Mobile Device Platforms

Mensch-Maschine-Interaktion 2, WS 2010/2011

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Lectures & Exercises

Lecture	Date	Topic
1	12.1.	Introduction to Mobile Platforms & Mobile Interaction
2	19.1.	Mobile Input and Output Technologies
3	26.1.	Mobile Communication, Location & Context
4	2.2.	Evaluation of Mobile Systems
5	9.2.	User Interface Design for Small Displays

Exercise	Date	Topic
0		Developing countries + Android-Eclipse
1	10.1.	Recipe input
2	17.1.	Touch input, gestures
3	24.1.	Location-based Audio
4	31.1.	Evaluation of mobile LMU Web portal

Mobile Human-Computer Interaction

- General topic
  - Human interaction with mobile and wearable devices
  - Human interaction while “on the move”
- Goals of this section
  - Learn about how to create mobile user interfaces
    - Mobile technologies
  - Understand that mobile interaction is interaction in context
    - “Human factors”
  - Learn about specific design considerations for mobile user interfaces
    - Small displays

More about this in WS in course on Mobile HCI

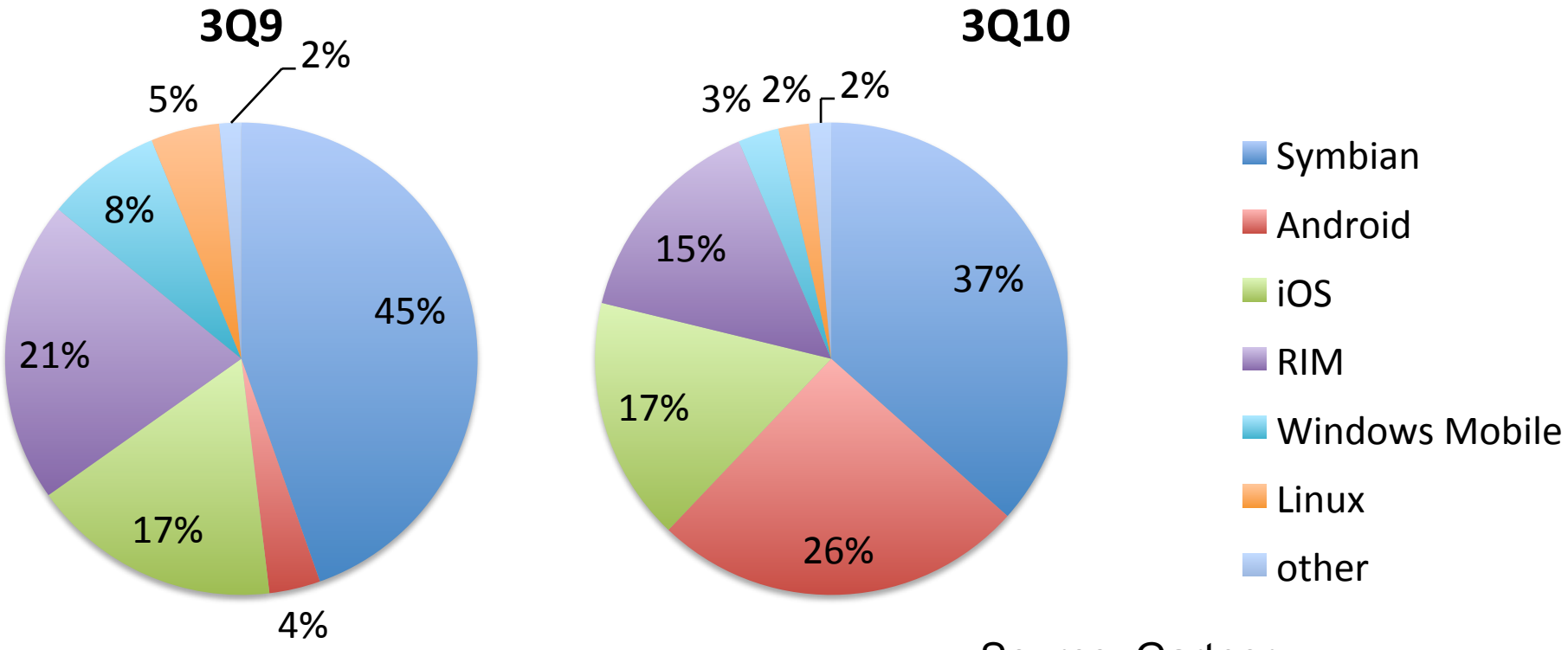
Mobile Device Development

- Platform specific
  - BREW (C, C++)
  - Symbian OS (C++, Python, Qt)
  - Apple iOS (Objective C)
  - Android (Java)
  - Windows CE / Windows Phone 7 (C#, C++)
- Platform independent
  - Java ME (Java Micro Edition)
  - Flash Lite / Flash
  - HTML 5, WAP / WML, cHTML (i-mode)
  - SMS, MMS

Mobile Application Development

- Who of you owns a mobile phone?
  - Is it possible to develop applications for this device?
  - Which platforms are supported?
  - Which programming languages and tools can be used?
  - How to install the programs on the device?

Market Shares: Smartphones

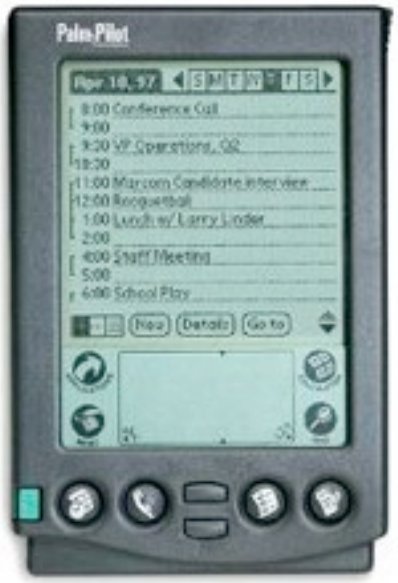


Source: Gartner
http://www.gartner.com/it/page.jsp?id=1466313

- Android market share grows rapidly
- Apple & Android share 81% mobile Web traffic
- Regional differences
  - USA: Apple, Android, RIM; Asia: Symbian

PDA Platforms: Palm OS / Windows Mobile

- Palm OS (historical, now webOS)
  - Operating system for PDAs
  - Initial release: 1996
  - Development: CodeWarrior Development Studio for Palm OS
  - Languages: C/C++



- Windows Mobile (Windows CE)
  - Operating system for PDAs and smart phones
  - Initial release: 1996
  - Development: Microsoft Visual Studio
  - Languages: C++, C#, Visual Basic .NET
  - http://www.microsoft.com/windowsmobile/

Windows Phone 7

en.wikipedia.org/wiki/Windows_Phone_7
windowsphone7.com
msdn.microsoft.com/en-us/windowsmobile

- Successor of Windows Mobile
  - Launched October 21, 2010
- “Metro” design language
  - “Typography is beautiful”, no decoration
  - “Start screen” made up of “tiles”
    - “Tiles” show live application data
  - “Hubs” integrate local and online content
    - “Pictures hub” = local photos & Facebook photo album
    - “People hub” = contacts from Gmail, Facebook, etc.
    - “Music and Video hub” integrates with Zune
    - “Games hub” integrates with Xbox Live
- Windows Phone Marketplace
- Advertising platform
- Programming: C#, Silverlight

Symbian

Symbian History

1984 Psion 1
(First PDA)

- 1997: Psion's EPOC OS
- 1998: Symbian consortium and Symbian OS
  - Ericsson, Nokia, Motorola, Psion (founders)
  - Sony Ericsson, Siemens, etc. (shareholders)
- 2000: First Symbian OS phone
  - Ericsson R380

- 2008: Nokia buys Symbian Ltd.
- 2009: Symbian made open source
  - July 2009: 250 million Symbian phones shipped
- Current version: Symbian^3
- 2010: Motorola, Samsung, LG, Sony-Ericsson will abandon the platform

Symbian Characteristics

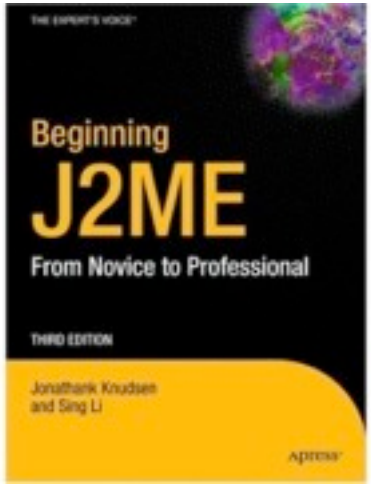
- OS for resource-constrained handheld devices
  - Pre-emptive multitasking, multithreading, memory protection, client-server architecture
  - Special features: conserving memory, reliability, CPU switched off when applications are not dealing with events
- From the developer's point of view
  - User interface framework
  - APIs (was Symbian C++; now C++, Qt)
  - SDK, Tools
- From the user's point of view
  - Consistent user interface
  - Extensible (third party applications)

Nokia N95

Java ME

Java ME: Java on Mobile Devices

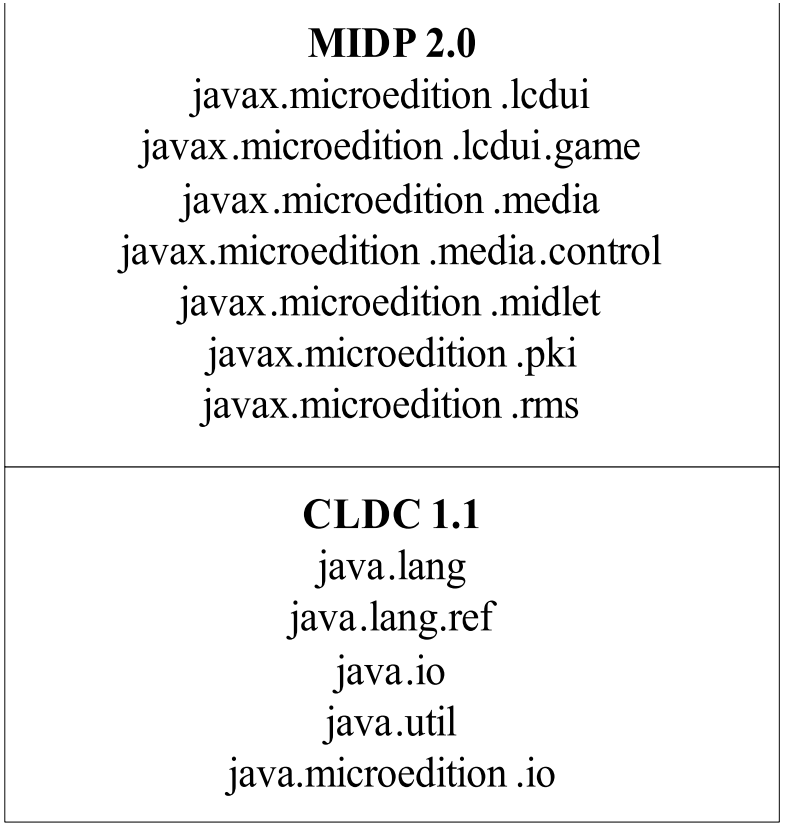
- "The most ubiquitous application platform for mobile devices" (SUN)
  - http://java.sun.com/javame/ (moved to Oracle)
  - More than 2 billion phones shipped supporting Java ME
  - Not supported by newest mobile operating systems



- Jonathan Knudsen and Sing Li. Beginning J2ME: From Novice to Professional. 2005.
- Source code: http://www.apress.com/resource/bookfile/2080

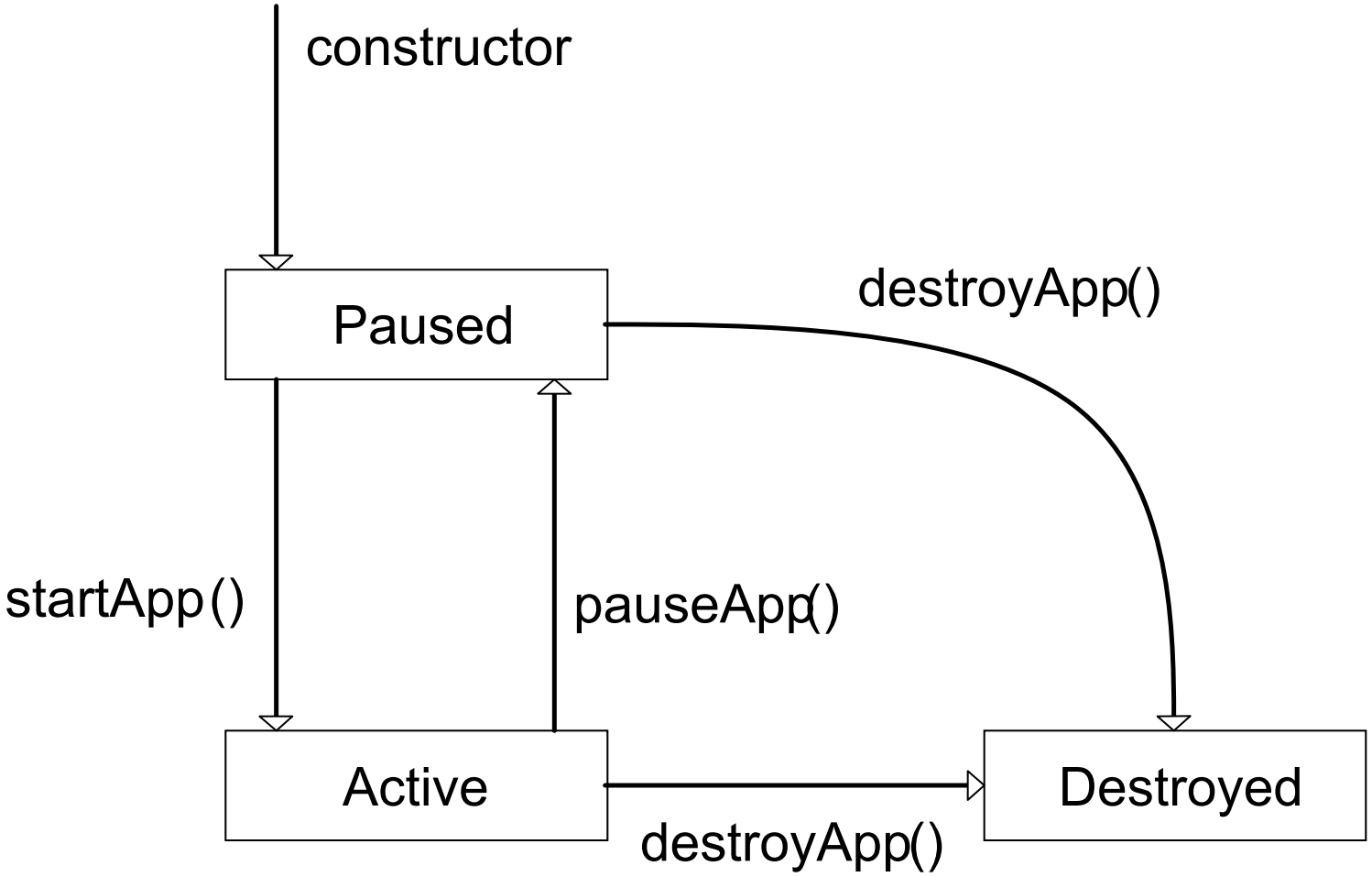
CLDC & MIDP

- Specify set of libraries for a particular device class
  - Mobile Information Device Profile (MIDP)
  - Connected Limited Device Configuration (CLDC)
- Device profiles for handheld devices, set-top boxes, etc.

