Android Applications

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ANDROID APPLICATIONS

Android Basics

- (Mostly) Three Categories of Applications
  - Foreground activities
    - Suspended when not visible
    - E.g. games, mashups
  - Background services
    - E.g. call screening, SMS auto-responders
  - Intermittent activity
    - E.g. media player

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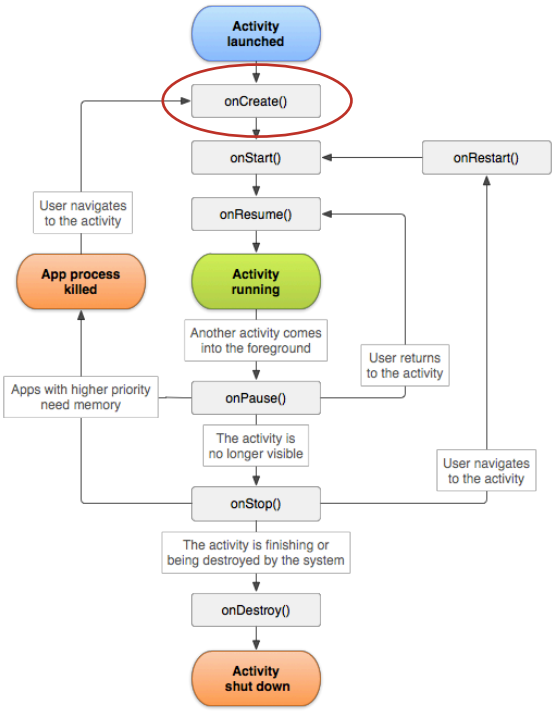
Activity Life Cycle



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Building Blocks for Applications

- Activities: presentation layer
- Services
- Broadcast Receivers
- Content Providers
- Intents
- Notifications

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Building Blocks for Applications

- Activities: presentation layer
  - UI for one focused endeavor
  - Visual content via views
  - Activities invoke other activities
- Services
- Broadcast Receivers
- Content Providers
- Intents
- Notifications

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Building Blocks for Applications

- Activities: presentation layer
- Services
  - Background services
  - RPC communication
  - Run in the *main* thread
- Broadcast Receivers
- Content Providers
- Intents
- Notifications

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Building Blocks for Applications

- Activities: presentation layer
- Services
- Broadcast Receivers
  - React to broadcast messages
  - Publish-subscribe (intents)
- Content Providers
- Intents
- Notifications

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Building Blocks for Applications

- Activities: presentation layer
- Services
- Broadcast Receivers
- Content Providers
  - Make data available
  - Content Resolver: start process
- Intents
- Notifications

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Building Blocks for Applications

- Activities: presentation layer
- Services
- Broadcast Receivers
- Content Providers
- Intents
  - Asynchronous messages
  - Intent filters
- Notifications

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Building Blocks for Applications

- Activities: presentation layer
- Services
- Broadcast Receivers
- Content Providers
- Intents
- Notifications
  - Dialogues and modal messages

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APPLICATION MANIFEST

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Application Manifest

- Stored in root of project hierarchy
  - AndroidManifest.xml
  - Define structure and metadata of application
  - Nodes for each of the components

```
<manifest
  xmlns:android="http://schemas.android.com/apk/res/android"
  package="edu.stevens.cs522.hello">
…
</manifest>
```

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Application Manifest

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="edu.stevens.cs522.hello"
    android:versionCode="1"
    android:versionName="1.0" >

    <uses-sdk
        android:minSdkVersion="8"
        android:targetSdkVersion="10" />

    <application
        android:allowBackup="true"
        android:icon="@drawable/ic_launcher"
        android:label="@string/app_name"
        android:theme="@style/AppTheme" >
        <activity
            android:name="edu.stevens.cs522.hello.HelloActivity"
            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>
```

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Application Manifest

- Manifest node tags
  - Application: container for…
    - Activity: specify intent filter
    - Service
    - Provider
    - Receiver: global broadcast receiver
  - Uses-permission:
    - Must be granted during installation
  - Permission
    - Declare to restrict access to components in app
  - instrumentation

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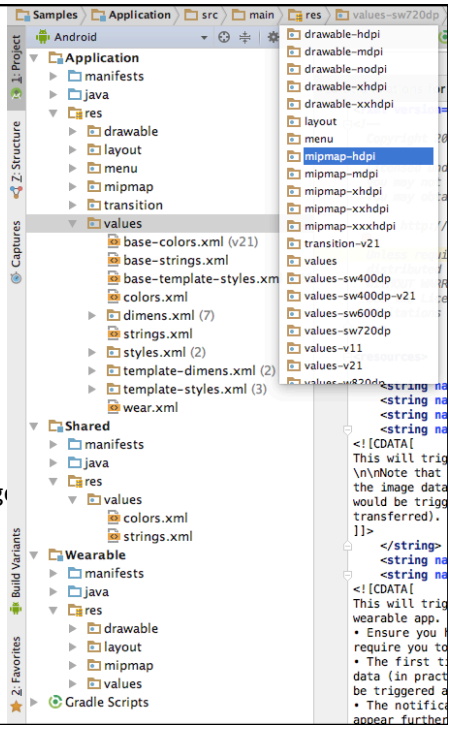
Resources

- External resources
  - Values
    - Strings, colors, dimensions, string or integer arrays
  - Styles and themes
    - Colors and fonts
  - Drawables
    - Bitmaps and (stretchable) imag
  - Layouts
    - UI specified statically in XML
    - Android best practice



Using Resources

- In code:
  - Using the static R class
  - Static subclasses e.g. R.string, R.drawable
  - Reference to resource table e.g. R.layout.main
  - Dynamic lookup

```
Resources myResources = getResources();
CharSequence styledText =
  myResources.getText(R.string.stop_message);
Button b = (Button) findViewById(R.id.ok_button);
```

```
<button
   android:id="@+id/ok_button"/>
```

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Using Resources

```
…<TextView
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:text="Hello, World"
    />…
```

- In code:
  - Using the static R class
  - Static subclasses e.g. R.string, R.drawable
  - Reference to resource table e.g. R.layout.main
  - Dynamic lookup

```
Resources myResources = getResources();
CharSequence styledText =
  myResources.getText(R.string.stop_message);
Button b = (Button) findViewById(R.id.ok_button);
```

- In resources

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Using Resources

```
…<TextView
    android:layout_width=”match_parent"
    android:layout_height="wrap_content"
    android:text=“@string/hello_message”
    />…
```

- In code:
  - Using the static R class
  - Static subclasses e.g. R.string, R.drawable
  - Reference to resource table e.g. R.layout.main
  - Dynamic lookup

```
Resources myResources = getResources();
CharSequence styledText =
  myResources.getText(R.string.stop_message);
Button b = (Button) findViewById(R.id.ok_button);
```

- In resources

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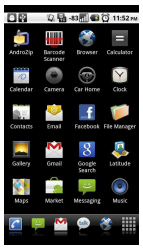
Activity Node in the Application Manifest

Entry point for a task

