last Known Location

- If you need to Get the **last known location** for the quick location information:

```
String locationProvider =
   LocationManager.NETWORK_PROVIDER;
   // Or use LocationManager.GPS_PROVIDER
Location lastKnownLocation =
   locationManager.getLastKnownLocation(locationProvide
   r);
```

User Experience

- A **high quality app** is more probable to have **higher user ratings, better rankings, more downloads.**
- Improve **stability** and **eliminate bugs**
- Improve **UI responsiveness**, a slow and unresponsive UI will disappoint the users.
- Improve **the ease of use**

User Experience

- **High quality User Interface**
- Having the **right set of features**
- You can find many good suggestions and best practices to improve your application following the link:

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