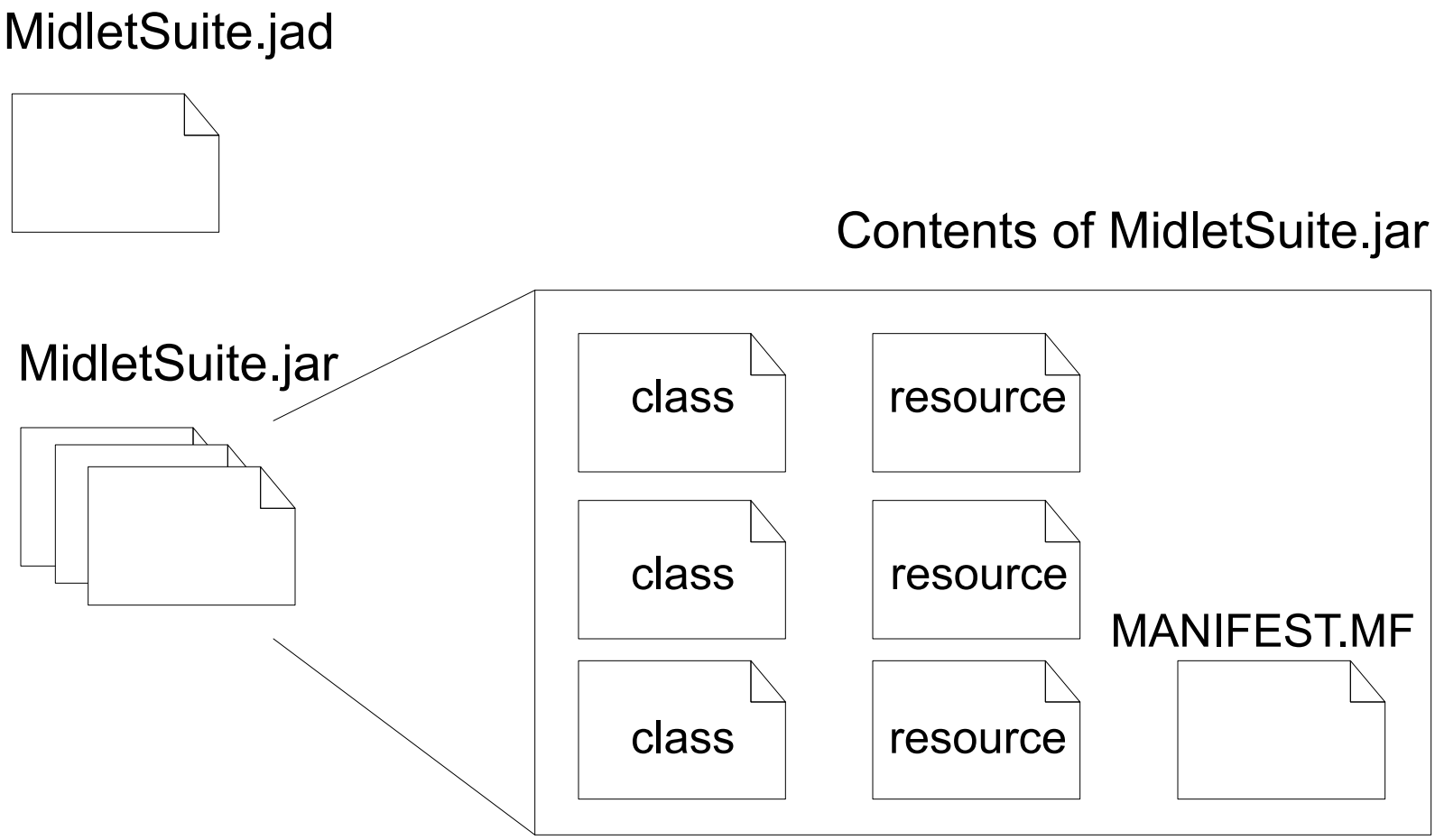


APIs restricted in comparison to J2SE

MIDlet (MIDP Application): Life Cycle



Anatomy of a MIDlet Suite

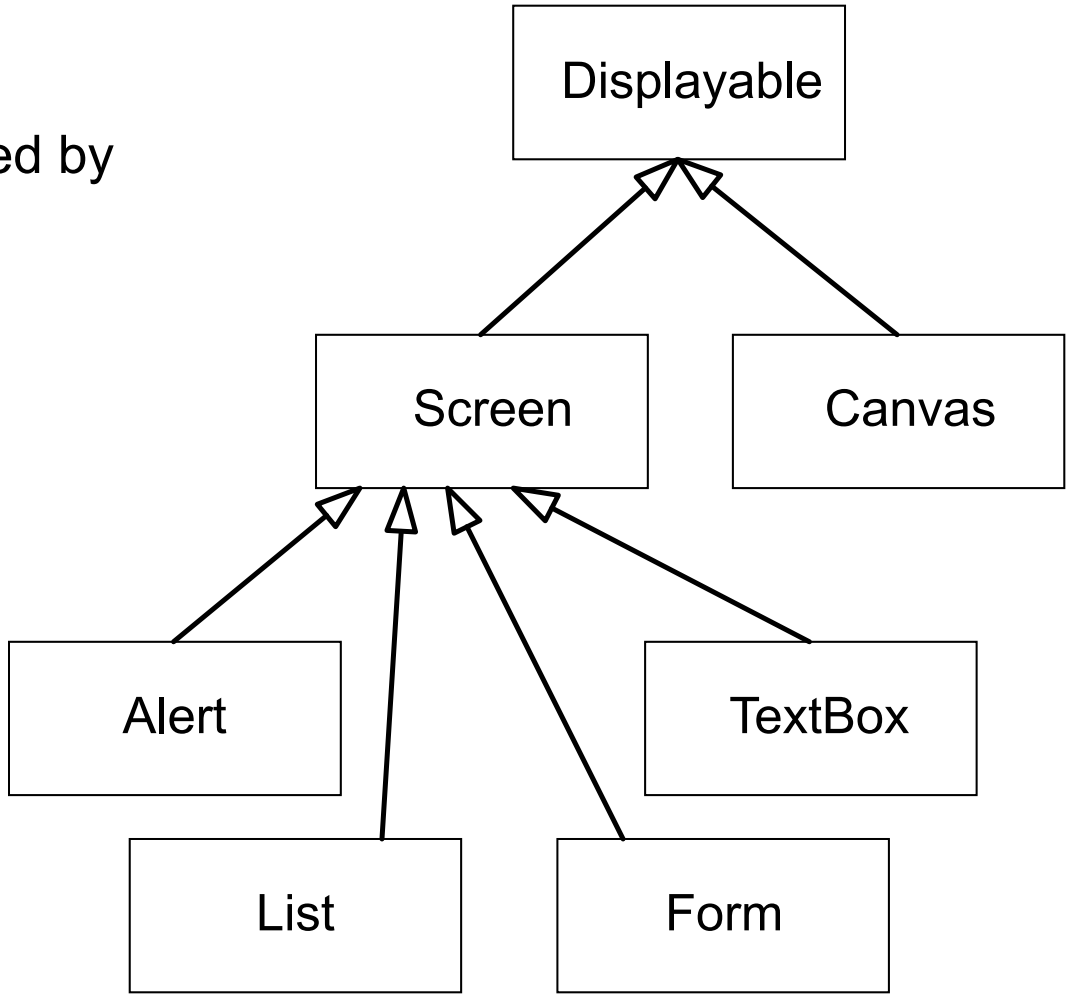


User Interface: View from the Top

- User-interface classes *javax.microedition.lcdui*
- Device display represented by *Display (getDisplay())*

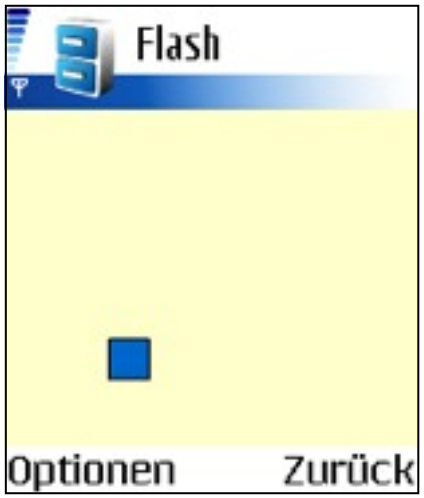
- *Display: easel*
- *Displayable: canvas on easel*

- *Canvas: Discovery*
- *Screen: Abstraction*



Prototyping: Adobe Flash / Flash Lite

- Rapid development of interactive content
- Cross-device development
  - Android, Windows Mobile, Windows Phone 7, Symbian, BREW, Palm webOS, Blackberry
  - Not iOS!
- Features
  - Language: ActionScript
  - Input: text entry; multitouch and gestures; accelerometer
  - Media handling (images, sound, video)
  - Loading and parsing of XML
  - Persistent data



http://www.adobemediaplayer.com/devnet/devices.html

Android

Android

- Free, open, mobile platform
  - “Software stack for mobile devices that includes an operating system, middleware and key applications.”
  - Apache v2 open-source license
- Open Handset Alliance
  - Group of 34 companies that develop Android platform
- Linux as hardware abstraction layer
  - Kernel, device drivers
- Java
  - Application framework
  - Applications (and C/C++ native SDK)

Android

- No distinction between core and 3rd party applications
  - All components can be replaced
- Integration of data on the phone with data on the Web
- T-Mobile G1
  - First commercial Android handset
  - Google Maps Street View, Gmail, YouTube
  - Available in the USA since October 23rd, 2008

http://code.google.com/android/dev-devices.html
http://en.wikipedia.org/wiki/T-Mobile_G1
http://www.htc.com/www/product/g1/overview.html

Outline

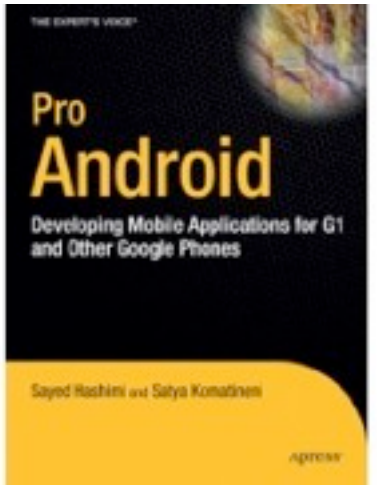
- The Android Platform
- Installing Android & Hello World
- Activity Lifecycle & Intents
- Resources & UI Components

Next lectures:

- Basic Graphics & Touch Input
- Location & Maps
- Bluetooth

Android Books

- Sayed Y. Hashimi, Satya Komatineni:
  Pro Android.
  Apress, 2009. ISBN 1430215968.
  - General introduction into the concepts of Android



- Many other books on Android available
  - http://tinyurl.com/399ksu3

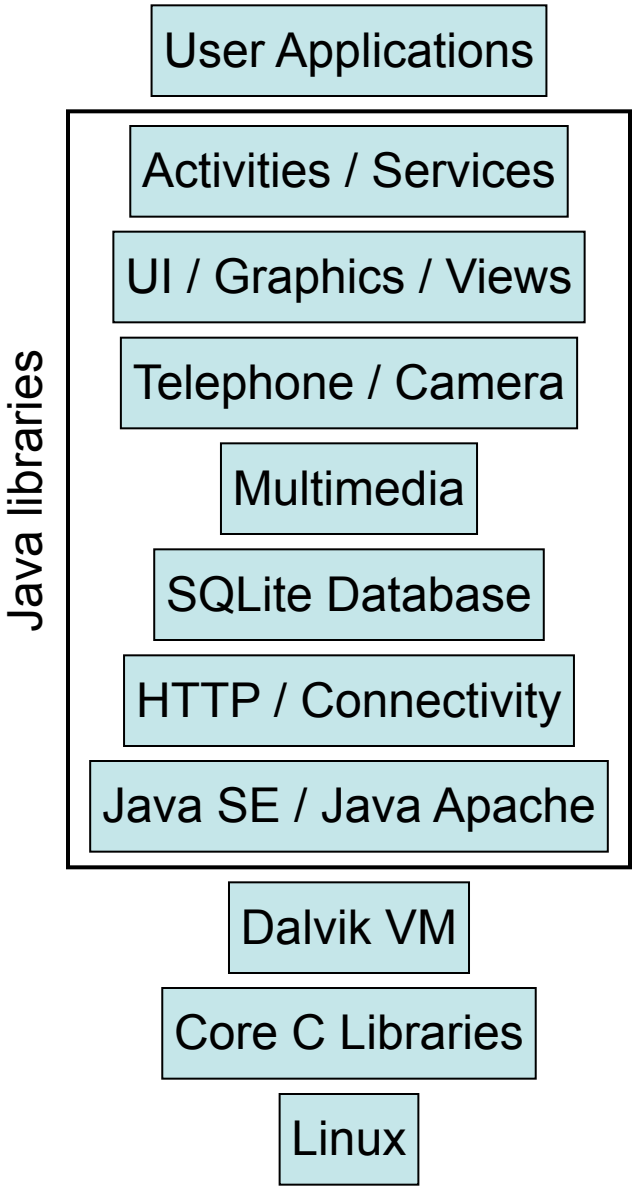
- Android developer pages
  (platform documentation)
  - http://developer.android.com

very good!

The Android Platform

The Android Platform

- General-purpose computing platform for mobile devices
- Linux-based OS stack
  - Hardware abstraction, memory management, process management
  - Dalvik VM (register-based, smaller class files)
- Application framework
  - Activities, services, telephony, connectivity, graphics, UI, etc.
  - Applications can publish capabilities, replace components
- Android SDK
  - Java API (most of Java SE)
  - UI framework



History of Android

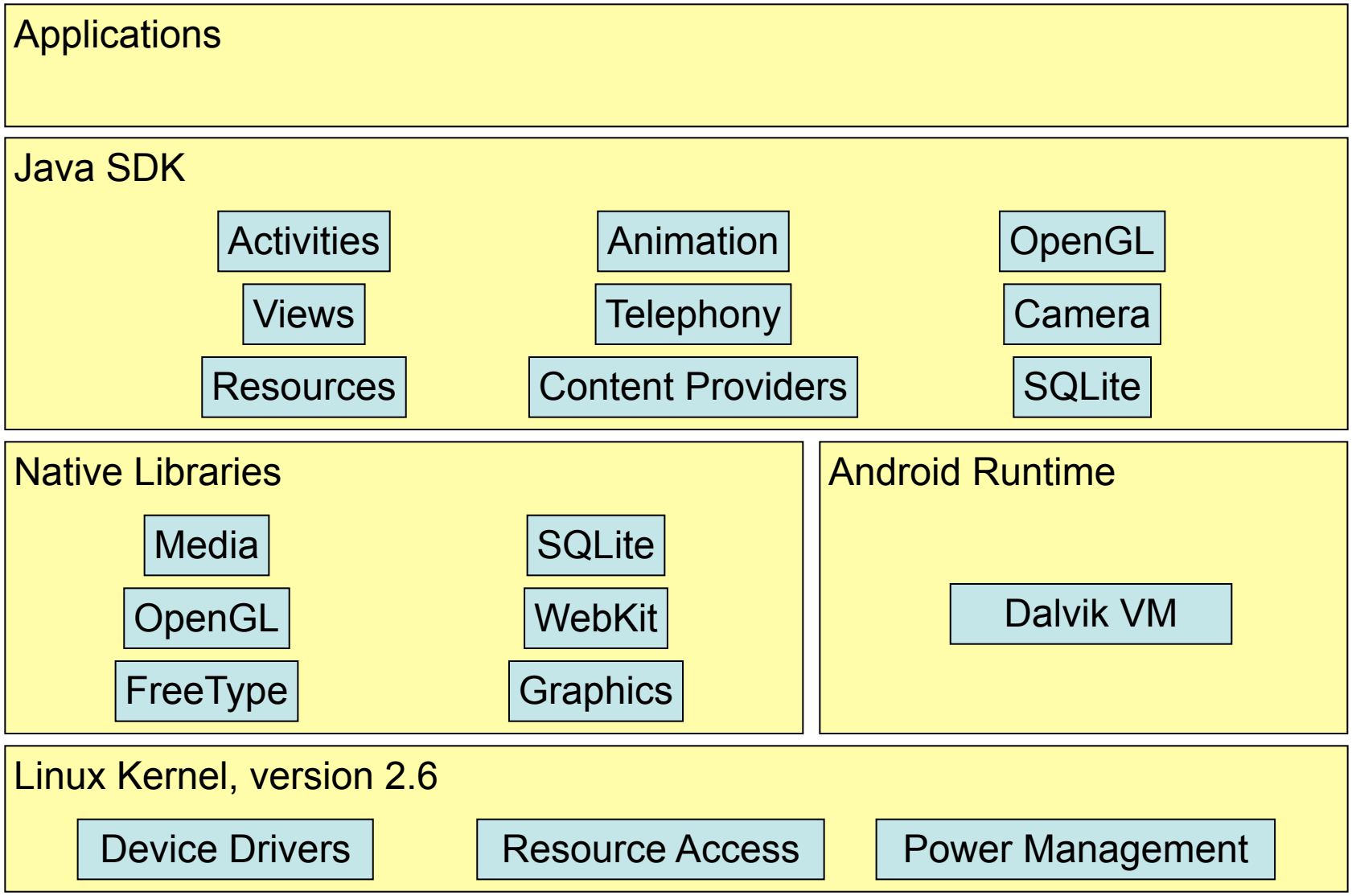
- 2005
  - Google buys startup company Android Inc.
  - Work on Dalvik VM starts
- 2007
  - Open Handset Alliance announced (http://www.openhandsetalliance.com)
  - “Early Look” SDK
- 2008
  - T-Mobile G1 announced
  - SDK 1.0 released
  - Android open sourced under Apache’s open source license
- 2009
  - SDKs 1.5 (Cupcake) and 1.6 (Donut) released

http://www.techradar.com/news/phone-and-communications/mobile-phones/a-complete-history-of-android-470327
http://www.wired.com/techbiz/media/magazine/16-07/ff_android?currentPage=all
http://en.wikipedia.org/wiki/Android_(operating_system)#History

Architectural Goals

- Encourage low-cost development of mobile applications
  - Openness, affordability, quality development framework
- Enable interaction between applications
  - Services, data exchange, UI
- Exploit cloud-computing model
  - Local data stores, backed up on the Web

Android Software Stack



Android Characteristics

- Activity
  - Applications structured as Activities
  - A logical unit of user action
  - Typically represented by a screen containing views
  - Can also be viewless (e.g. a service)
- Framework manages lifecycle of activity
  - Hide, restore, stop, close activity windows
- Declarative UI definition (XML files)
  - Resources (view definitions, strings, bitmaps)

Installing Android and Hello World

Installing Android (1/2)