```
<activity android:label=“@string/app_name”
          android:name=“.MyActivity”>
  <intent-filter>
    <action
        android:name=“android.intent.action.MAIN”/>
    <category
      android:name=“android.intent.category.LAUNCHER”/>
  </intent-filter>
</activity>
```

Icon in the application launcher



INTENTS

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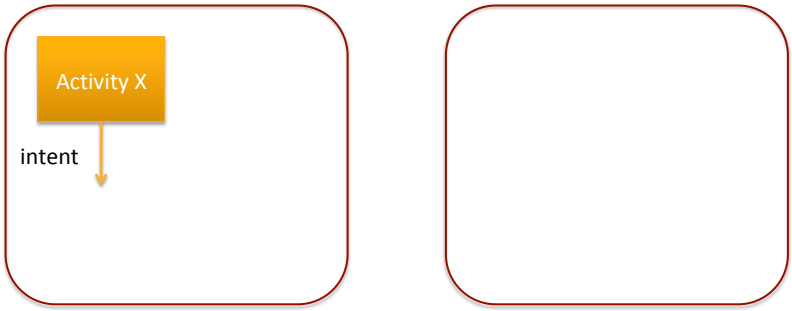
Intents

- Intents: Asynchronous messages to launch new activities / services, or send broadcasts

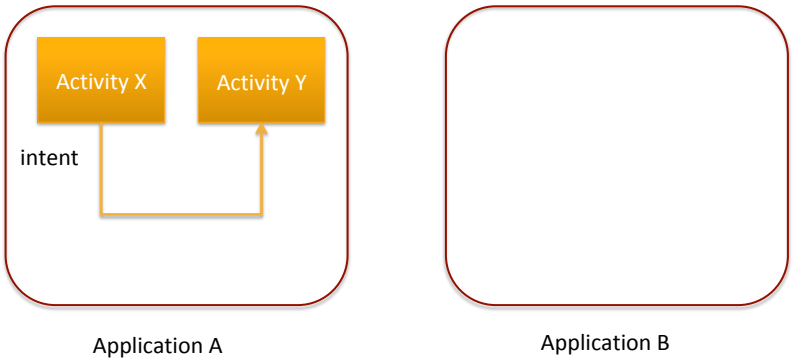


Application A

Application B

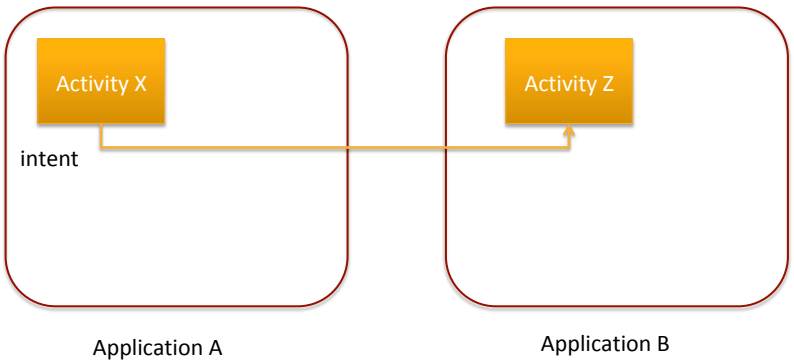
Intents

- Intents: Asynchronous messages to launch new activities / services, or send broadcasts



Intents

- Intents: Asynchronous messages to launch new activities / services, or send broadcasts



Intents

- Explicit intents: specify the activity to be started

```
Intent intent = new Intent(MyActivity.this,
                           MyOtherActivity.class);
startActivity(intent);
```

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Intents

- Explicit intents: specify the activity to be started

```
Intent intent = new Intent(MyActivity.this,
                           MyOtherActivity.class);
startActivity(intent);
```

- Implicit intents: specify data and action, and system resolves the activity

```
Intent intent = new Intent(Intent.ACTION_DIAL,
                     Uri.parse("tel:555-2368"));
startActivity(intent);
```

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Information in Intents (1)

- Component name: for handler of intent
  - For explicit intents
- Action
  - String naming action to be performed
  - E.g. ACTION_CALL, ACTION_EDIT, ACTION_SYNC
  - Akin to a method name
- Data
  - URI, and opt MIME type, of data to be acted on
  - E.g. ACTION_CALL with tel: URI
  - E.g. ACTION_EDIT with URI of document
  - E.g. ACTION_VIEW with content://contacts/people/17

Information in Intents (2)

- Category:
  - The kind of component that should handle the intent
  - E.g. CATEGORY_BROWSABLE
  - E.g. CATEGORY_DEFAULT
  - E.g. CATEGORY_HOME
  - E.g. CATEGORY_LAUNCHER
- Extras
  - Key-value pairs
- Flags

Intent Filters (1)

- Intent filters register activities, services and broadcast receivers
  - `<intent-filter>` element in component's manifest node
  - Child elements for action, data, category

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Intent Filters (2)

- Intent filters register activities, services and broadcast receivers
  - `<intent-filter>` element in component's manifest node
  - Child elements for action, data, category

```
<intent-filter . . . >
   <action
   android:name="com.example.project.SHOW_CURRENT" />
   <action
   android:name="com.example.project.SHOW_RECENT" />
   <action
   android:name="com.example.project.SHOW_PENDING" />
      . . .
</intent-filter>
```

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Intent Filters (3)

- Intent filters register activities, services and broadcast receivers
  - `<intent-filter>` element in component's manifest node
  - Child elements for action, data, category

```
<intent-filter ... >
  <data android:mimeType="audio/mpeg" ... />

  <data android:mimeType="video/mpeg"
   android:scheme="http"
   host="www.example.com"
   port="200" path="/folder/subfolder" ... />
   ...
</intent-filter>
```

`http://www.example.com:200/folder/subfolder`

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Intent Filters (3)

- Intent filters register activities, services and broadcast receivers
  - `<intent-filter>` element in component's manifest node
  - Child elements for action, data, category

```
<intent-filter ...>
  <category
   android:name="android.intent.category.DEFAULT" />
  <category
   android:name="android.intent.category.BROWSABLE" />
  ...
</intent-filter>
```

Every category in the intent object must match a category in the filter

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Intent Resolution

- Android lists available intent filters
- Matching intent filters:
  - Intent filters must match action and category
    - Match all categories
  - Match intent data URI to intent filter data tag
    - Match scheme, host/authority, path or mime type, where specified

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Resolving action and data

- Activity started because it matched intent
- Must learn action and data

```
public void onCreate(Bundle icicle) {
  super.onCreate(icicle);
  setContentView (R.layout.main);

  Intent intent = getIntent();
  String action = intent.getAction();
  Uri data = intent.getData();
}
```

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Subactivities with Results

- Parent Activity: Launching a subactivity:

```
Uri data = …;
Intent intent = new Intent(Intent.ACTION_PICK, data);
// Result returned in onActivityResult
startActivityForResult(intent, PICK_SUBACTIVITY);
```

Start a subactivity for a dialog (there are lighter weight alternatives)…

Request code

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Subactivities with Results

- Child Activity: Returning Results (`onCreate` method):

```
Button okButton = (Button) findViewById(R.id.ok_button);

ButtonListener okListener = new View.OnClickListener() {
   public void onClick(View view) {
      Uri data = …;
      Intent result = new Intent(null, data);
      result.putExtra(IS_INPUT_CORRECT, inputCorrect);
      setResult(RESULT_OK, result);
      finish();
   }
}

okButton.setOnClickListener(okListener);
```

Subactivity registers listener for clicking OK…

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Subactivities with Results

- Child Activity: Returning Results (`onCreate` method):

```
Button cancelButton =
   (Button) findViewById(R.id.cancel_button);

ButtonListener cancelListener = new
  View.OnClickListener() {
      public void onClick(View view) {
         setResult(RESULT_CANCELED, null);
         finish();
      }
   }

cancelButton.setOnClickListener(cancelListener);
```

…and registers listener for clicking CANCEL…

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Subactivities with Results

- Parent Activity: Handling Results:

```
public void onActivityResult(int requestCode,
                             int resultCode,
                             Intent data) {
   super.onActivityResult(requestCode, resultCode, data);

   switch(requestCode) {
      case (PICK_SUBACTIVITY) :
         if (resultCode == Activity.RESULT_OK) {
            // TODO Handle user clicked OK.
         }
         break;
   }
}
```

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S

```
Uri data = …;
Intent intent = new Intent(Intent.ACTION_PICK, data);
// Result returned in onActivityResult
startActivityForResult(intent, PICK_SUBACTIVITY);
```

- Handling Results:

```
public void onActivityResult(int requestCode,
                             int resultCode,
                             Intent data) {
   super.onActivityResult(requestCode, resultCode, data);