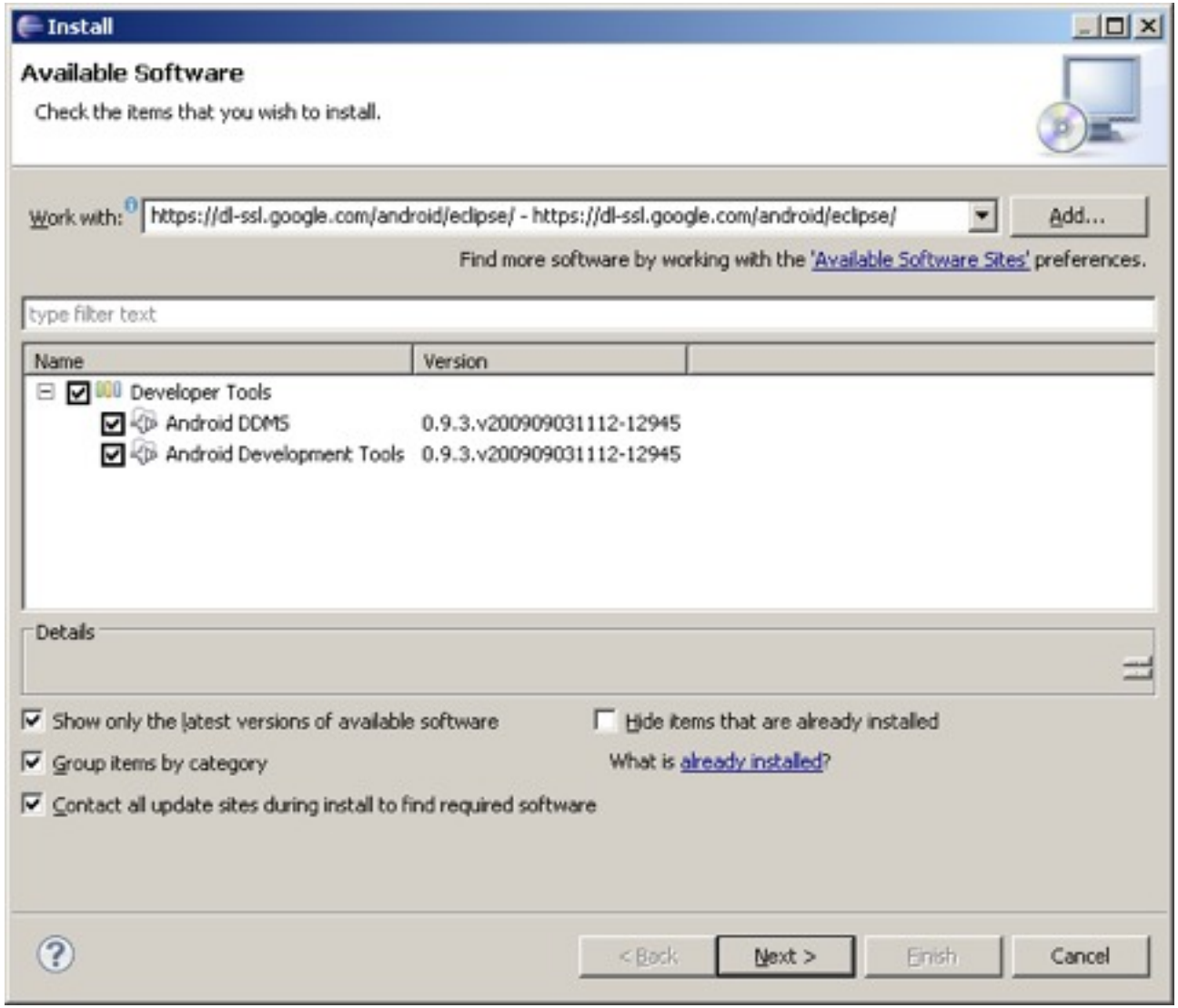
- Java JDK 6, Standard Edition (not only JRE)
  - http://java.sun.com/javase/downloads/index.jsp
- Eclipse IDE (3.4 or newer)
  - http://www.eclipse.org/downloads/
  - Eclipse IDE for Java Developers
- Android SDK starter package (depending on your platform)
  - http://dl.google.com/android/android-sdk_r08-windows.zip
  - http://dl.google.com/android/android-sdk_r08-mac_86.zip
  - http://dl.google.com/android/android-sdk_r08-linux_86.tgz
- See also: “Quick Steps”
  - http://developer.android.com/sdk/index.html

Installing Android in Eclipse (2/2)

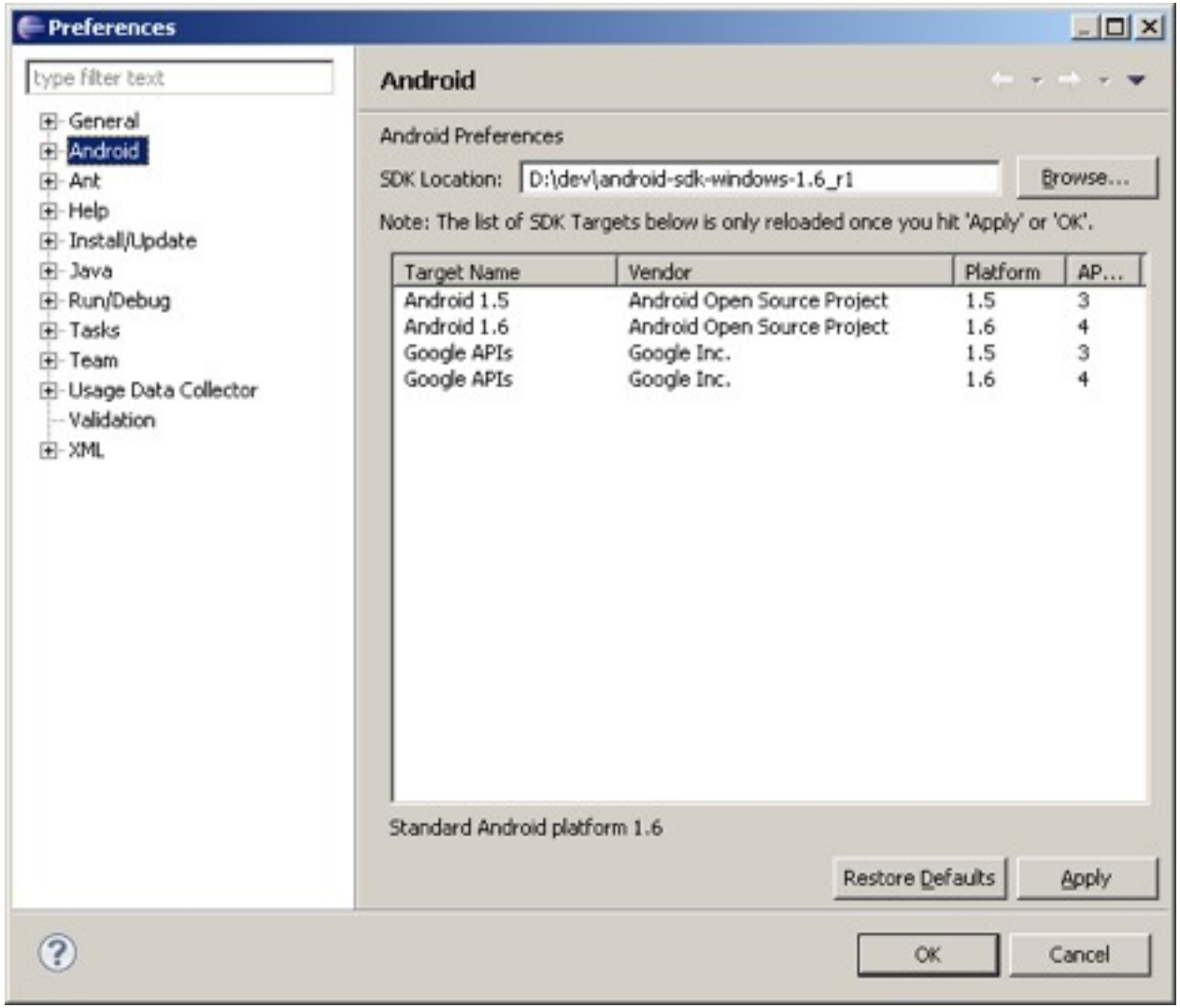
- In Eclipse: Install New Software...
  - https://dl-ssl.google.com/android/eclipse/
- Point Eclipse to the Android SDK starter package
  - Menu: Preferences, Android, SDK Location
- In Eclipse: Android SDK and AVD Manager
  - Install packages, update all...
  - Add new virtual device for newest platform version.

In Eclipse: Install New Software...

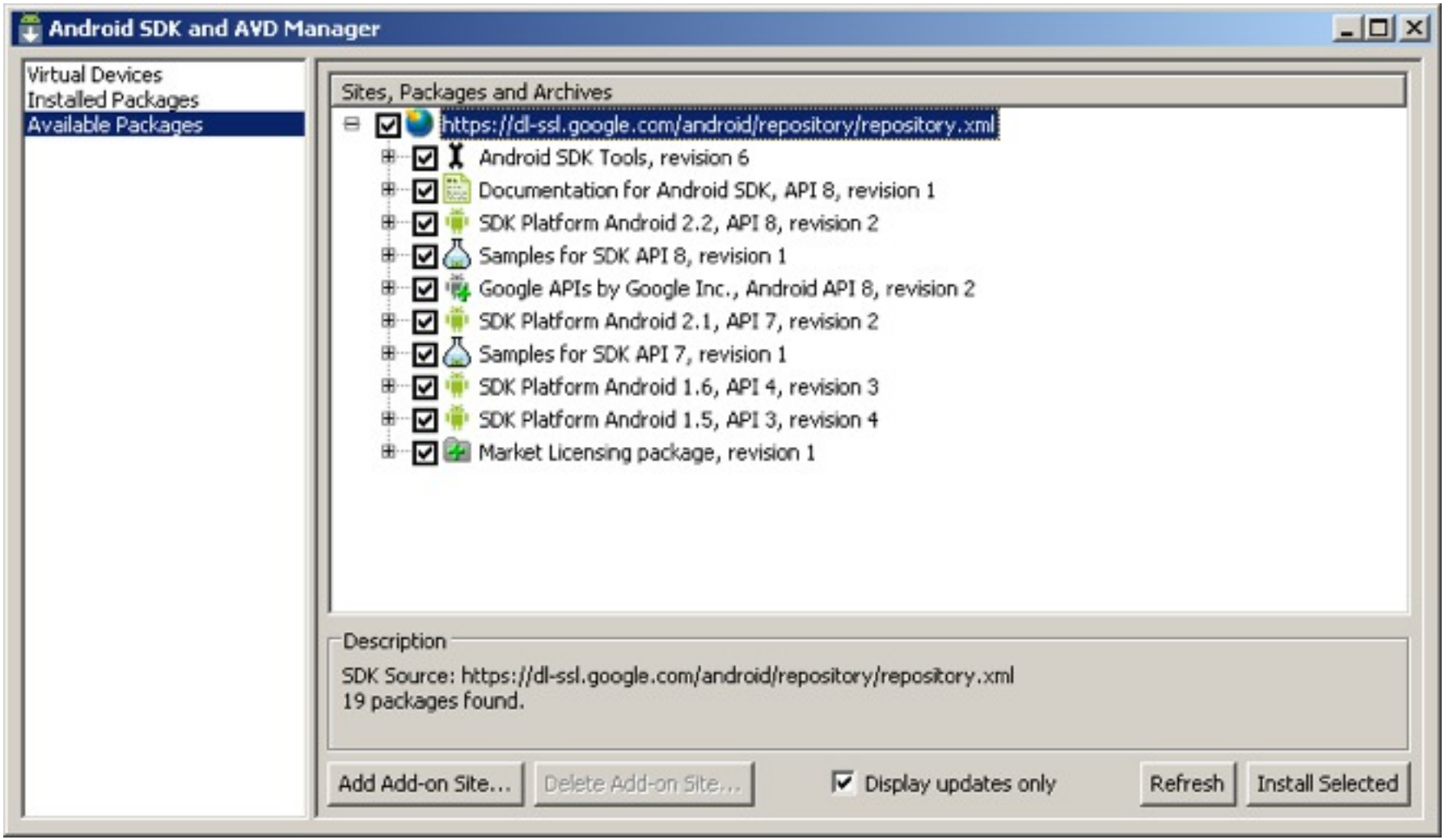
Android Plugin – https://dl-ssl.google.com/android/eclipse/



Set Path to Android SDK Starter Package

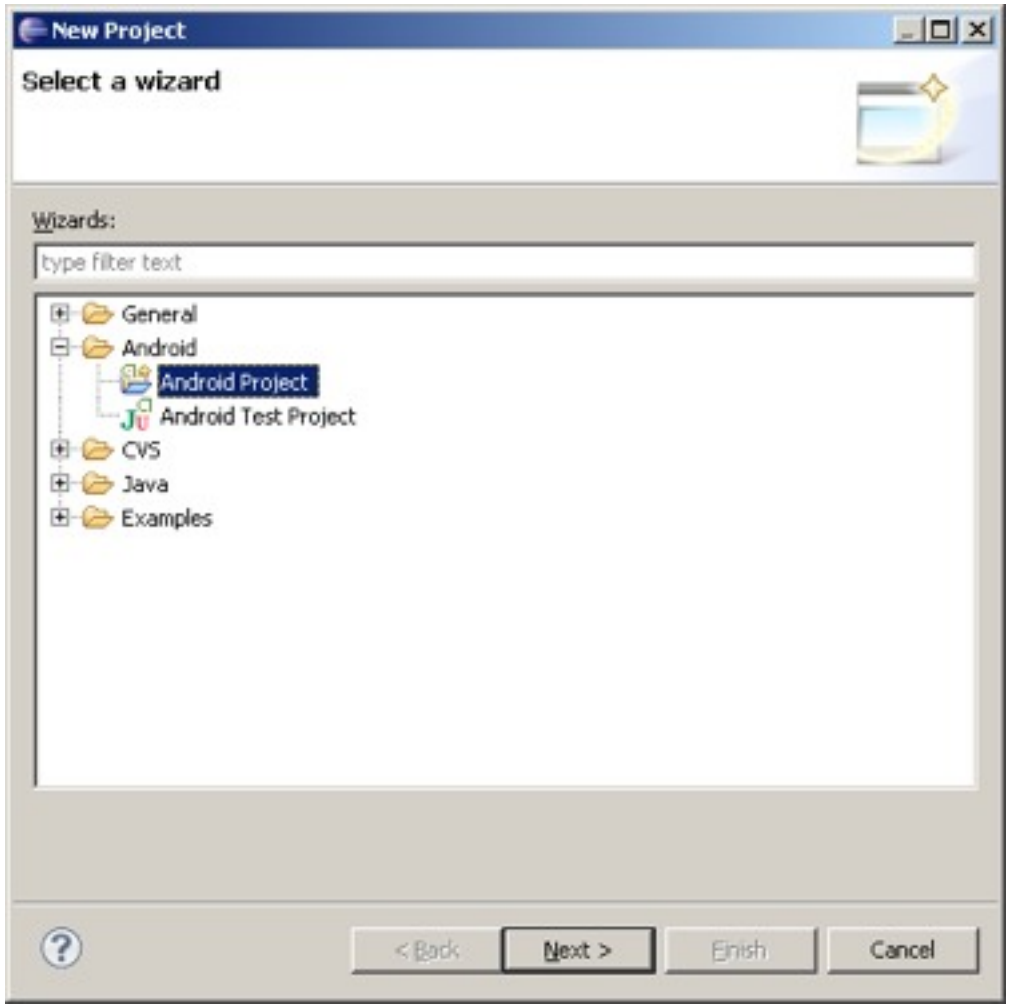


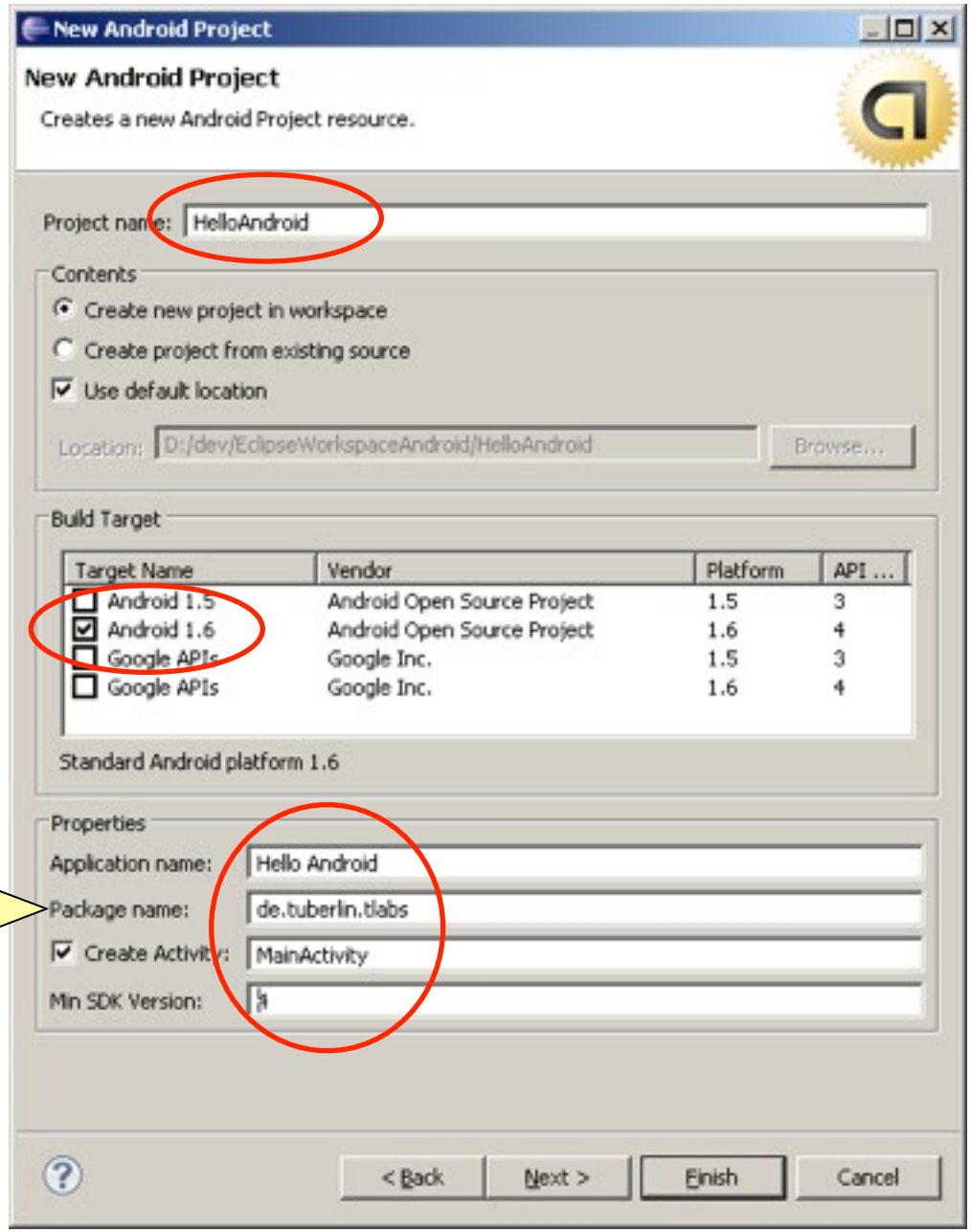
Update Packages



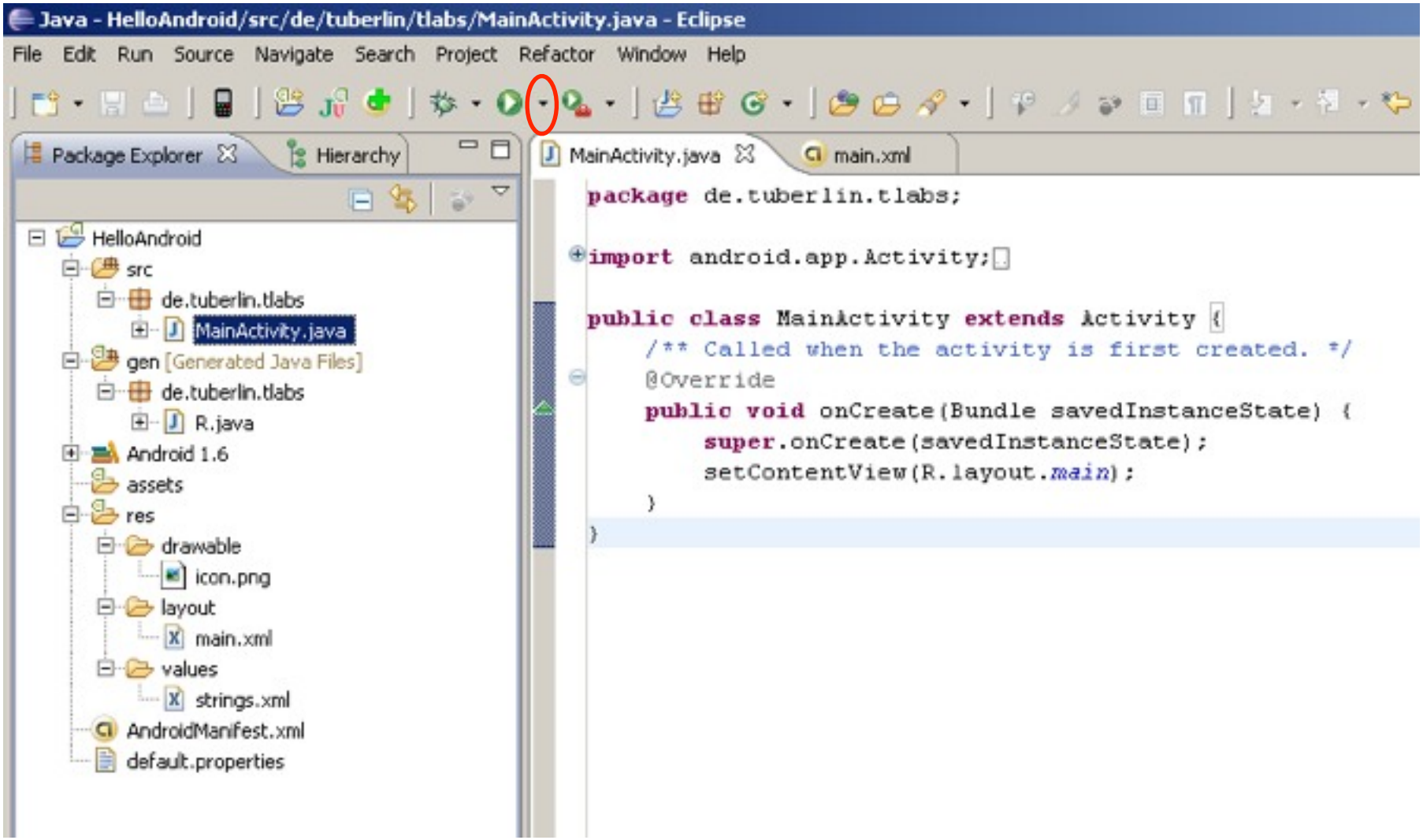
Creating Your First Android Project

File → New Project → Android → Android Project





Uniquely identifies the application!


Java - HelloAndroid/src/de/tuberlin/tlabs/MainActivity.java - Eclipse
File Edit Run Source Navigate Search Project Refactor Window Help
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R.java
Android 1.6
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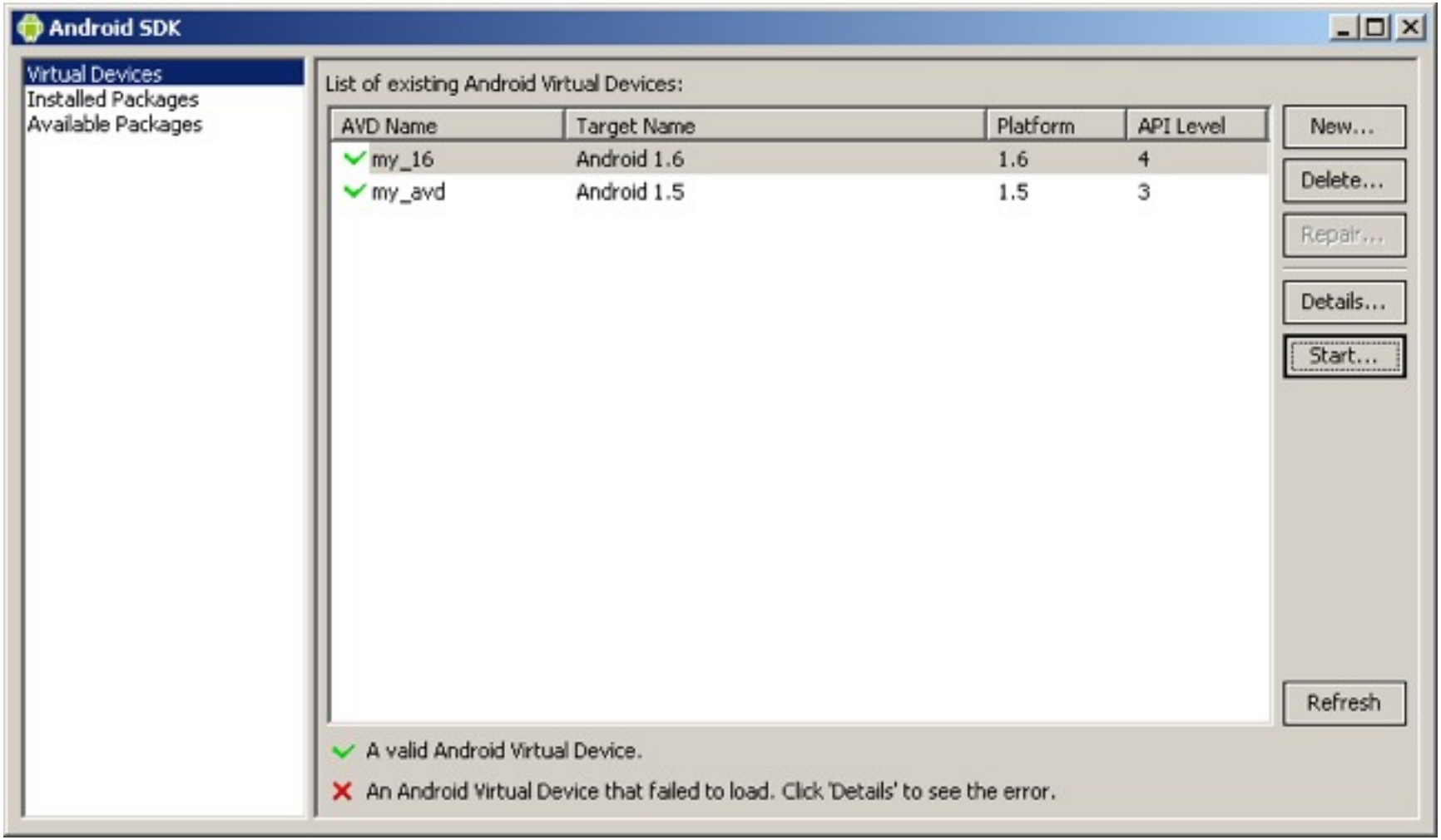
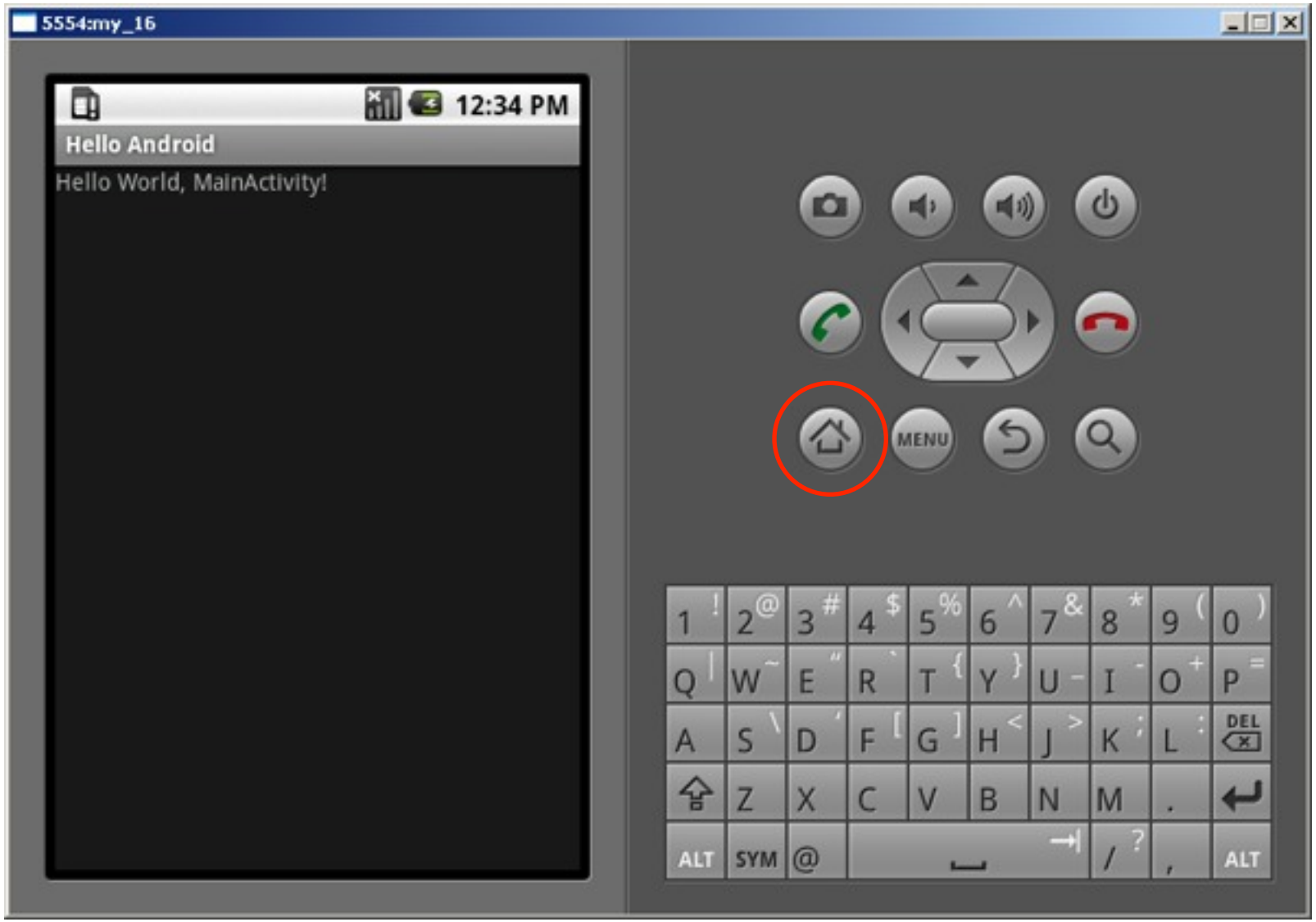
icon.png
layout
main.xml
values
strings.xml
AndroidManifest.xml
default.properties
MainActivity.java
main.xml
package de.tuberlin.tlabs;
import android.app.Activity;
public class MainActivity extends Activity {
/** Called when the activity is first created. */
@Override
public void onCreate(Bundle savedInstanceState) {
super.onCreate(savedInstanceState);
setContentView(R.layout.main);
}
}

Define Missing Android Virtual Device




5554:my_16
12:34 PM
Hello Android
Hello World, MainActivity!
MENU


5554:my_16
12:35 PM
Google
Messaging
Dialer
Contacts
Browser
MENU
ALT
SYM
ALT
DEL


5554:my_16
12:35 PM
Google
Alarm Clock
Browser
Calculator
Camcorder
Camera
Contacts
Custom Locale
Dev Tools
Dialer
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Gallery
Gestures Builder
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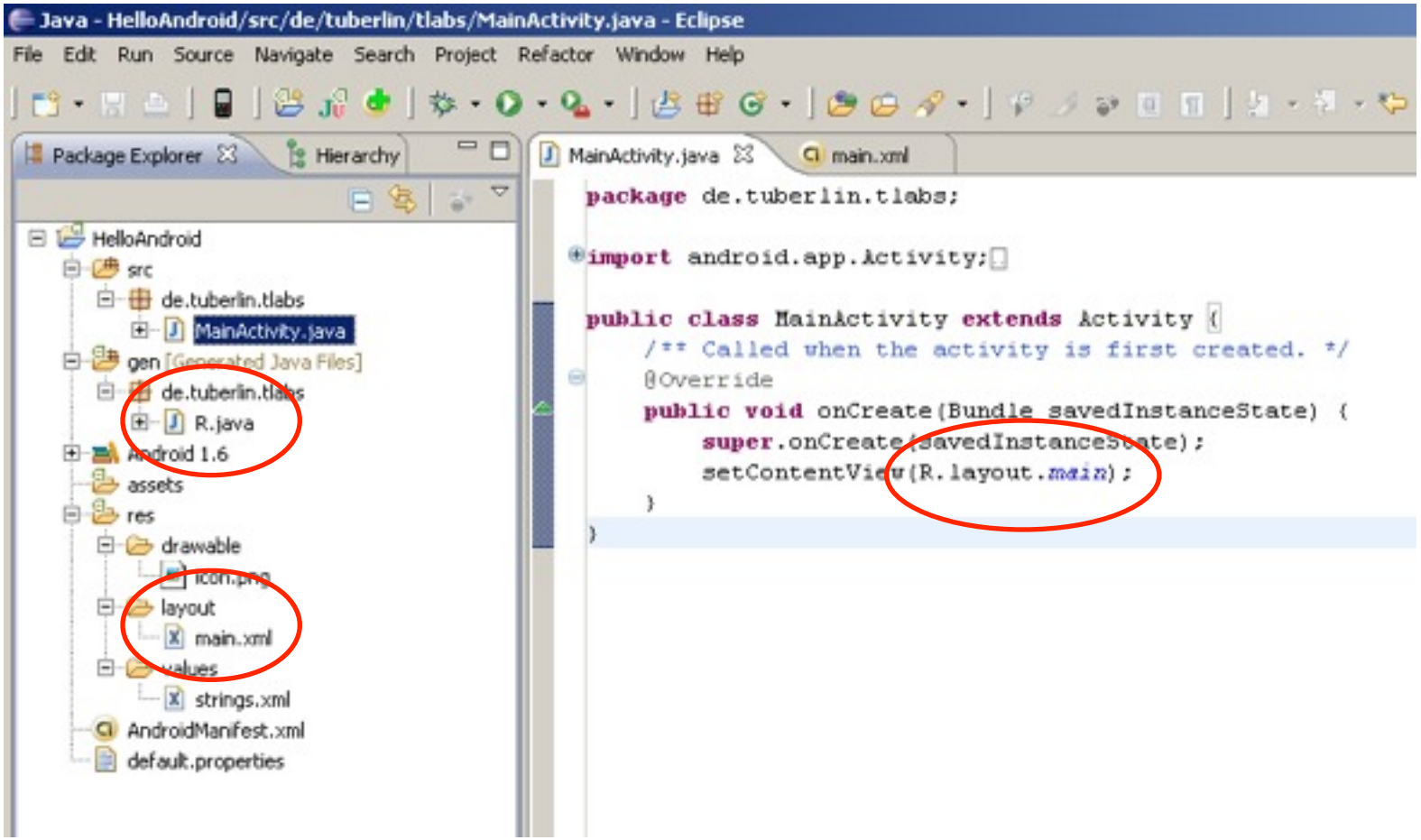
DEL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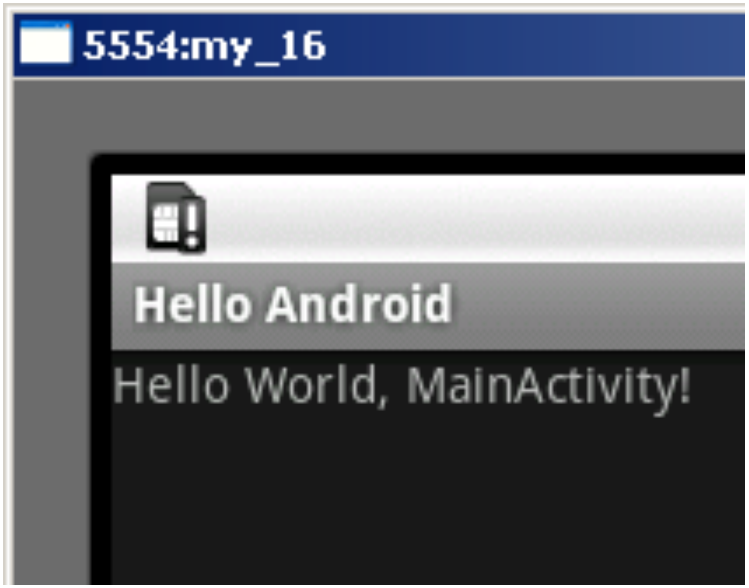
}