   switch(requestCode) {
      case (PICK_SUBACTIVITY) :
         if (resultCode == Activity.RESULT_OK) {
            // TODO Handle user clicked OK.
         }
         break;
   }
}
```

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TASKS AND ACTIVITIES

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Tasks and Activities

Task: stack of activities

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Tasks and Activities

An activity uses an intent to activate another activity

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Tasks and Activities

Activity 5

Activity 4

Activity 3

Activity 2

Activity 1

The user may choose to start another task from the home screen.

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Tasks and Activities

Activity 5

Activity 4

Activity 3

Activity 2

Activity 1

Go back to previous task via the home screen

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Tasks and Activities

BACK: go to the previous activity in *this* task

Almost all of this can be reprogrammed using intents and affinities.

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Affinities

- Afinity between activities in an application
- `taskAffinity` attribute of `<activity>`
  - element to override default
- May be shared with activities in other tasks

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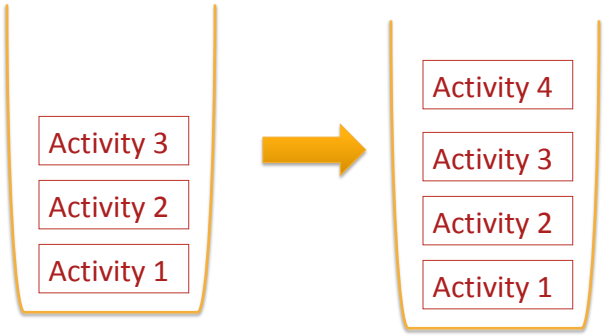
Affinities

Default behavior



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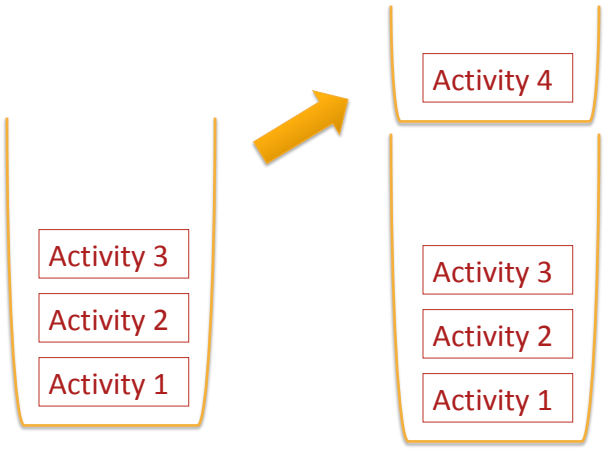
Affinities

FLAG_ACTIVITY_NEW_TASK flag
in the intent



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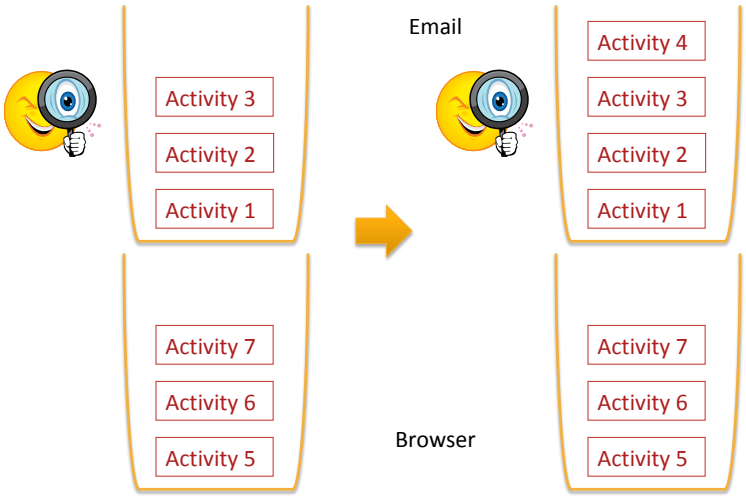
Affinities

allowTaskReparenting attribute in activity element



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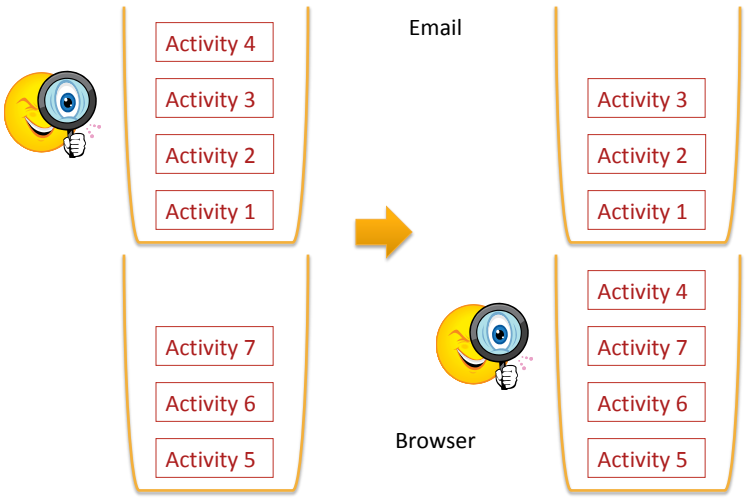
Affinities

allowTaskReparenting attribute in activity element



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Processes and Threads

- Component elements (<activity>, <service>, <receiver>, <provider>) can specify with process attribute where they should run
  - Each component may run in its own process
  - Some components may share a process
  - Components of different applications may run in same process

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Launch Modes

Specified in <activity> element's launchMode attribute

	Which task activity starts in (default)	Multiple instances of activity	Other activities in its task	New instance for new intent
standard (default)	Originating task	Yes	Yes	Yes
singleTop	Originating task	Yes	Yes	Re-used if on top of stack
singleTask	New task	No	Yes (but it is always root activity)	No, intent dropped if not on top
singleInstance	New task	No	No	No, only activity in task

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Processes and Threads

- Each component runs in the main thread
- Free up resources: which process to terminate?

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ACTIVITY LIFE CYCLE

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Activity States

- Active
- Paused
- Stopped
- Inactive

Visible and running

Visible but some other activity is running

No longer visible

Not yet launched or just killed

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Application Priority

Active Process

Visible Process

Started Service Process

Background Process

Empty Process

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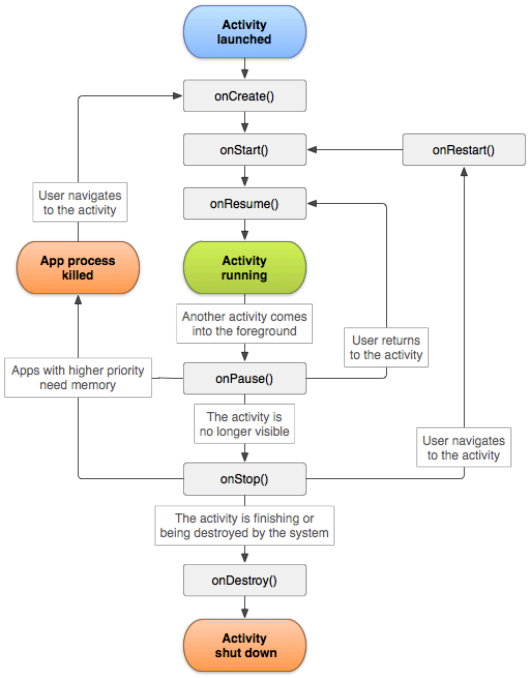
Activity Life Cycle



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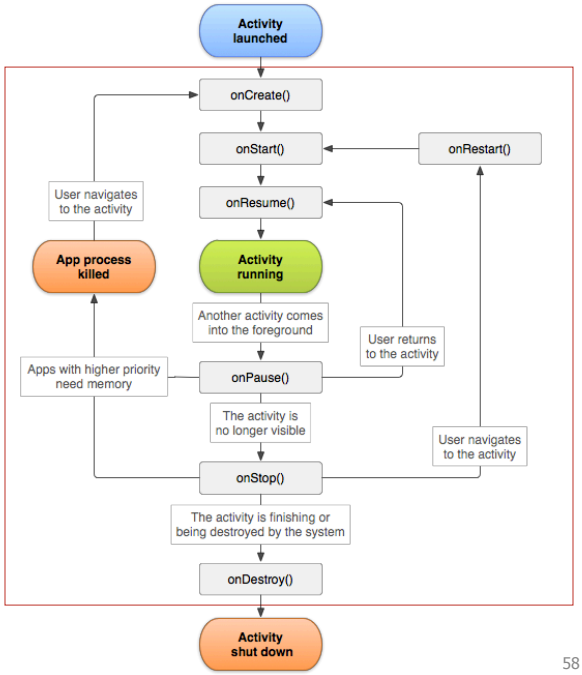
Full lifetime
- From first call to onCreate…
- …to final call to onDestroy
- Avoid creation of short-term objects, create them once in onCreate



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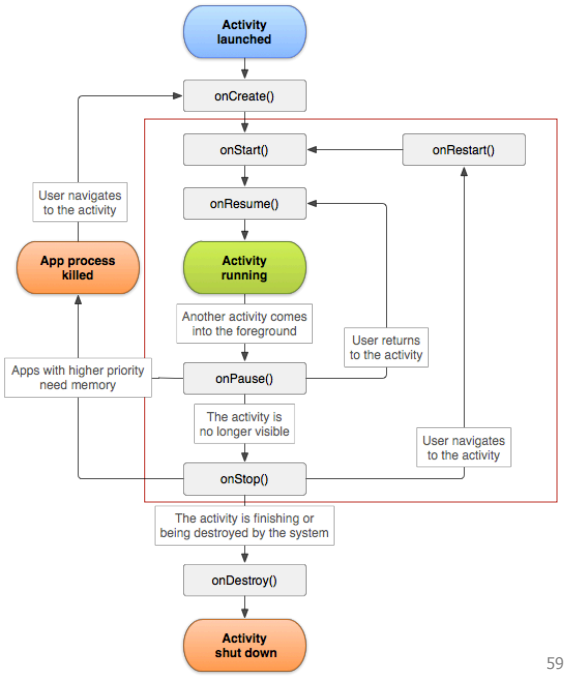
Visible lifetime
- From call to onStart to onStop
- Visible but does not have the focus



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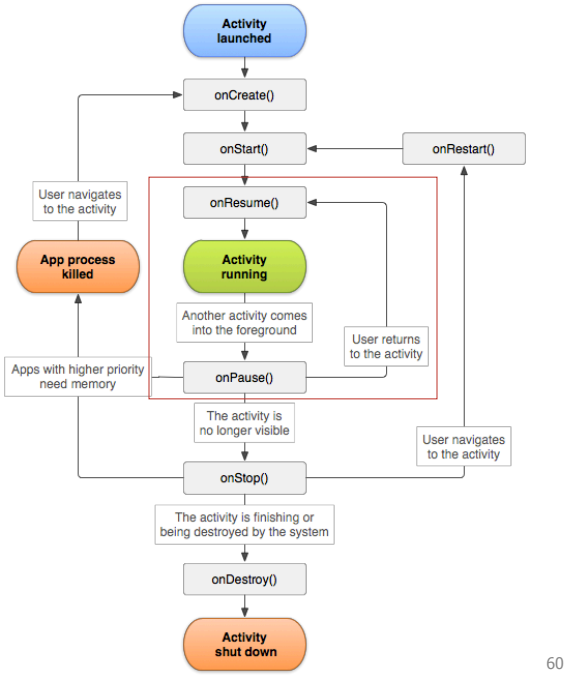
Active lifetime
- From call to onResume to onPause
- onSaveInstanceState called just before onPause, to save UI state, to be reloaded by call to ~~onRestoreInstanceState~~ onCreate



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Activity Life Cycle Methods

- onCreate: create objects and prepare to display
- onRestart: prepare to display
- onStart: app is (partially?) visible
- onResume: begin interaction with user
- onPause: pause interaction (e.g. dialog-themed activity)
- onStop: obscured (e.g. free up cache space)
- onDestroy

Example: Playing Music