Declarative definition of UIs
main.xml

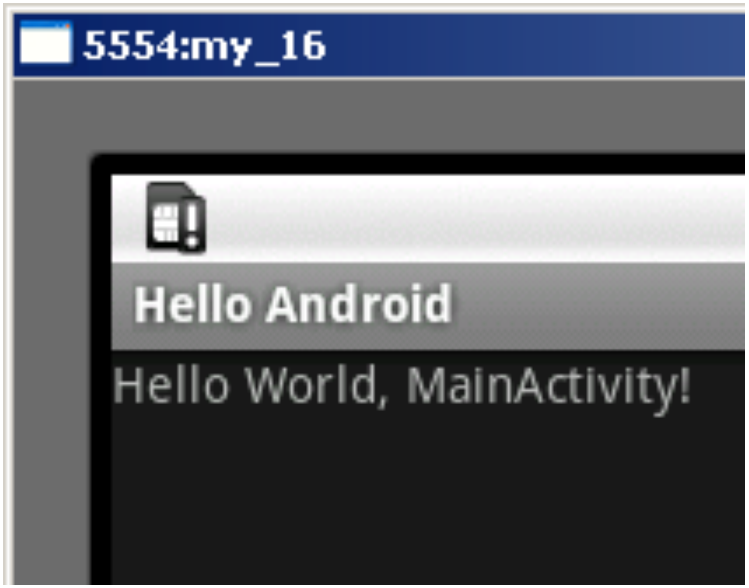
```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    >
<TextView
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"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



Separating text strings from code strings.xml

```
<?xml version="1.0" encoding="utf-8"?>
<resources>
    <string name="hello">Hello World, MainActivity!</string>
    <string name="app_name">Hello Android</string>
</resources>
```

- Default language in res/values/strings.xml
- Localized languages in res/values-xx (language qualifier)
  - French in res/values-fr/strings.xml
  - Hindi in res/values-hi/strings.xml
  - Etc.

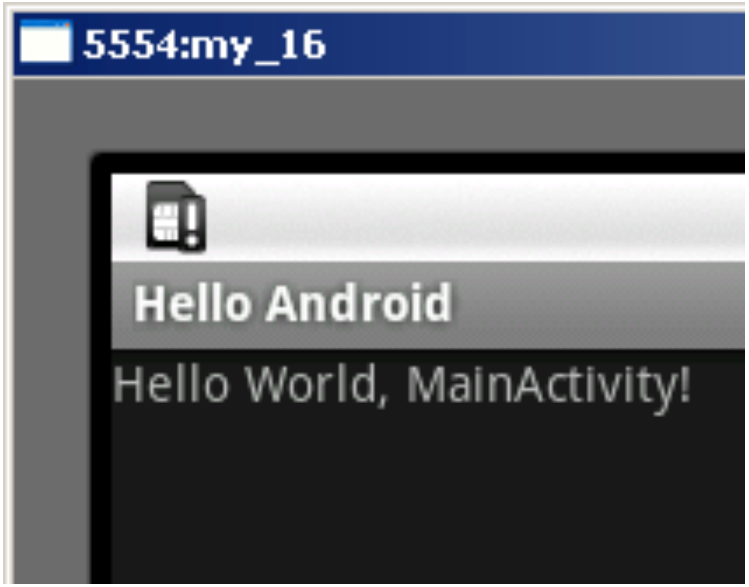


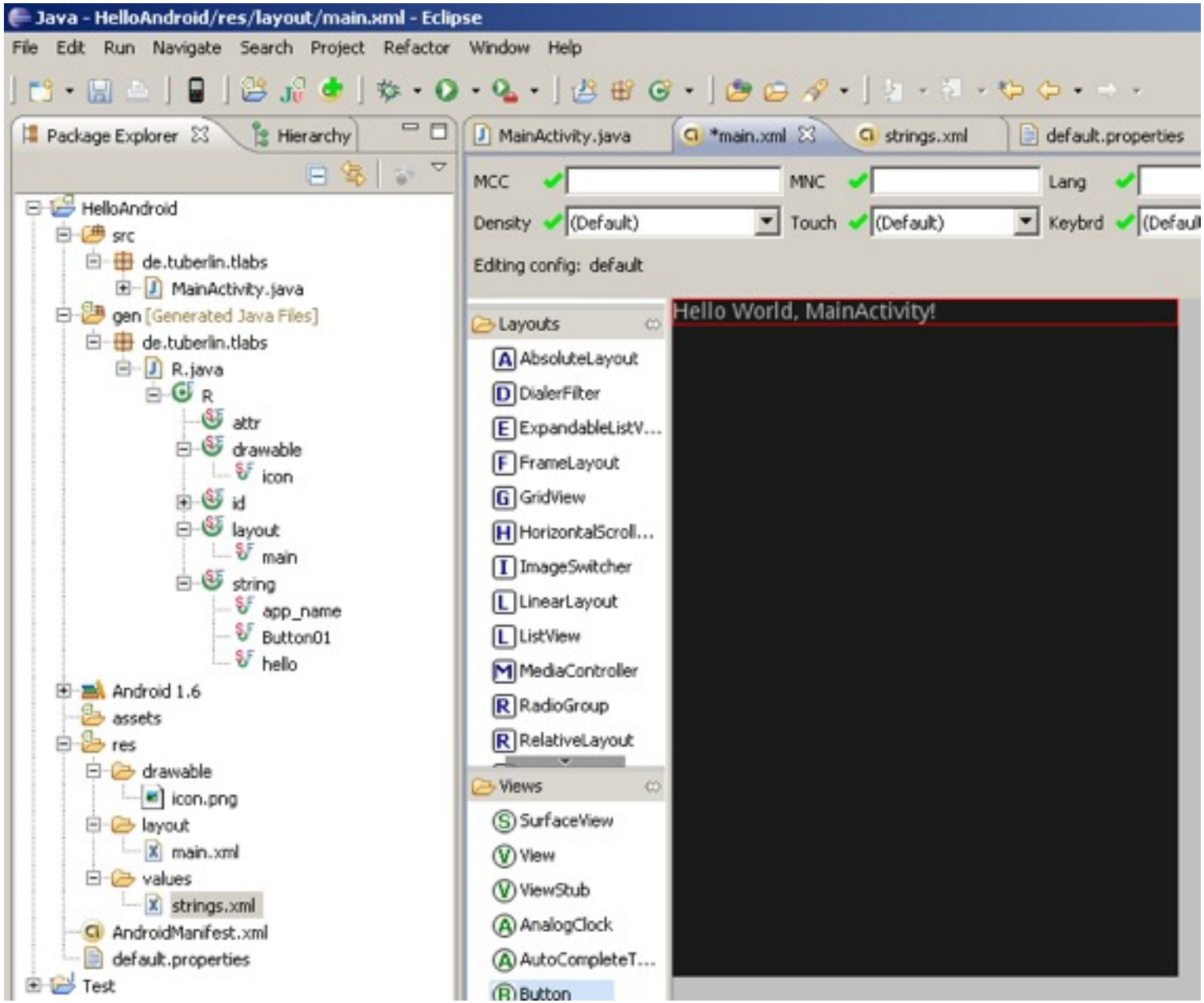
R.java

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

package de.tuberlin.tlabs;

public final class R {
    public static final class attr {
    }
    public static final class drawable {
        public static final int icon=0x7f020000;
    }
    public static final class id {
        public static final int Button01=0x7f050000;
    }
    public static final class layout {
        public static final int main=0x7f030000;
    }
    public static final class string {
        public static final int Button01=0x7f040002;
        public static final int app_name=0x7f040001;
        public static final int hello=0x7f040000;
    }
}
```

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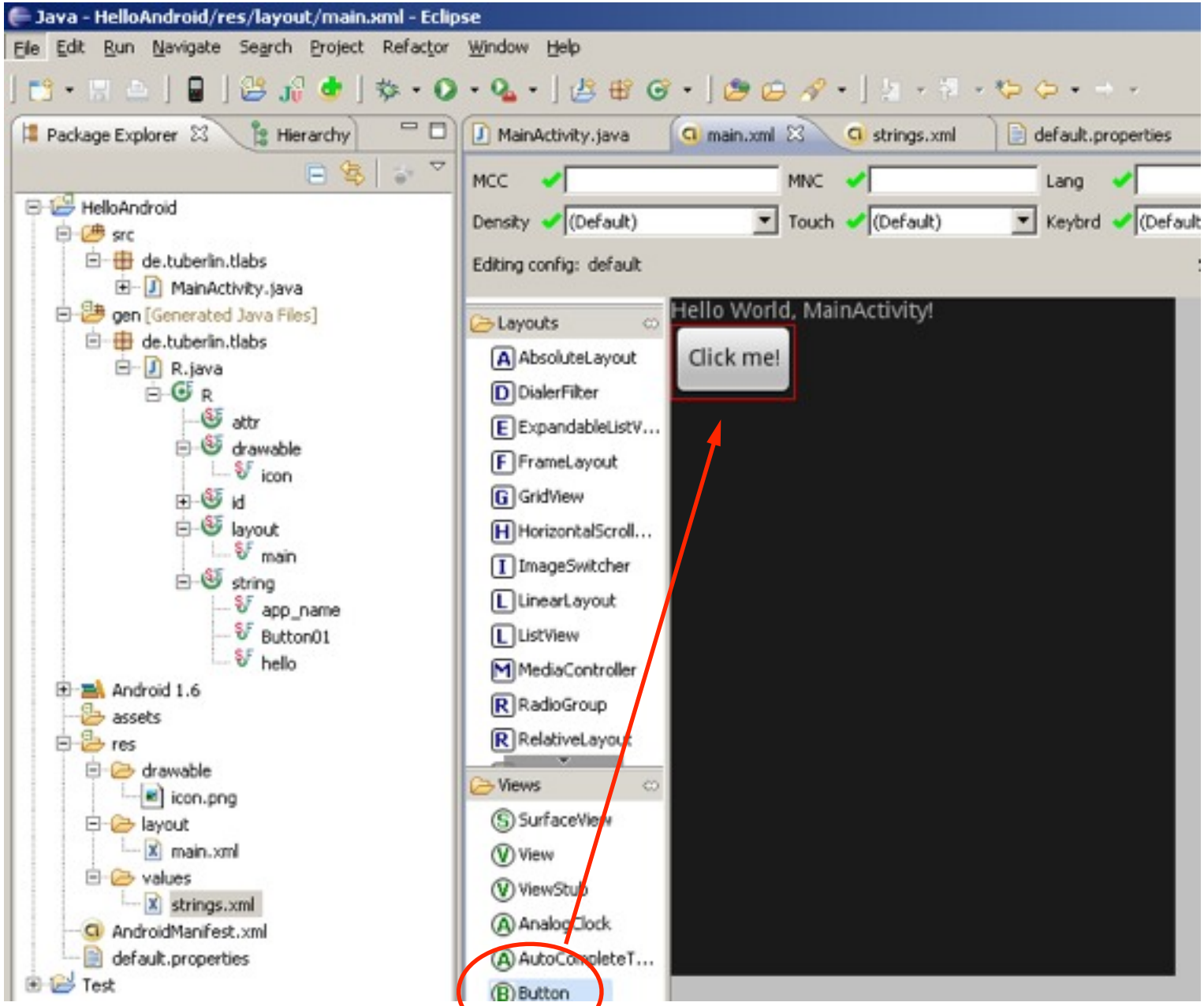
MainActivity.java
*main.xml
strings.xml
default.properties
MCC
MNC
Lang
Density
(Default)
Touch
(Default)
Keybrd
Editing config: default
Layouts
AbsoluteLayout
DialerFilter
ExpandableListV...
FrameLayout
GridView
HorizontalScroll...
ImageSwitcher
LinearLayout
ListView
MediaController
RadioGroup
RelativeLayout
Views
SurfaceView
View
ViewStub
AnalogClock
AutoCompleteT...
Button
Hello World, MainActivity!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strings.xml
default.properties
MCC
MNC
Lang
Density
(Default)
Touch
(Default)
Keybrd
Editing config: default
Layouts
AbsoluteLayout
DialerFilter
ExpandableListV...
FrameLayout
GridView
HorizontalScroll...
ImageSwitcher
LinearLayout
ListView
MediaController
RadioGroup
RelativeLayout
Views
SurfaceView
View
ViewStub
AnalogClock
AutoCompleteT...
Button
Hello World, MainActivity!
Click me!

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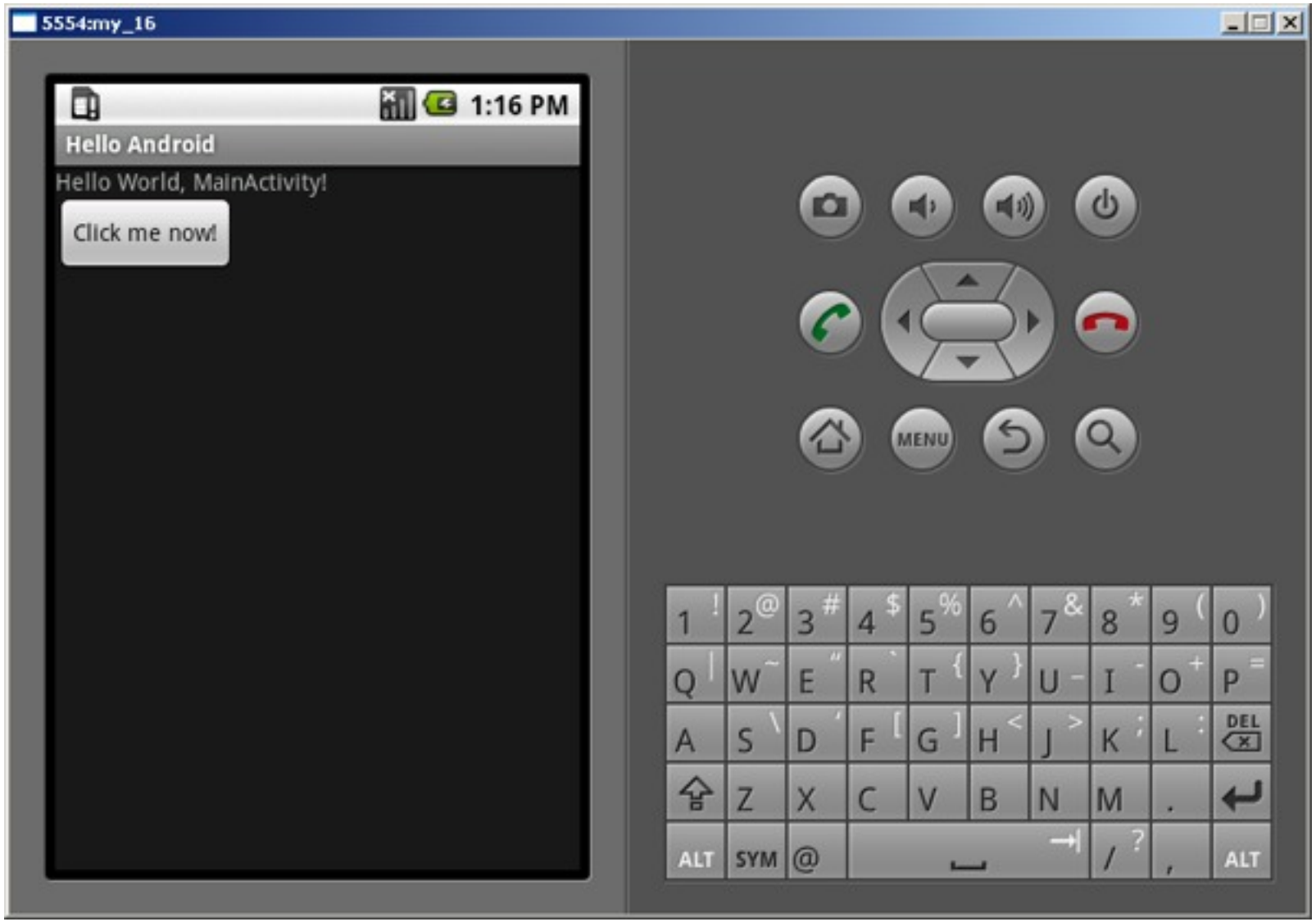
    >
<TextView
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:text="@string/hello"
    />
<Button
    android:text="@string/Button01"
    android:id="@+id/Button01"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    />
</LinearLayout>
```

strings.xml

```
<?xml version="1.0" encoding="utf-8"?>
<resources>
    <string name="hello">Hello World, MainActivity!</string>
    <string name="app_name">Hello Android</string>
    <string name="Button01">Click me now!</string>
</resources>
```


5554:my_16
1:16 PM
Hello Android
Hello World, MainActivity!
Click me now!
MENU

Define the contents of the application AndroidManifest.xml

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="de.tuberlin.tlabs"
    android:versionCode="1"
    android:versionName="1.0">
  <application android:icon="@drawable/icon" android:label="@string/app_name">
    <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>
  <uses-sdk android:minSdkVersion="4" />
</manifest>
```

Uniquely identifies the application!

Add for android:debuggable="true" on-device debugging!