```
class MyActivity extends Activity {

  MediaPlayer mp;

  public void onCreate(Bundle state) {
    super.onCreate(state);
    mp = new MediaPlayer();
    mp.setAudioStreamType(AudioManager.STREAM_MUSIC);
    mp.setDataSource(...);  // e.g. URI for content provider
  }

  public void onStart() {
    super.onStart();
    mp.prepare();  // Should really use prepareAsync()
  }

  public void onResume() {
    super.onResume();
    mp.start();
  }
```

Example: Playing Music

```
class MyActivity extends Activity {

  public void onPause() {
    super.onPause();
    mp.pause();
  }

  public void onStop() {
    super.onStop();
    mp.stop();
  }

  public void onDestroy() {
    super.onDestroy();
    mp.release();
    mp = null;
  }
```

Example: Playing Music

```
class MyActivity extends Activity {

  MediaPlayer mp;

  public void onCreate(Bundle state) {
    super.onCreate(state);
    mp = new MediaPlayer();
    mp.setAudioStreamType(AudioManager.STREAM_MUSIC);
    mp.setDataSource(...);  // e.g. URI for content provider
    mp.prepare();  // Should really use prepareAsync()
  }

  public void onResume() {
    super.onResume();
    mp.start();
  }
```

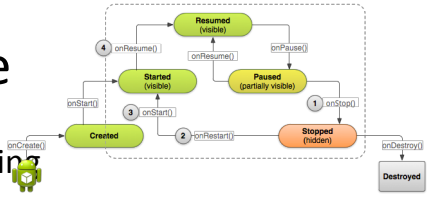
Example: Playing Music

```
class MyActivity extends Activity {

  public void onPause() {
    super.onPause();
    mp.pause();
  }

  public void onDestroy() {
    super.onDestroy();
    mp.stop();
    mp.release();
    mp = null;
  }
```

Application UI State



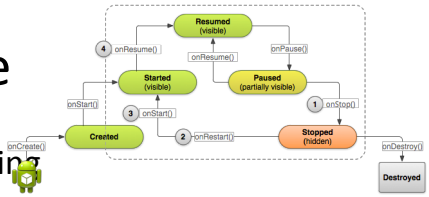
- Save UI state before destroying

```
private static final String
    PLAYER_STATE_KEY = ”PLAYER_STATE_KEY";

private int playerScore;

@Override
public void onSaveInstanceState(Bundle state) {
  state.putInt(PLAYER_STATE_KEY, playerScore);
  super.onSaveInstanceState(state);
}
```

Application UI State



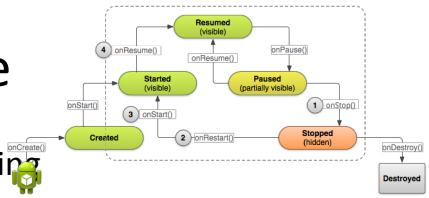
- Save UI state before destroying

```
private static final String
     PLAYER_STATE_KEY = ”PLAYER_STATE_KEY";

 private int playerScore;

 @Override
 public void onRestoreInstanceState(Bundle state) {
   super.onRestoreInstanceState(state);
   playerScore = state.getInt(PLAYER_STATE_KEY, 0);
 }
```


Application UI State



- Save UI state before destroying

```
private static final String
     PLAYER_STATE_KEY = ”PLAYER_STATE_KEY";

 private int playerScore;

 @Override
 public void onCreate(Bundle state) {
   super.onCreate(state);
   if (state != null) {
      playerScore = state.getInt(PLAYER_STATE_KEY, 0);
   }
 }
```

USER INTERFACES

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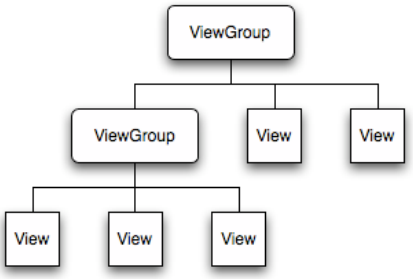
View Hierarchy



- View groups define hierarchies of views.
- The layout on the screen is described in an XML document (elements are views and view groups).
- Input controls are views that support interaction e.g. buttons, text entry, etc.

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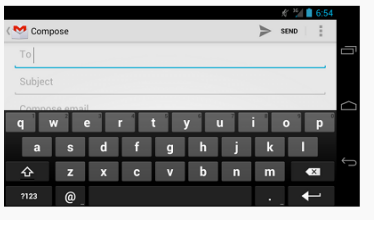
Views

- TextView
- EditText
- Spinner
- Button
- CheckBox
- RadioButton
- Etc…

```
<EditText
    android:id="@+id/email_address"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:hint="@string/email_hint"
    android:inputType="textEmailAddress" />
```



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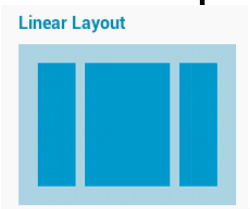
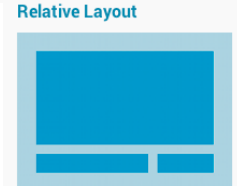
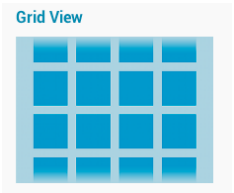
View Groups

- LinearLayout
- AbsoluteLayout
- TableLayout
- RelativeLayout
- FrameLayout
- WebView
- ScrollView
- ListView
- GridView







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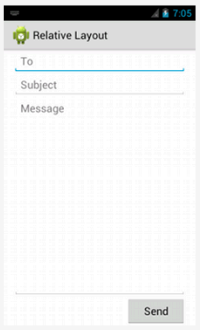
Attributes

- layout_width, layout_height
  - match_parent
  - wrap_content
- layout_marginTop, layout_marginBottom
- layout_marginLeft, layout_marginRight
- layout_gravity
- layout_weight
- layout_x
- layout_y

For LinearLayout or TableLayout

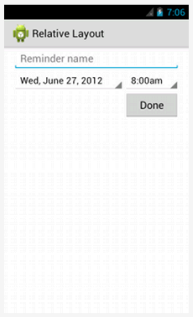
Linear Layout

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:paddingLeft="16dp"
    android:paddingRight="16dp"
    android:orientation="vertical" >
    <EditText
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:hint="@string/to" />
    <EditText
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:hint="@string/subject" />
    <EditText
        android:layout_width="fill_parent"
        android:layout_height="0dp"
        android:layout_weight="1"
        android:gravity="top"
        android:hint="@string/message" />
    <Button
        android:layout_width="100dp"
        android:layout_height="wrap_content"
        android:layout_gravity="right"
        android:text="@string/send" />
</LinearLayout>
```