- Initial activity of application
- Listed in application launcher

UI from XML resources
MainActivity.java

```
package de.tuberlin.tlabs;

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

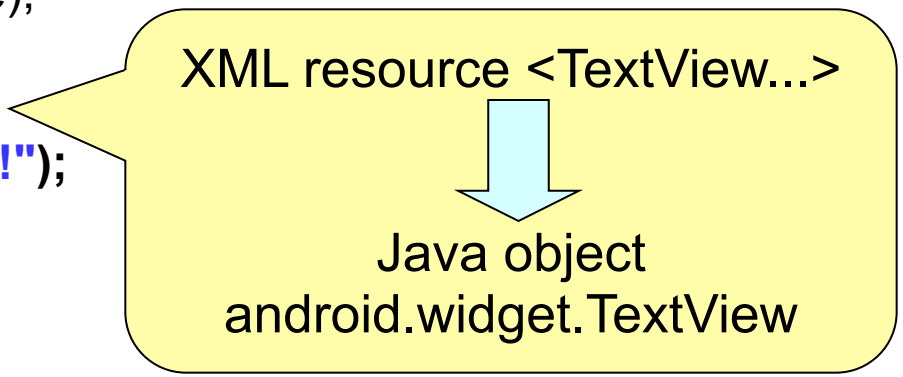
public class MainActivity extends Activity {
    /** Called when the activity is first created. */
    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.main);
    }
}
```

UI programmatically defined MainActivity.java

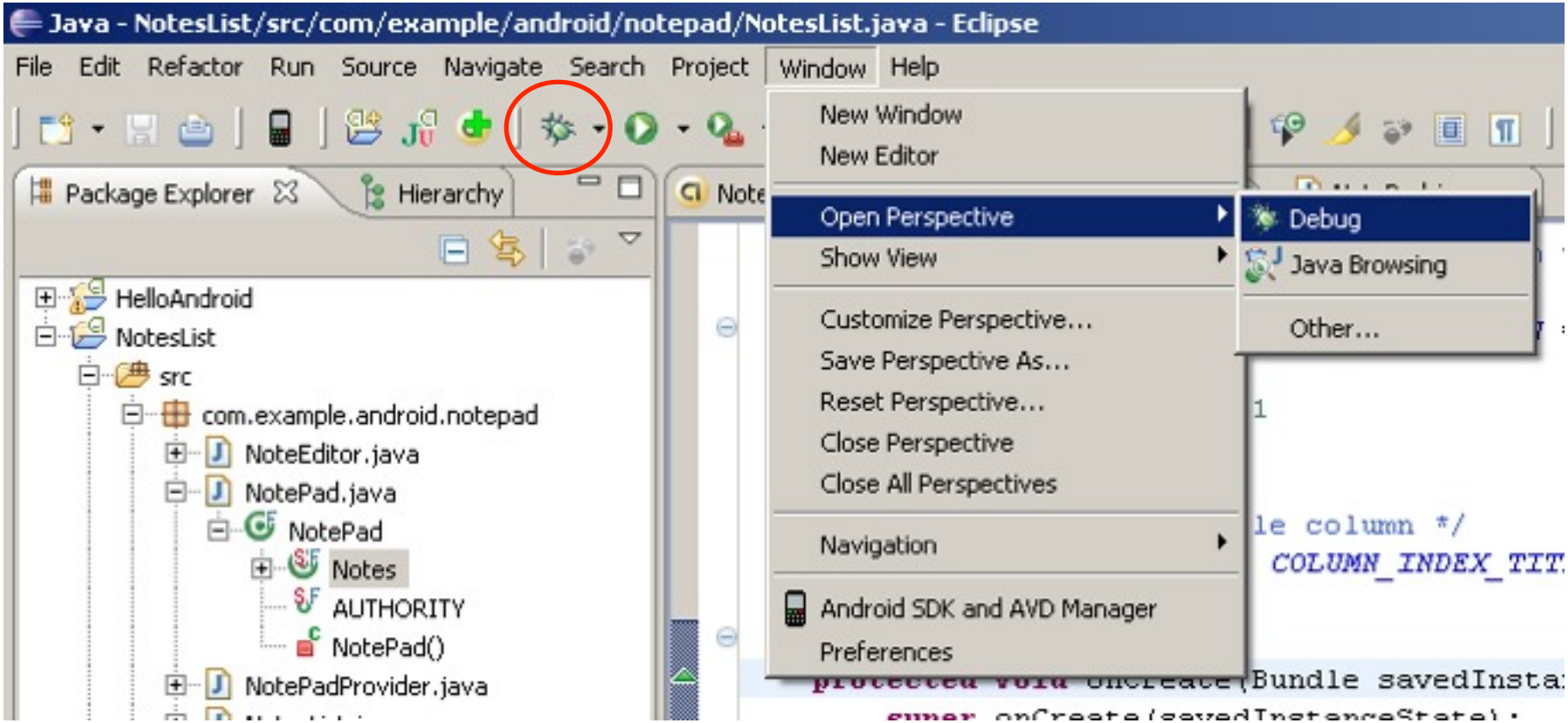
```
package de.tuberlin.tlabs;

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

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

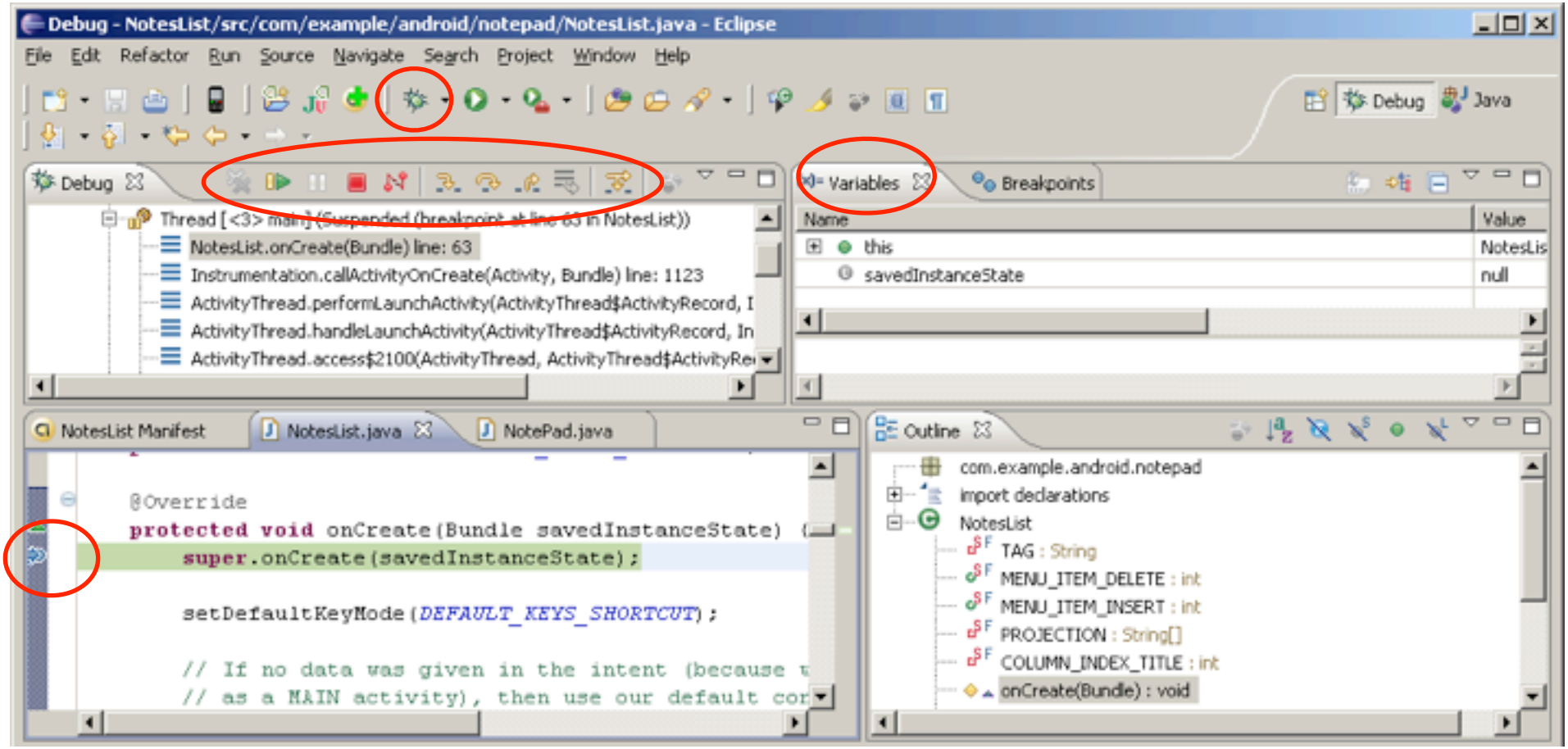


Eclipse Perspectives

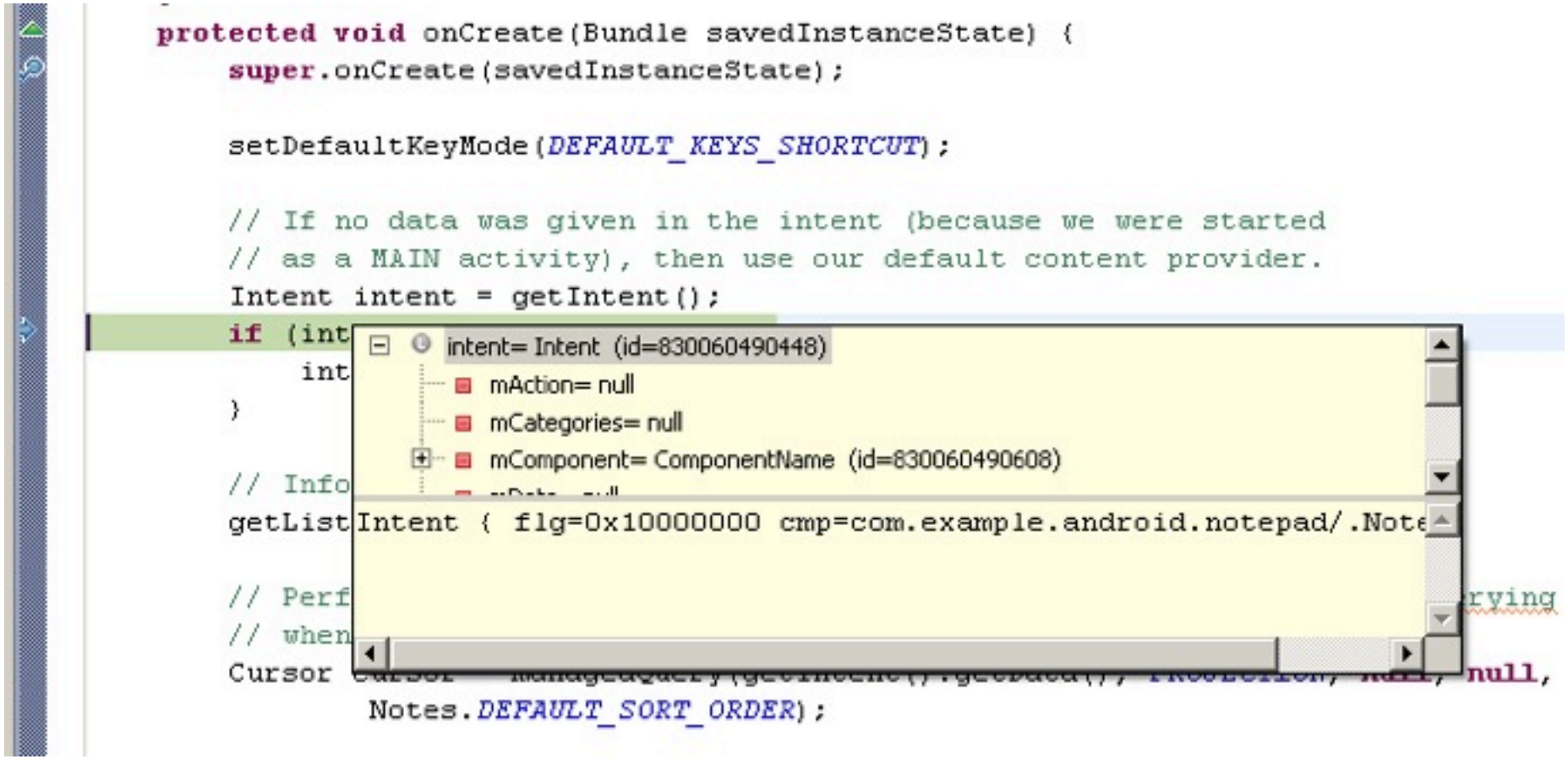


Debugging in the Emulator

- Set Breakpoint with Ctrl+Shift+B (⌘ +Shift+B)
- Step through code with F5, F6, F7 (*fn* + F5, F6, F7)

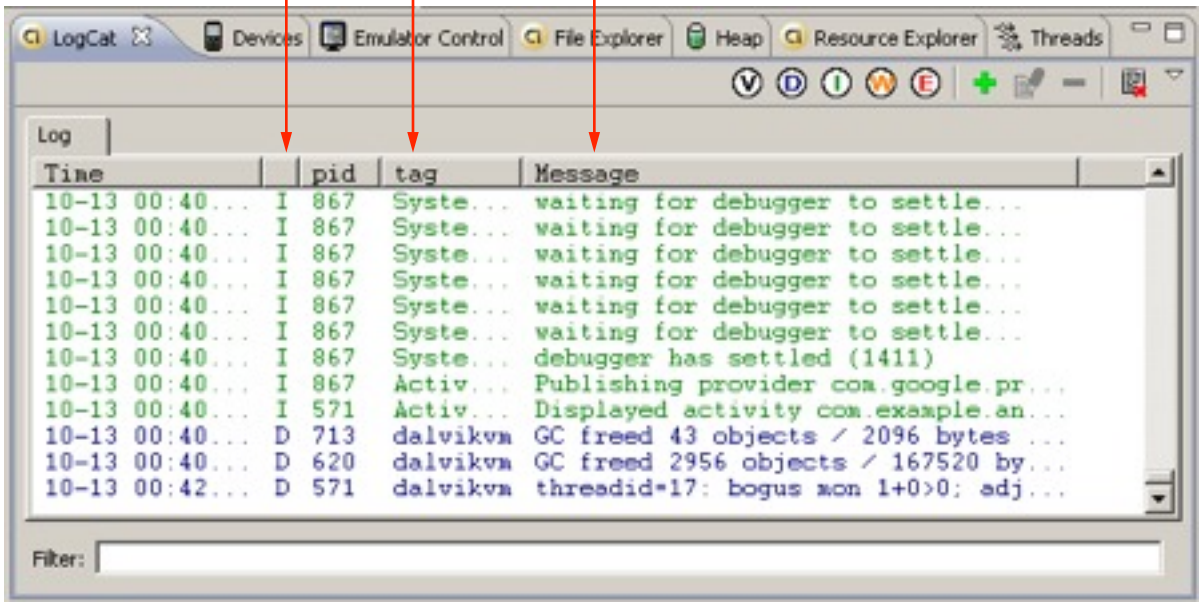


Inspecting Variables



Logging and Tracing

- android.util.Log
  - informational, warning, error methods
  - Example: *Log.d(TAG, "getAddress: " + s);*
- android.os.Debug
  - Debug.startMethodTracing
  - Debug.stopMethodTracing
  - trace viewer tool
- File explorer tool to view files on the device



Concepts so far

- Project directory structure
  - src, gen, assets, res, AndroidManifest.xml
- Resources
  - Declarative view definitions in XML
  - Localization of string resources
  - Selection of icons/images based on resolution
  - Resource identifiers
- Application as collection of Activities
- Manifest file

Activity and Application Lifecycle

Applications

- Default: Application ⇔ Linux process ⇔ Virtual Machine
- Each application has a unique Linux user ID
  - Application files only accessible by this Linux user ID
- Applications can share a user ID
  - Applications with the same ID can share a process/VM
- Application components
  - Activities
  - Services
  - Broadcast receivers
  - Content providers
- Components can register their capabilities with the system
  - Declared in manifest file
  - Example: Barcode recognition service for other application

Activities

- Independent components of the application
  - Components “crash” individually
- Represent data and behavior of one View
  - Roughly: the model and controller of the MVC pattern
- Example: text messaging application
  - Activity 1 shows list of contacts
  - Activity 2 to write a message to a chosen contact
  - Activity 3 to review sent messages
- View of an Activity typically fills the screen
  - Views grouped in hierarchy
  - Parents control layout of children
  - Leaf view react to user actions
  - Associate root view with activity: activity.*setContentView(view id);*

Services

- Application component without a user interface
- Runs in the background and performs some task
- Example: Downloading data from the network
- Local services: invoked from the same process
- Remote services: invoked from other processes
  - But: from same device
  - Android Interface Definition Language (AIDL)
  - Remote Procedure Call (RPC)
  - Exposing service to clients: declaration in manifest file

Broadcast Receivers

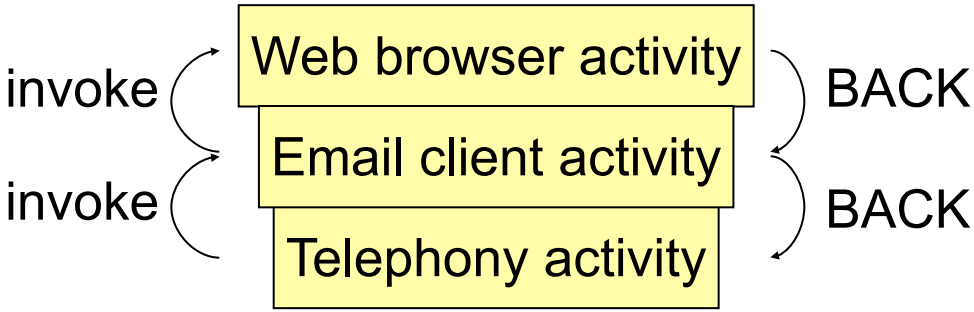
- Application component that receives and reacts to broadcasts
  - No user interface
- System receives and dispatches broadcasts
- Example broadcasts
  - From System: Timezone changed, battery low, language setting changed
  - From an applications: download finished
- Reaction to broadcast
  - Post a notification to the status bar → NotificationManager
  - Start an activity with a user interface
  - Etc.

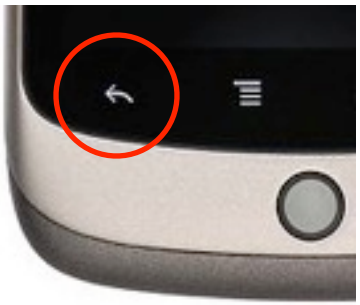
Content Providers

- Common interface for querying an application's data
  - Images, contact information, notes, emails, etc.
  - Content provider defines public URI
  - Expose data as rows and columns of a table
- Data sources (not exposed)
  - File system
  - SQLite database
  - Network
- Content resolvers
  - Dynamic lookup of content provider based on URI
  - Example: content://com.google.provider.NotePad/notes/3

Tasks

- Task: what the user experiences as an “application”
  - Notion of an “application” blurry in component-based system
  - Tasks can span multiple activities and applications
- Example scenario for a task
  - User talks on the phone, looks up an email to answer a question, follows a link to a Web page with the desired information
  - Talk on phone: telephony application
  - Look up email: email client
  - Reading Web page: web browser
- Activity stack of a task:



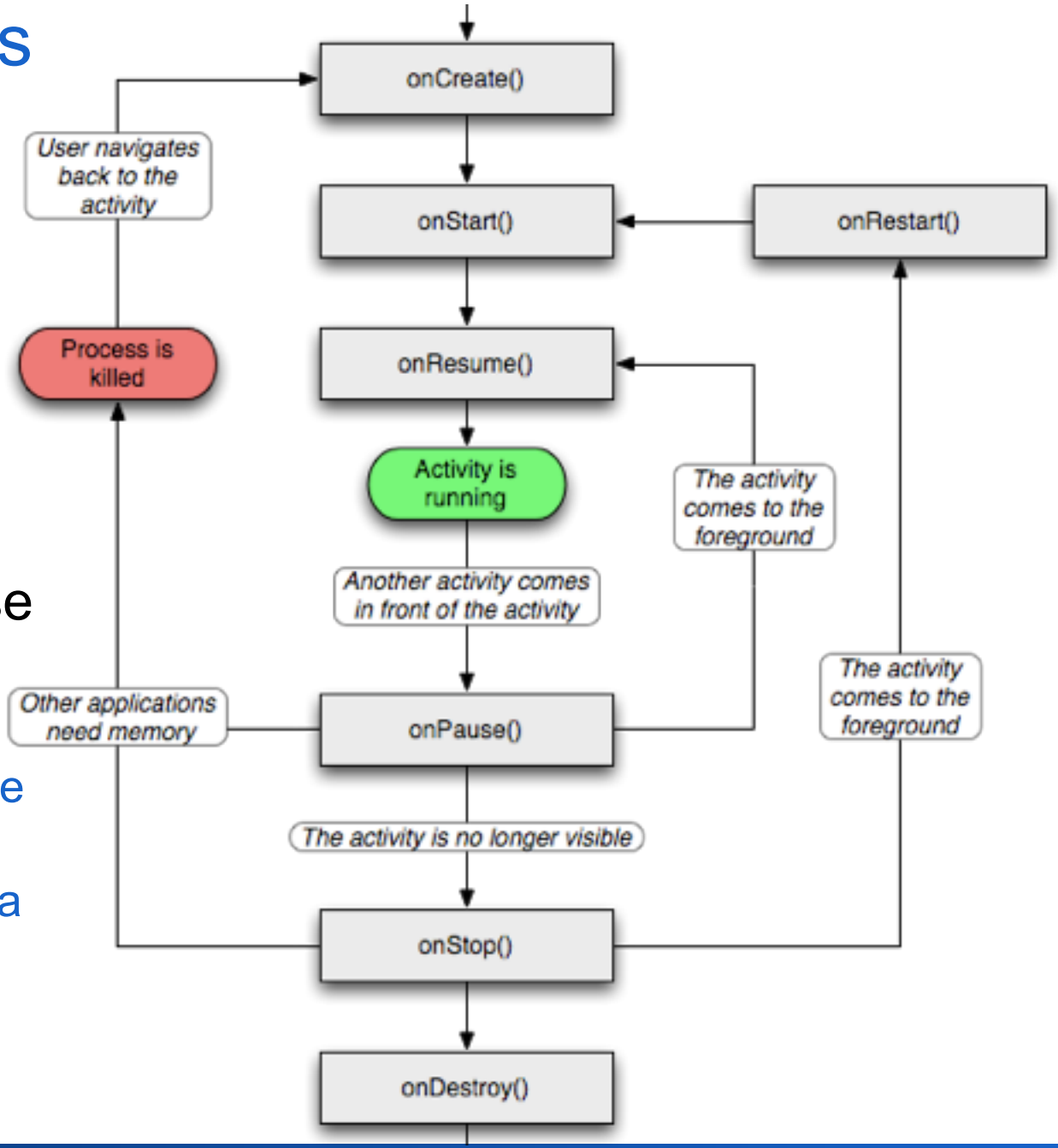


Activity Lifecycle

- Managed by system based on resources and user needs
- States
  - Running: in foreground (at top of activity stack)
  - Paused: partially visible, lost focus (e.g. dialog on top)
  - Stopped: invisible
- Lifecycle callback methods of an Activity
  - **protected void** onCreate(Bundle savedInstanceState);
  - **protected void** onStart();
  - **protected void** onRestart();
  - **protected void** onResume();
  - **protected void** onPause();
  - **protected void** onStop();
  - **protected void** onDestroy();

State Transitions of an Activity

- Use callback methods to manage state and resources of the activity
- Example: onPause
  - Stop OpenGL screen updates
  - Stop game engine updates
  - Stop sending data via the network



Intents

Intents

- Intents are
  - Messages to the system
  - (Passive) representations of an operation to be performed
  - “Glue” between activities
  - Enable late runtime binding across applications
- Primary pieces: action and data
  - Example: action: ACTION_VIEW, data: URI to view
- Intents used to
  - Invoke other applications
  - Raise events (→ publish-and-subscribe)
  - Represent actions to be performed in the future
- Intent registry
  - http://www.openintents.org

Example: Invoking an Activity

- **Activity to be invoked**

```
public class BasicActivity extends Activity {
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.main);
} }
```

- **In AndroidManifest.xml**

```
<activity android:name="BasicActivity" android:label="My Basic Activity">
    <intent-filter>
        <action android:name="com.andbk.intent.action.ShowBasicView" />
        <category android:name="android.intent.category.DEFAULT" />
    </intent-filter>
</activity>
```

- **From another activity**

```
Intent intent = new Intent("com.andbk.intent.action.ShowBasicView");
startActivity(intent);
```

Available Intents in Android

- Available intents
  - Browser: open a browser window
  - Dialer: calling phone numbers
  - Google Maps: open to the given location
  - Google Streetview: open to the given location
- Intents list
  - http://developer.android.com/guide/appendix/g-app-intents.html
- Examples

```
Intent intent = new Intent(Intent.ACTION_VIEW);
intent.setData(Uri.parse("http://www.lmu.de"));
startActivity(intent);

Intent intent = new Intent(Intent.ACTION_VIEW);
intent.setData(Uri.parse("geo:52.5127,13.3210?z=17"));
startActivity(intent);
```

Intent Resolution

- Intent resolution maps Intent to component
- If multiple possible receivers, shows selection list

- Matching Intent against all <intent-filter> descriptions in all installed application packages
- Information used for resolution
  - Action
  - Category
  - MIME type / scheme

Matching Intents to Activities

- Generic action ACTION_VIEW

```
Intent intent = new Intent(Intent.ACTION_VIEW);
intent.setData(Uri.parse("http://www.lmu.de"));
startActivity(intent);
```

- Intent registration names scheme

```
<activity ...>
    <intent-filter>
        <action android:name="android.intent.action.VIEW" />
        <data android:scheme="http" />
        <data android:scheme="https" />
    </intent-filter>
</activity>
```

Matching Intents to Activities

- Other data attributes
  - host, mimeType, port, path, pathPattern, pathPrefix
- Handling a MIME type

```
<intent-filter>
    <action android:name="android.intent.action.VIEW" />
    <data android:mimeType="vnd.android.cursor.dir/vnd.google.note" />
</intent-filter>
```

- Passing additional information to an intent

```
Bundle b = new Bundle();
// add key/value pairs to bundle
intent.putExtras(b);
```

Explicit Intents

- Invoking an Activity by ComponentName

```
Intent intent = new Intent();
ComponentName cn = new ComponentName
    ("com.android.contacts",
    "com.android.contacts.ContactsEntryActivity");
intent.setComponent(cn);
startActivity(intent);
```

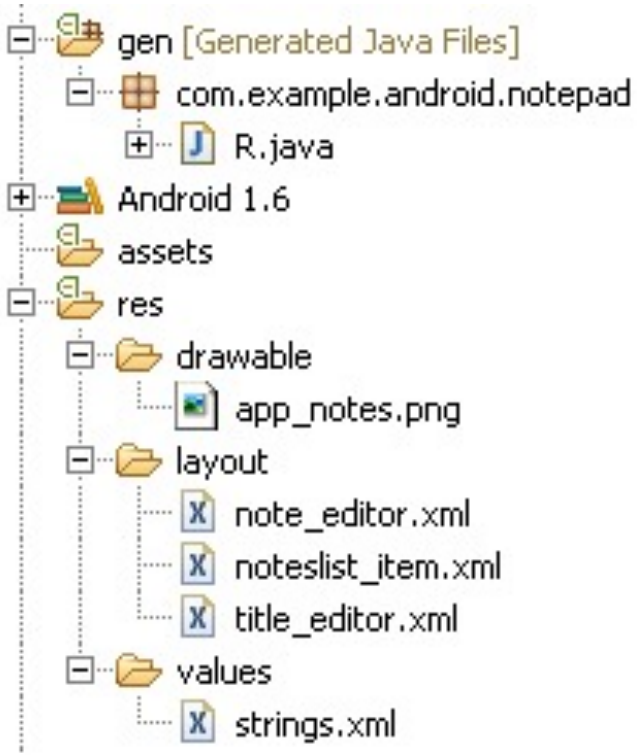
- Invoking an activity by class (is accessible)

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

Resources

Resources

- Declarative definition of UI elements
  - Examples: strings, bitmaps, dialog boxes, audio
- Separate from source code
  - Change resources and code independently
  - Example: localization, look & feel changes
- Resource identifiers → R.java
  - Source code uses resource ID
  - R.java automatically updated



String Resources

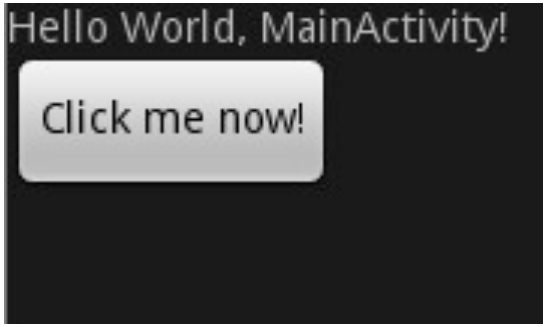
- In /res/values/strings.xml

```
<?xml version="1.0" encoding="utf-8"?>
<resources>
    <string name="app_name">Note Pad</string>
    <string name="button_ok">OK</string>
    ...
</resources>
```

- In /gen/<package>/R.java

```
public final class R {
    public static final class string {
        public static final int app_name=0x7f04000b;
        public static final int button_ok=0x7f04000c;
        ...
    }
}
```

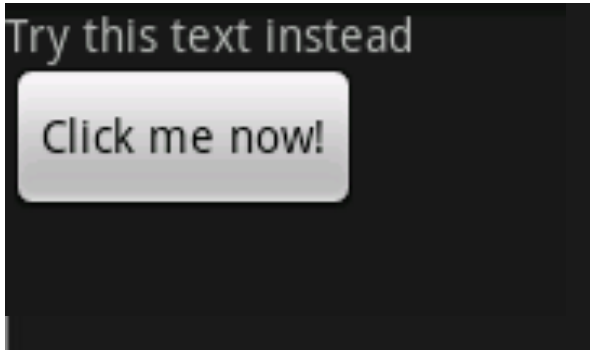
Layout Resources



- View for a screen defined in an XML file
- In /res/layout/main.xml

```
<?xml version="1.0" encoding="utf-8"?>
  <LinearLayout xmlns:android="http://schemas.android.com/apk/res/
  android"
   android:orientation="vertical"
   android:layout_width="fill_parent“ android:layout_height="fill_parent“ >
  <TextView
   android:text="@string/hello" /> android:id="@+id/text1"
   android:layout_width="fill_parent"
   android:layout_height="wrap_content"
  <Button
   android:text="@string/Button01" android:id="@+id/Button01"
   android:layout_width="wrap_content"
   android:layout_height="wrap_content" />
  </LinearLayout>
```

Layout Resources



- Instantiated in Java

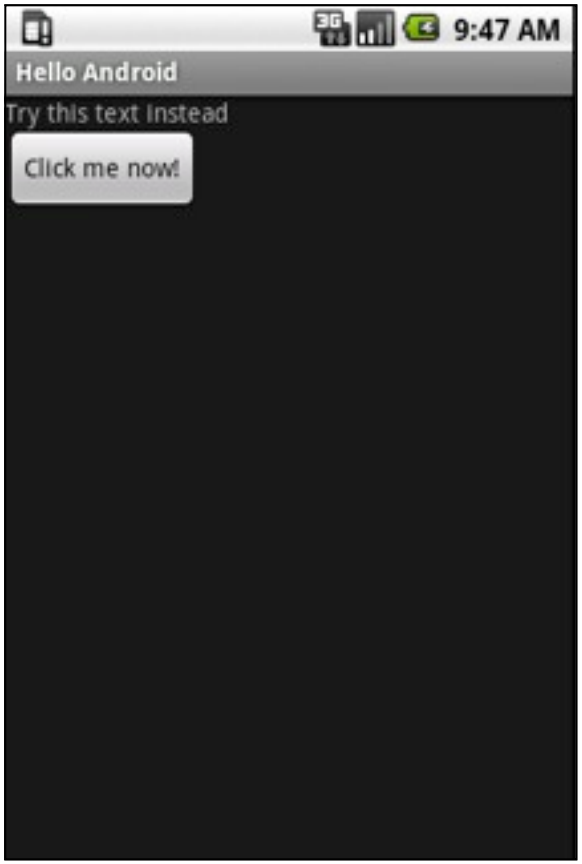
```
public class MainActivity extends Activity {

public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);

    setContentView(R.layout.main);

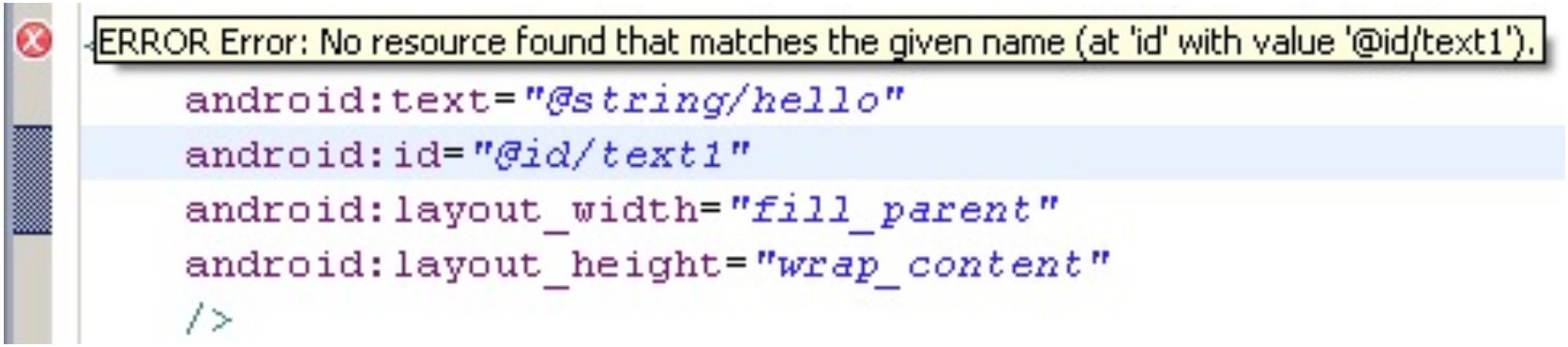
    TextView tv = (TextView)
            this.findViewById(R.id.text1);
    tv.setText("Try this text instead");

}
}
```



Resource-Reference Syntax

- “+” Use id if it already exists, otherwise create new id
- @id/text1



- @+id/text1

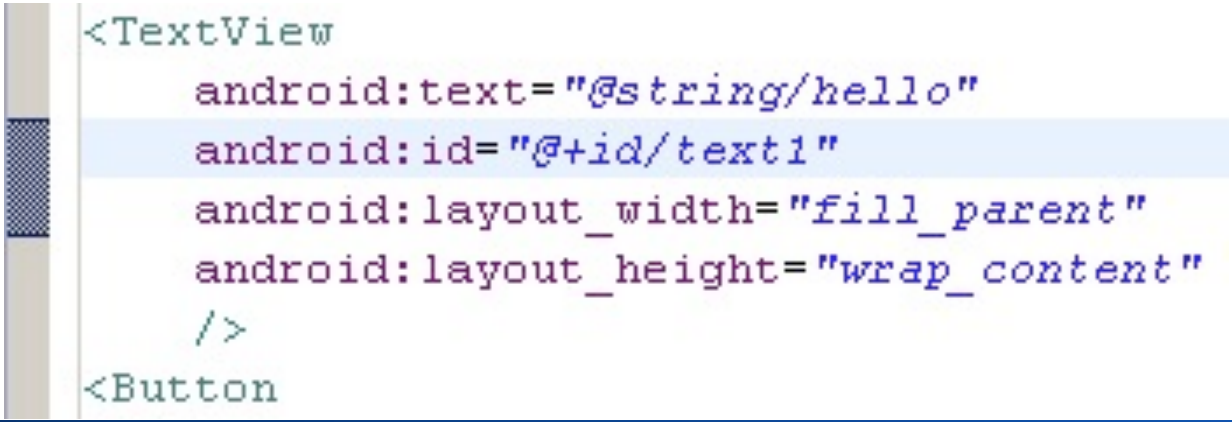
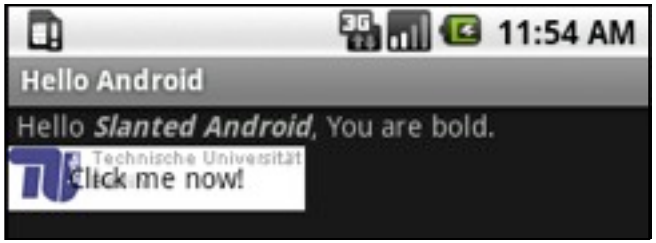


Image Resources

- Automatic id generation for images in /res/drawable
  - Example: /res/drawable/sample_image.jpg
    → R.drawable.sample_image
- Supported types: .gif, .jpg, .png



- Usage in XML

```
<Button android:text="@string/Button01"
...
android:background="@drawable/sample_image" />
```

- Usage in Java