Relative Layout

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout xmlns:android="http://schemas.android.co
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:paddingLeft="16dp"
    android:paddingRight="16dp" >
    <EditText
        android:id="@+id/name"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:hint="@string/reminder" />
    <Spinner
        android:id="@+id/dates"
        android:layout_width="0dp"
        android:layout_height="wrap_content"
        android:layout_below="@id/name"
        android:layout_alignParentLeft="true"
        android:layout_toLeftOf="@+id/times" />
    <Spinner
        android:id="@id/times"
        android:layout_width="96dp"
        android:layout_height="wrap_content"
        android:layout_below="@id/name"
        android:layout_alignParentRight="true" />
    <Button
        android:layout_width="96dp"
        android:layout_height="wrap_content"
        android:layout_below="@id/times"
        android:layout_alignParentRight="true"
        android:text="@string/done" />
</RelativeLayout>
```



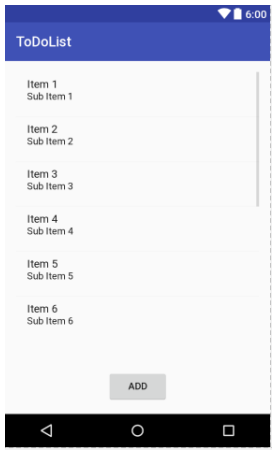
Layout Parameters

```
<LinearLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical">

    ….

    <Button
        android:text="@string/button_add"
        android:layout_width=”wrap_content"
        android:layout_height="wrap_content"
        android:layout_gravity=”center”
        android:id="@+id/add_button" />

</LinearLayout>
```



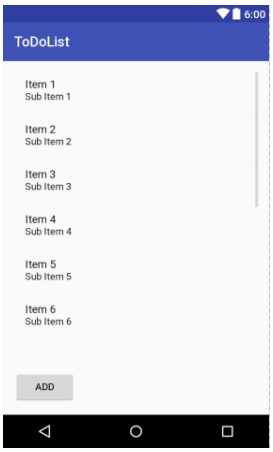
Layout Parameters

```
<LinearLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical">

    ….

    <Button
        android:text="@string/button_add"
        android:layout_width=”wrap_content"
        android:layout_height="wrap_content"
        android:layout_gravity="left"
        android:id="@+id/add_button" />

</LinearLayout>
```



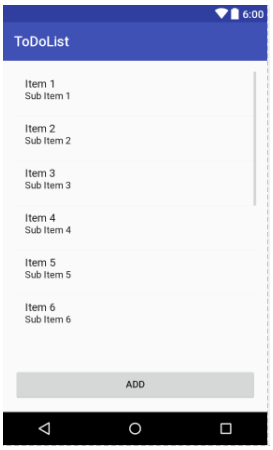
Layout Parameters

```
<LinearLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical">

    ….

    <Button
        android:text="@string/button_add"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:layout_gravity="left"
        android:id="@+id/add_button" />

</LinearLayout>
```



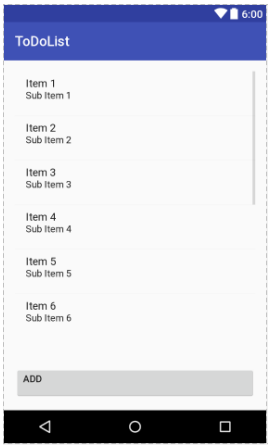
Layout Parameters

```
<LinearLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical">

    ….

    <Button
        android:text="@string/button_add"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:layout_gravity="left"
        android:gravity="left"
        android:id="@+id/add_button" />

</LinearLayout>
```



Layout Weight

```
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="horizontal"
    android:layout_width="match_parent"
    android:layout_height="match_parent">

    <TextView
        android:text="Name"
        android:layout_weight="0.4"
        android:layout_width="0dp"
        android:layout_height="wrap_content"
        android:id="@+id/name" />

    <TextView
        android:text="Dept"
        android:layout_weight="0.4"
        android:layout_width="0dp"
        android:layout_height="wrap_c
        android:id="@+id/dept" />

    <TextView
        android:text="Salary"
        android:layout_weight="0.2"
        android:layout_width="0dp"
        android:layout_height="wrap_c
        android:id="@+id/salary" />

</LinearLayout>
```

Event Listener API

- `onClick()`
  - from `View.OnClickListener`
- `onLongClick()`
  - from `View.OnLongClickListener`
- `onFocusChange()`
  - from `View.onFocusChange`
- `onKey()`
  - from `View.OnKeyListener`
  - *Hardware key*
- `onTouch()`
  - from `View.OnTouchListener`
- `onCreateContextMenu()`
  - from View.OnCreateContextMenuListener

Example: Button

```
private OnClickListener btnListener =
   new OnClickListener() {
      public void onClick(View v) {
        // do something when the button is clicked
      }
   };

protected void onCreate(Bundle savedValues) {
    ...
    // Capture button from layout
    Button okButton = (Button)findViewById(R.id.ok_button);
    // Register the onClick listener
    okButton.setOnClickListener(btnListener);
    ...
}
```

Example: Button

```
public class ExampleActivity extends Activity
                              implements OnClickListener {
   protected void onCreate(Bundle savedValues) {
      ...
      Button okButton =
                (Button)findViewById(R.id.ok_button);
      okButton.setOnClickListener(this);
   }

   // Implement the OnClickListener callback
   public void onClick(View v) {
      // do something when the button is clicked
   }
   ...
}
```

Example: Edit Text

```
final EditText myEditText =
          (EditText)findViewById(R.id.myEditText);

// Assign a listener to the button
OnClickListener btnListener = new OnClickListener() {
    public void onClick(View v) {
        ... myEditText.getText().toString() ...
        myEditText.setText("");
    }
}

okButton.setOnClickListener(btnListener);
```

Example: Edit Text

```
myEditText = (EditText)findViewById(R.id.myEditText);

// Process input when textbox loses input focus
OnFocusChangeListener textListener = new OnFocusChangeListener() {
    private boolean hadFocus = false;
    public void onFocusChange(View v, boolean hasFocus) {
        if (hasFocus) {
           hadFocus = true;
        } else {
           ... myEditText.getText().toString() ...
           myEditText.setText("");
           hadFocus = false;
        }
   }
}

myEditText.setOnFocusChangeListener(textListener);
```

In button click listener:
`button.requestFocusFromTouch()`

Event Handlers

- Defined for View API
- Modify for customized view

- `onKeyDown (int, KeyEvent)`
- `onKeyUp (int, KeyEvent)`
- `onTrackballEvent (MotionEvent)`
- `onTouchEvent (MotionEvent)`
- `onFocusChanged (boolean, int, Rect)`

Creating New Views

- Modify an existing view
  - Override event handlers e.g. onDraw(), onMeasure(), …
- Compound Control: Combine controls
  - Example: dropdown box combining TextView and Button
  - Best approach: Extend Layout class
- Custom View: Create an entirely new control
- Custom key press handling: e.g. for games

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ADAPTERS

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Adapters

- Bind data to user-interface views
- Create child views to represent each item
- Provide access to the underlying data
- Useful pre-defined adapter classes:
  - ArrayAdapter
    - Bind array of data to a view
  - SimpleCursorAdapter
    - Bind result of database query to a view

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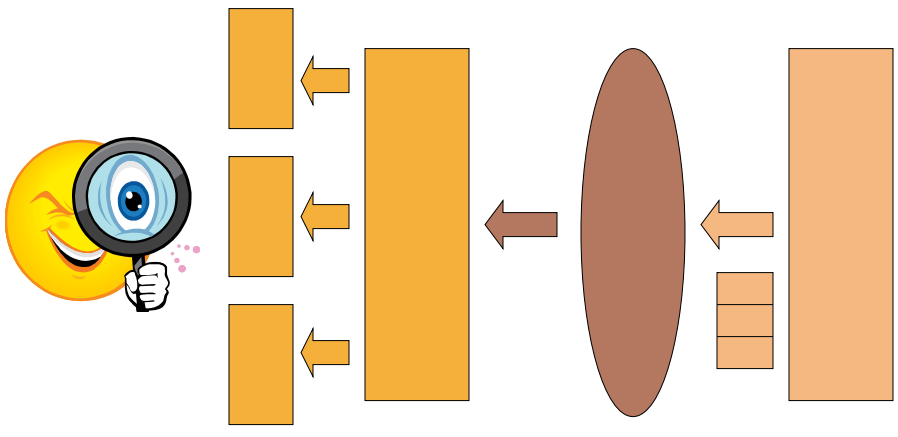
Adapters



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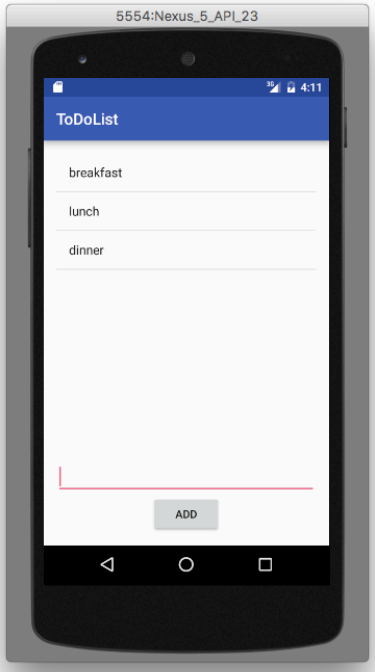

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Example: To Do List

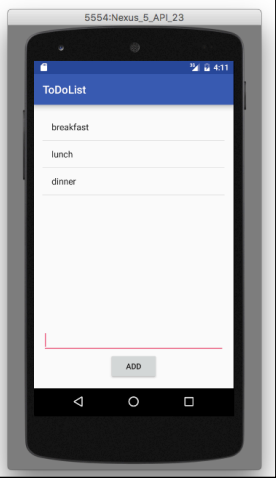
```
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:id="@+id/activity_main"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical">

    <ListView
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:layout_weight="1"
        android:id="@+id/list" />

    <EditText
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:inputType="text"
        android:id="@+id/item" />

    <Button
        android:text="@string/button_add"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_gravity="center_horizontal"
        android:id="@+id/add_button" />

</LinearLayout>
```



Example: To Do List

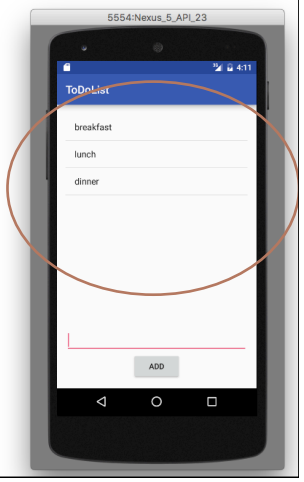
```
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:id="@+id/activity_main"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical">

    <ListView
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:layout_weight="1"
        android:id="@+id/list" />

    <EditText
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:inputType="text"
        android:id="@+id/item" />

    <Button
        android:text="@string/button_add"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_gravity="center_horizontal"
        android:id="@+id/add_button" />

</LinearLayout>
```



Example: To Do List

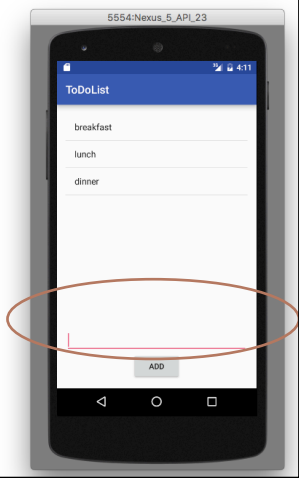
```
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:id="@+id/activity_main"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical">

    <ListView
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:layout_weight="1"
        android:id="@+id/list" />

    <EditText
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:inputType="text"
        android:id="@+id/item" />

    <Button
        android:text="@string/button_add"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_gravity="center_horizontal"
        android:id="@+id/add_button" />

</LinearLayout>
```



Example: To Do List

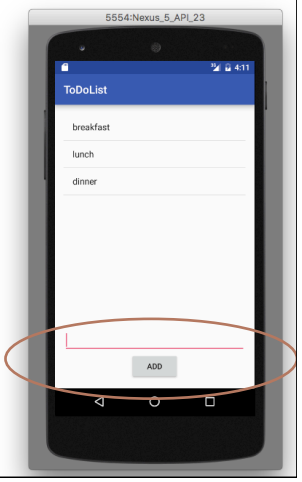
```
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:id="@+id/activity_main"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical">

    <ListView
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:layout_weight="1"
        android:id="@+id/list" />

    <EditText
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:inputType="text"
        android:id="@+id/item" />

    <Button
        android:text="@string/add_button"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_gravity="center_horizontal"
        android:id="@+id/add_button" />

</LinearLayout>
```



Example (cont'd)

```
ListView list = (ListView)findViewById(R.id.items);

ArrayList<String> items = new ArrayList<String>();

ArrayAdapter<String> arrayAdapter =
      new ArrayAdapter<String>(this,
                  android.R.layout.simple_list_item_1,
                  items);

list.setAdapter(arrayAdapter);

...
```

```
<ListView
    android:id="@+id/items"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
/>
```

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```
final EditText item = (EditText)findViewById(R.id.item);

OnClickListener addListener = new OnClickListener() {
    public void onClick(View v) {
        // Add a new todo item and clear the input box.
        items.add(item.getText().toString());
        item.setText("");
        arrayAdapter.notifyDataSetChanged();
    }
}

Button addButton = (Button) findViewById(R.id.add_button);
addButton.setOnClickListener(addListener);
```

```
<EditText
    android:id="@+id/item"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:inputType="text"
/>
```

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MENUS

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Example: “Game” Menu

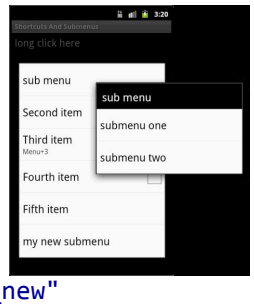
```
<?xml version="1.0" encoding="utf-8"?>
<menu
    xmlns:android=”...">
    <item android:id="@+id/new_game"
          android:icon="@drawable/ic_new_game"
          android:title="@string/new_game"
          android:showAsAction="ifRoom"/>
    <item android:id="@+id/help"
          android:icon="@drawable/ic_help"
          android:title="@string/help" />
</menu>
```

Example: “Game” Menu

```
<?xml version="1.0" encoding="utf-8"?>
<menu xmlns:tools="schemas.android.com/tools"
    tools:context=”activity class"
    xmlns:app="http://schemas.android.com/apk/res-auto”
    xmlns:android=”...">
    <item android:id="@+id/new_game"
          android:icon="@drawable/ic_new_game"
          android:title="@string/new_game"
          app:showAsAction="ifRoom"/>
    <item android:id="@+id/help"
          android:icon="@drawable/ic_help"
          android:title="@string/help" />
</menu>
```

If using compatibility library

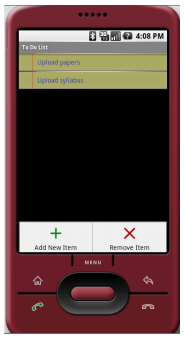
Example: “File” Submenu

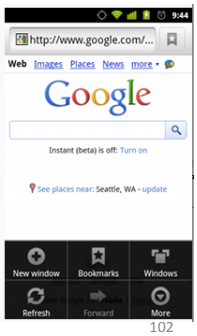



```
<?xml version="1.0" encoding="utf-8"?>
<menu xmlns:android=”...">
    ...
    <item android:id="@+id/file"
          android:title="@string/file" >
        <!-- "file" submenu -->
        <menu>
            <item android:id="@+id/create_new"
                  android:title="@string/create_new" />
            <item android:id="@+id/open"
                  android:title="@string/open" />
        </menu>
    </item>
</menu>
```

Options Menu (Android 2.3-)

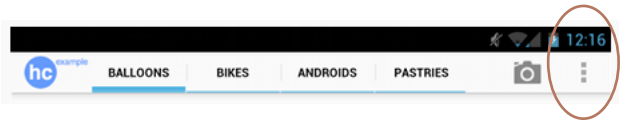
- Access via Menu button
  - *Deprecated*
- Icon menu
  - Up to 6 items
  - No check boxes or radio buttons
- Expanded menu
  - Pop-up menu of extra items
- Submenus





Options Menu: Android 3.0+

- Accessing menu:
  - Action bar
- Default:
  - All items under *action overflow*



- Promote menu items to action bar
  - `android:showAsAction="ifRoom"` in `<item>` element

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Options Menu: Creation

- Inflating menu in activity:

```
@Override
public boolean onCreateOptionsMenu(Menu menu) {
    MenuInflater inflater = getMenuInflater();
    inflater.inflate(R.menu.game_menu, menu);
    return true;
}
```

  - Android 2.3-: Called when user first selects menu
  - Android 3.0+: Called when activity created
- Runtime addition: **`add()`**
- Changing menu items: **`onPrepareOptionsMenu()`**

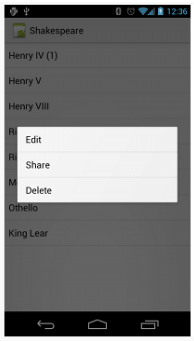
Options Menu: Handling Input

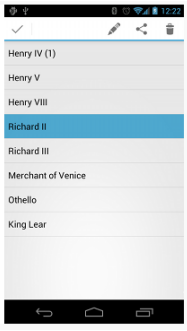
- Handling item selection:

```
@Override
public boolean
   onOptionsItemSelected(MenuItem item) {
   switch (item.getItemId()) {
        case R.id.new_game:
            newGame(); return true;
        case R.id.help:
            showHelp(); return true;
        default:
            return
            super.onOptionsItemSelected(item);
    }
}
```

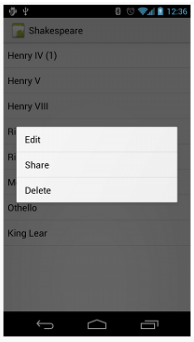
Context Menu

- Based on currently focused view
  - Like “right-click” (long click)
  - Typically for ListView or GridView item
- Floating Context Menu
  - Operate on one view at a time
- Contextual Action Bar
  - Operate on multiple views





Context Menu: Workflow



- Register context menu for view:
  `registerForContextMenu(View)`
  – ListView or GridView: menu for all items
- Define callback for menu creation:
  `onCreateContextMenu(ContextMenu, View, ContextMenuInfo)`
- Define response to user input:
  `onContextItemSelected(MenuItem)`

Context Menu: Creation

```
public class ToDoList extends Activity {

public void onCreate(Bundle icicle) {
   ...
   myListView = (ListView)findViewById(R.id.myListView);
   ...
   registerForContextMenu(myListView);
  }

public void onCreateContextMenu(ContextMenu menu, View v,
                ContextMenu.ContextMenuInfo menuInfo) {
   super.onCreateContextMenu(menu, v, menuInfo);
   MenuInflater inflater = getMenuInflater();
   inflater.inflate(R.menu.context_menu, menu);
}
```

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Context Menu: Selection

```
@Override
public boolean onContextItemSelected(MenuItem item) {
    AdapterContextMenuInfo info =
            (AdapterContextMenuInfo) item.getMenuInfo();
    switch (item.getItemId()) {
        case R.id.edit:
            editNote(info.id);
            return true;
        case R.id.delete:
            deleteNote(info.id);
            return true;
        default:
            return super.onContextItemSelected(item);
    }
}
```

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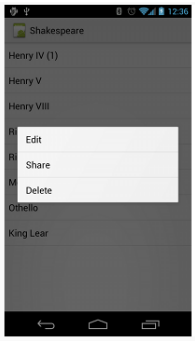
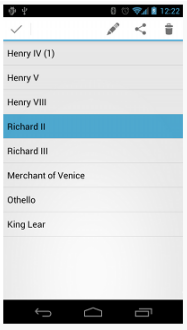
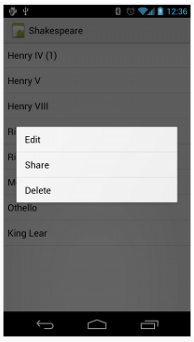
Contextual Action Mode

- Trigger:
  - Long click on view
  - User selects checkbox etc
- Contextual Action Bar
  - Visually overtakes action bar
- Exit CAM
  - BACK button
  - Select Done from action bar
  - Deselect all items





Contextual Action Mode: Single Item



- Implement `ActionMode.Callback`
  - `ActionMode` parameter
  - `setTitle()`, `setSubTitle()`, etc
- Call `startActionMode()` with callback
- Ex: in `View.onLongClickListener` handler: *next slide*

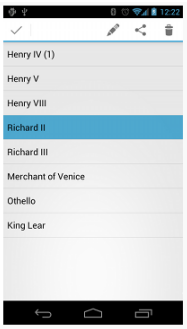
```
private ActionMode.Callback callback = new ActionMode.Callback() {

   public boolean onCreateActionMode(ActionMode mode, Menu menu) {
      MenuInflater inflater = mode.getMenuInflater();
      inflater.inflate(R.menu.context_menu, menu);
      return true;
   }

   public boolean onPrepareActionMode(ActionMode m, Menu u)
   { return false; }

   public boolean onActionItemClicked(ActionMode m, MenuItem item) {
        switch (item.getItemId()) {
            case R.id.menu_foo:
                ... m.finish(); return true;
            default:
                return false;
        }
   }

   public void onDestroyActionMode(ActionMode mode)
   { actionMode = null; /* "actionMode" defined in parent class */ }
};
```

Contextual Action Mode: Single Item

```
View.OnLongClickListener longListener =
   new View.OnLongClickListener() {

      // Called when the user long-clicks on someView
      public boolean onLongClick(View view) {
         if (actionMode != null) {
            return false;
         }

         // Start the CAB using the callback defined above
         actionMode =
            getActivity().startActionMode(callback);
         view.setSelected(true);
         return true;
      }
   };

view.setOnLongClickListener(longListener);
```

Contextual Action Mode: Multi Item

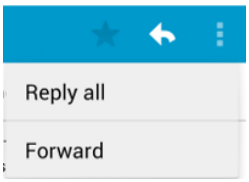
- Implement `AbsListView.MultiChoiceItemListener`
- Call `setChoiceMode()` with `CHOICE_MODE_MULTIPLE_MODAL`
- Call `setMultiChoiceModeListener()` with callback
- Call `setItemChecked()` to add item to selection



```
listView.setChoiceMode(ListView.CHOICE_MODE_MULTIPLE_MODAL);
listView.setMultiChoiceModeListener(new MultiChoiceModeListener() {

   public void onItemCheckedStateChanged(ActionMode m, int pos,
                                         long id, boolean checked) {
      // Do something when items are selected/de-selected,
   }
   public boolean onActionItemClicked(ActionMode m, MenuItem item) {
      // See Single Item example
   }
   public boolean onCreateActionMode(ActionMode mode, Menu menu) {
      // See Single Item example
   }
   public void onDestroyActionMode(ActionMode mode) {
      // When CAB is removed. Default: items are deselected.
   }
   public boolean onPrepareActionMode(ActionMode m, Menu u)
   { return false; }
})
```

Popup Menu

- Modal menu anchored to a view
  - Overflow-style menu
  - Options for menu command
  - Drop-down (similar to Spinner)



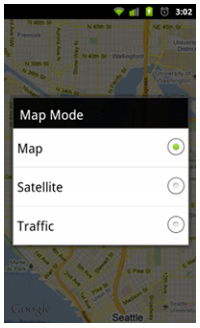
- Instantiate PopupMenu class
- Inflate with MenuInflater or PopupMenu.inflate()
- Show with PopupMenu.show()
- Input: PopupMenu.OnMenuItemClickListener
- Dismissal: PopupMenu.OnDismissListener

Popup Menu

```
public void showPopup(View v) {
   PopupMenu popup = new PopupMenu(this, v);

   // This activity implements OnMenuItemClickListener
   popup.setOnMenuItemClickListener(this);

   MenuInflater inflater = popup.getMenuInflater();
   inflater.inflate(R.menu.actions, popup.getMenu());
   // Android v11+
   // popup.inflate(R.menu.actions);

   popup.show();
}
```

Menu Groups and Checkable Menu Items

```
<menu xmlns:android=”...">
   <group android:checkableBehavior="single">
      <item android:id="@+id/red"
            android:title="@string/red" />
      <item android:id="@+id/blue"
            android:title="@string/blue" />
   </group>
</menu>
```



Checkable Behavior:

- `single`: radio button
- `all`: check box
- `none`

Checkable Menu Items

- Respond to selection of menu item:

```
@Override
public boolean onOptionsItemSelected(MenuItem item) {
    switch (item.getItemId()) {
        case R.id.vibrate:
        case R.id.dont_vibrate:
            if (item.isChecked())
               item.setChecked(false);
            else
               item.setChecked(true);
            return true;
        default:
            return super.onOptionsItemSelected(item);
    }
}
```

Intent Filters for Plugins (1)

- Idea: dynamically generate menus that describe actions that can be applied to data displayed on the screen
- Range of options can vary dynamically depending on intent filters of installed application base

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Intent Filters for Plugins (2)

- Idea: dynamically generate menus that describe actions that can be applied to data displayed on the screen
- Range of options can vary dynamically depending on intent filters of installed application base
- Use `addIntentOptions` method of a menu object to add menu options at run-time
  - Categories ALTERNATIVE and SELECTED_ALTERNATIVE identify activities that can be presented to users in a menu of options

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```
public boolean onCreateOptionsMenu(Menu menu){
    super.onCreateOptionsMenu(menu);

   // The offering app must include a category of
   // Intent.CATEGORY_ALTERNATIVE.
   Intent intent = new Intent(null, dataUri);
   intent.addCategory(Intent.CATEGORY_ALTERNATIVE);

   // Search and populate the menu with acceptable offering apps.
   menu.addIntentOptions(
       R.id.intent_group,  // Menu group for new items
       0,      // Unique item ID (none)
       0,      // Order for the items (none)
       this.getComponentName(),   // The current activity name
       null,   // Specific items to place first (none)
       intent, 0, null // Intent, flag, MenuItems (array)
   );
   return true;
}
```

Intent Filters for Plugins (3)

Intent Filter for TitleEditor activity (from Notepad example):

```
<intent-filter android:label="@string/resolve_title">
  <action android:name="com.android.notepad.action.EDIT_TITLE" />
  <category android:name="android.intent.category.DEFAULT" />
  <category android:name="android.intent.category.ALTERNATIVE" />
  <category android:name="android.intent.category.SELECTED_ALTERNATIVE
  <data android:mimeType="vnd.android.cursor.item/vnd.google.note" />
</intent-filter>
```

This intent resolves to TitleEditor:

```
action: com.android.notepad.action.EDIT_TITLE
data: content://com.google.provider.NotePad/notes/ID
```

Asks the activity to display the title associated with note *ID*,
and allow the user to edit the title.

Dialogs

- Common UI Metaphor
- Three ways to implement:
  - Dialog-themed Activities
  - Derive from DialogFragment class
    - Use AlertDialog builder
    - ⋯or manage custom dialog
    - No need to register in the manifest
  - Toasts
    - Non-modal transient message boxes

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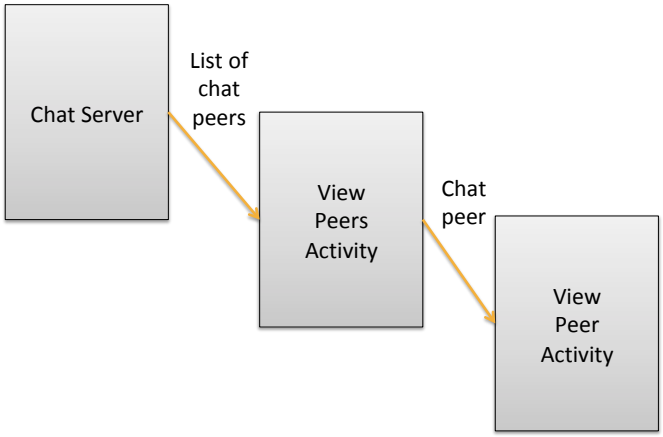
PARCELS AND PARCELABLE

Example: Chat Server App



Intent Extras

- Example: Simple Data

```
Intent intent = new Intent();
intent.putExtra("name", name);
intent.putExtra("age", age);
```

- Structured Data

```
public class Data {
  public String name;
  public int age;
}
Data data = new Data(); ...
intent.putExtra("data", data); // ???
```

Implementing Parcelable

- Structured Data

```
public class Data implements Parcelable {
  public String name;
  public int age;
  public void writeToParcel(Parcel out, ...) {
    out.writeString(name);
    out.writeInt(age);
  }
  public Data(Parcel in) {
    name = in.readString();
    age = in.readInt();
  }
}
Data data = new Data(); ...
intent.putExtra("data", data); //
```

```
public class ChatServer extends Activity {
  private ArrayList<Peer> peers;

  public void onOptionItemSelected(...) { ...
    Intent intent = new Intent(this, ViewPeersActivity.class);
    intent.putParcelableArrayListExtra
             (ViewPeersActivity.PEER_KEY, peers);
    startActivity(intent); ...
  }
}

public class ViewPeersActivity extends Activity {
  public static final PEERS_KEY = "peers";

  public void onCreate(Bundle state) {
    Intent intent = getIntent();
    ArrayList<Peer> peers =
           intent.getParcelableArrayListExtra(PEERS_KEY);
    ...
  }
```

SOCKET PROGRAMMING

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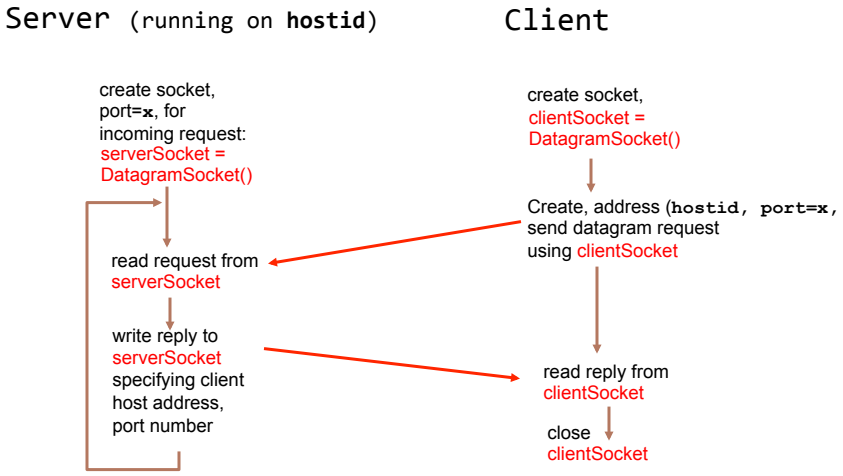
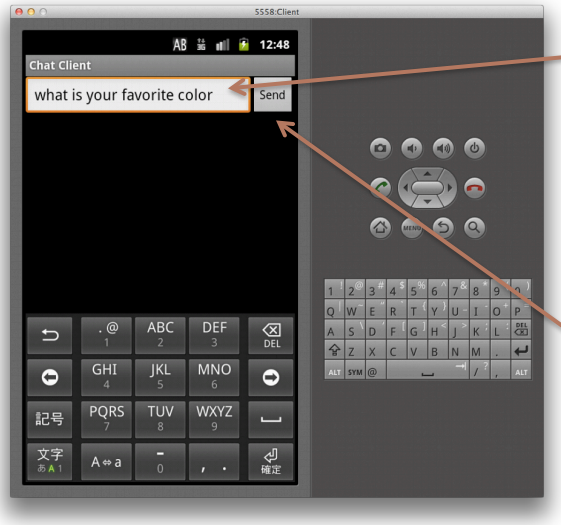
Android Manifest

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="edu.stevens.cs522.chat.oneway"
    android:versionCode="1"
    android:versionName="1.0" >

    <uses-sdk android:minSdkVersion="10" />

    <uses-permission android:name="android.permission.INTERNET" />
    <uses-permission android:name="android.permission.WIFI" />

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


Client/server socket interaction: UDP



Socket Client

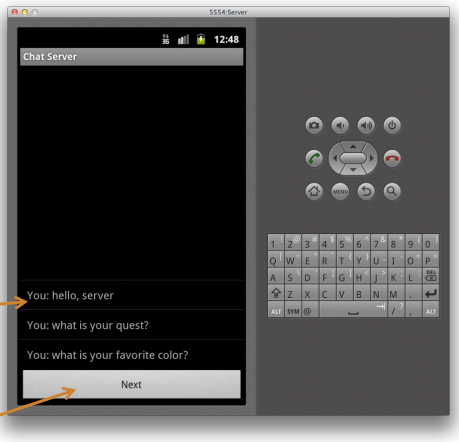


Text input from the user

Sends the input from the user to the UDP Server

Socket Server

- Create an application that acts as a UDP server to receive messages from the UDP client



List of messages received so far

Press to get the next message

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Handling Exceptions

```
try {
  // Operations that may fail
  // and throw an exception;
} catch (Exception e) {
    Log.e(TAG,
     "Caught UDP Exception: "+e.getMessage());
    Toast.makeText(UDPServer.this,
     "UDP Error: "+ e.getMessage()),
     Toast.LENGTH_LONG).show();
}
```