```
Button b = (Button)this.findViewById(R.id.Button01);
b.setBackgroundResource(R.drawable.sample_image);
```

UI Components

- Common Controls
- Layout Managers
- Menus
- Dialogs

Common Controls

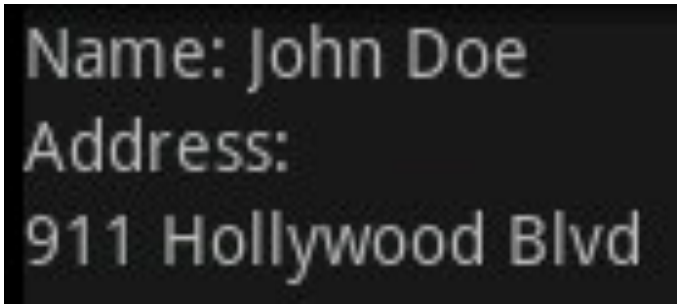
- Predefined user interface elements (“controls”, “widgets”)
  - Define basic interaction patterns
  - Semantics known to users
- Standard widgets
  - Text fields, buttons, lists, grids, date & time controls
- Android-specific controls
  - MapView (display a geographic map)
  - Gallery (display a list of photos)

Core UI Component Classes

java.lang.Object
↑ android.view.View
↑ android.view.ViewGroup
↑ android.widget.LinearLayout

- android.view.View
  - Rectangular area on the screen
  - Responsible for drawing and event handling
  - Base class for widgets (buttons, text fields, etc.)
- android.view.ViewGroup
  - Is a view and contains other views (“container”)
  - Base class for layouts
- Layouts
  - Invisible containers that hold other Views
  - Define their layout properties (position, padding, size, etc.)
  - Example: LinearLayout (horizontal / vertical list of children)

Creating a UI in Java

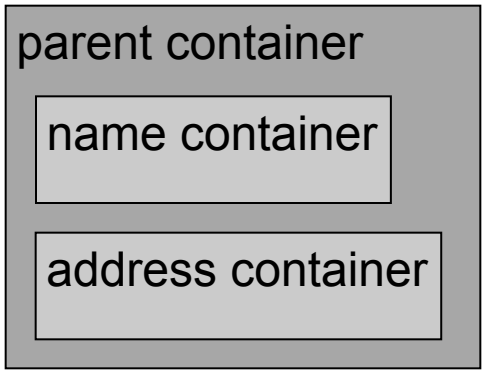



```
package com.androidbook.ch04;

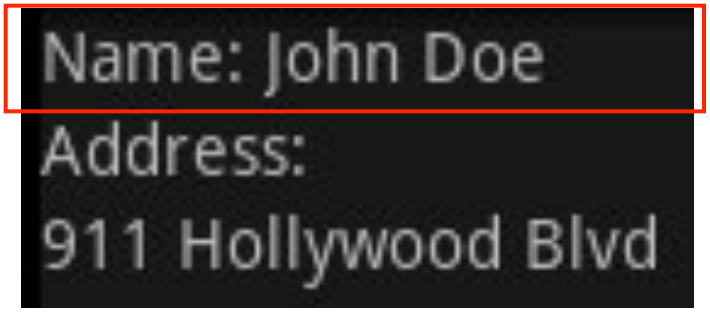
import android.app.Activity;
import android.os.Bundle;
import android.view.ViewGroup.LayoutParams;
import android.widget.LinearLayout;
import android.widget.TextView;

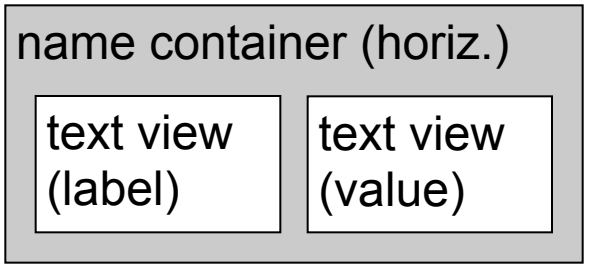
public class MainActivity extends Activity {
    private LinearLayout nameContainer;
    private LinearLayout addressContainer;
    private LinearLayout parentContainer;

    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        createNameContainer();
        createAddressContainer();
        createParentContainer();
        setContentView(parentContainer);
}
```



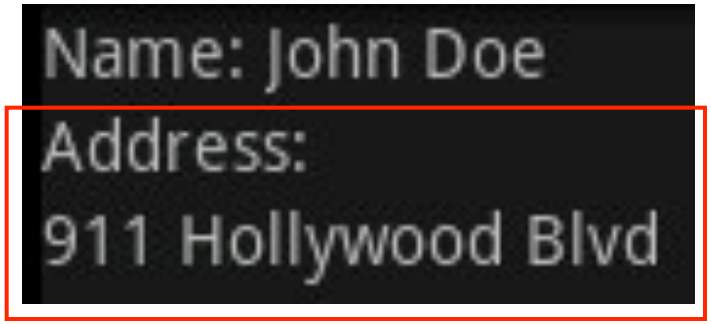
Creating a UI in Java

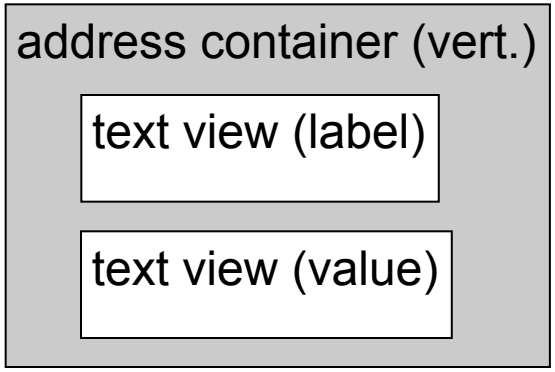





```
private void createNameContainer() {
    nameContainer = new LinearLayout(this);
    nameContainer.setLayoutParams(
        new LayoutParams(
            LayoutParams.FILL_PARENT,
            LayoutParams.WRAP_CONTENT));
    nameContainer.setOrientation(LinearLayout.HORIZONTAL);
    TextView nameLbl = new TextView(this);
    nameLbl.setText("Name: ");
    nameContainer.addView(nameLbl);
    TextView nameValueLbl = new TextView(this);
    nameValueLbl.setText("John Doe");
    nameContainer.addView(nameValueLbl);
}
```

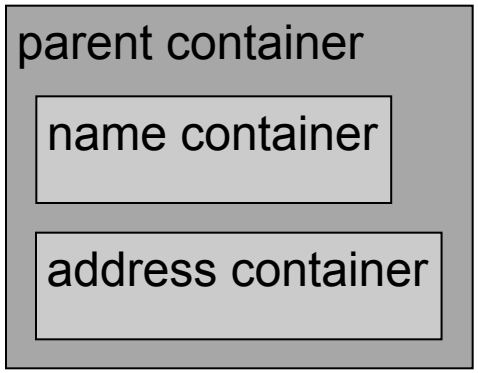
Creating a UI in Java






```
private void createAddressContainer() {
    addressContainer = new LinearLayout(this);
    addressContainer.setLayoutParams(
        new LayoutParams(
            LayoutParams.FILL_PARENT,
            LayoutParams.WRAP_CONTENT));
    addressContainer.setOrientation(LinearLayout.VERTICAL);
    TextView addrLbl = new TextView(this);
    addrLbl.setText("Address:");
    TextView addrValueLbl = new TextView(this);
    addrValueLbl.setText("911 Hollywood Blvd");
    addressContainer.addView(addrLbl);
    addressContainer.addView(addrValueLbl);
}
```

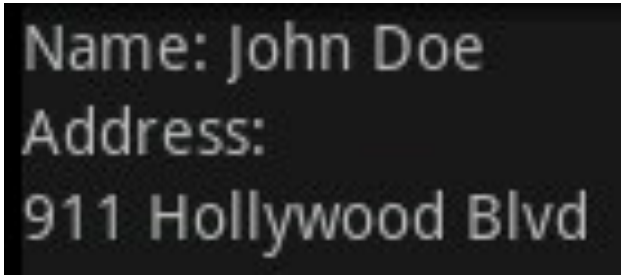
Creating a UI in Java




```
private void createParentContainer() {
    parentContainer = new LinearLayout(this);
    parentContainer.setLayoutParams(new LayoutParams(
        LayoutParams.FILL_PARENT,
        LayoutParams.FILL_PARENT));
    parentContainer.setOrientation(LinearLayout.VERTICAL);
    parentContainer.addView(nameContainer);
    parentContainer.addView(addressContainer);
}

}
```

Creating a UI in XML (/res/layout/test.xml)




```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical" android:layout_width="fill_parent"
    android:layout_height="fill_parent">
  <LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
      android:orientation="horizontal" android:layout_width="fill_parent"
      android:layout_height="wrap_content">
    <TextView android:layout_width="wrap_content"
      android:layout_height="wrap_content" android:text="Name: " />
    <TextView android:layout_width="wrap_content"
      android:layout_height="wrap_content" android:text="John Doe" />
  </LinearLayout>
  <LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical" android:layout_width="fill_parent"
    android:layout_height="wrap_content">
  <TextView android:layout_width="fill_parent"
    android:layout_height="wrap_content" android:text="Address:" />
  <TextView android:layout_width="fill_parent"
    android:layout_height="wrap_content" android:text="911 Hollywood Blvd." />
  </LinearLayout>
</LinearLayout>
```

Setting the XML UI in Java

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

Design UI in XML, Reference in Java

- Assign IDs in XML

```
<TextView android:id="@+id/nameValue" .../>
<TextView android:id="@+id/addrValue" ... />
```

- Refer to controls using IDs

```
TextView nameValue = (TextView) findViewById(R.id.nameValue);
nameValue.setText("John Doe");
TextView addrValue = (TextView)findViewById(R.id.addrValue);
addrValue.setText("911 Hollywood Blvd.");
```

- View must have been loaded before referencing IDs

```
setContentView(R.layout.test);
```

Common Controls

Text Controls

- TextView
  - Display text, no editing
  - Automatic link creation if text contains URLs

    android:autoLink="all“
- EditText
  - Text editing
  - Expands as needed
  - Correct spelling errors

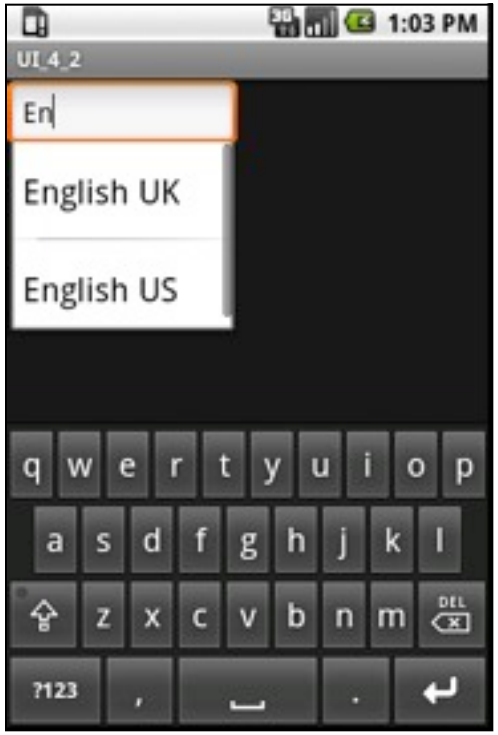
    android:autoText="true"
- AutoCompleteTextView
  - Displays suggestions for word completion
- MultiCompleteTextView
  - Displays suggestions for each word

EditView Input Type

- android:inputType=*"textEmailAddress"*

- android:inputType=*“phone“*

AutoCompleteTextView



- XML

```
<AutoCompleteTextView
    android:id="@+id/auto" ... />
```

- Java

```
AutoCompleteTextView actv =
    (AutoCompleteTextView) findViewById(R.id.auto);
ArrayAdapter<String> aa = new ArrayAdapter<String>(this,
        android.R.layout.simple_dropdown_item_1line,
        new String[] {"English UK", "English US", "Hebrew", "Hindi", ... });
    actv.setAdapter(aa);
```

- Adapter
  - Resource ID for showing a single item
  - The data to use

Handling Button Click Events

- XML

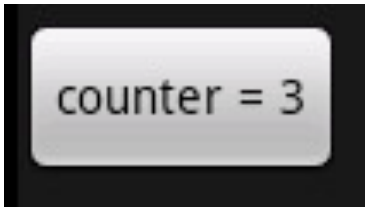
```
<Button android:id="@+id/button1" android:text="Basic Button"
android:layout_width="wrap_content"
    android:layout_height="wrap_content" />
```

- Java

```
public class MainActivity extends Activity implements
    View.OnClickListener {
    public void onCreate(Bundle savedInstanceState) {
        ...
        Button b = (Button) findViewById(R.id.button1);
        b.setOnClickListener(this);
    }

    private int counter = 0;

    public void onClick(View v) {
        Button b = (Button)v;
        b.setText("counter = " + (++counter));
    }
}
```



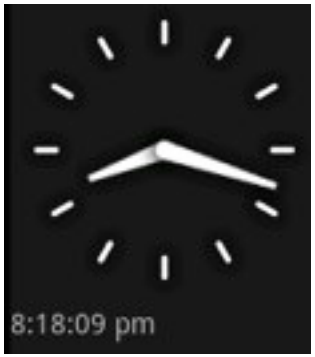
List Controls

- Vertical list of items
- Usage
  - Derive from android.app.ListActivity.ListActivity
  - Set a ListView
  - Setting data for the list view via setListAdapter
- Definition of list item in list_item.xml

```
<LinearLayout ...>
    <CheckBox android:id="@+id/checkbox" ... />
    <TextView android:id="@+id/textview1" ... />
    <TextView android:id="@+id/textview2" ... />
    ...
</LinearLayout>
```

Android Specific Controls

- DatePicker and TimePicker
- AnalogClock and DigitalClock
- MapView
- Gallery

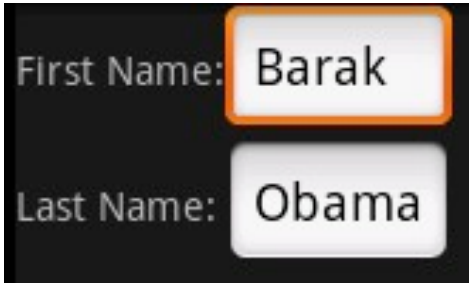


Layout Managers

LayoutManagers

- LayoutManagers
  - Are containers for views (children)
  - Have specific strategy for controlling children's size and position
- Layout Managers in Android
  - LinearLayout: horizontal or vertical arrangement
  - TableLayout: tabular form
  - RelativeLayout: arrange children relative to one another or parent
  - AbsoluteLayout: absolute coordinates
  - FrameLayout: dynamically change controls
- Layout_width and layout_height
  - fill_parent: child wants to fill available space within the parent
  - wrap_content: child wants to be large enough to fit its content

TableLayout



- Extension of LinearLayout
- Example:

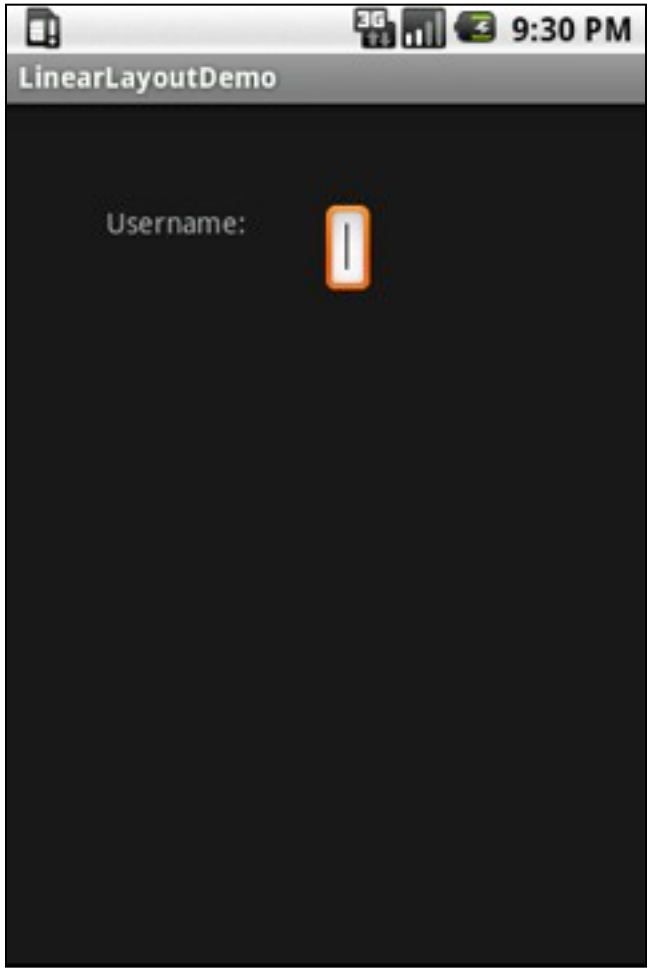
```
<TableLayout android:layout_width="fill_parent"
    android:layout_height="fill_parent">
<TableRow>
    <TextView android:layout_width="wrap_content"
    android:layout_height="wrap_content" android:text="First Name:" />
    <EditText android:layout_width="wrap_content"
    android:layout_height="wrap_content" android:text="Barak" />
</TableRow>
<TableRow>
    <TextView android:layout_width="wrap_content"
    android:layout_height="wrap_content" android:text="Last Name:" />
    <EditText android:layout_width="wrap_content"
    android:layout_height="wrap_content" android:text="Obama" />
</TableRow>
</TableLayout>
```

RelativeLayout


```
<RelativeLayout android:layout_width="fill_parent"
    android:layout_height="wrap_content">
    <TextView android:id="@+id/userNameLbl"
        android:text="Username: "
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:layout_alignParentTop="true" />
    <EditText android:id="@+id/userNameText"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:layout_below="@id/userNameLbl" />
    <TextView android:id="@+id/disclaimerLbl"
        android:text="Use at your own risk... "
        android:layout_width="fill_parent" android:layout_height="wrap_content"
        android:layout_alignParentBottom="true" />
</RelativeLayout>
```

AbsoluteLayout

```
<AbsoluteLayout
        android:layout_width="fill_parent"
        android:layout_height="fill_parent" >
    <TextView android:text="Username:"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_x="50px"
        android:layout_y="50px" />
    <EditText
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_x="160px"
        android:layout_y="50px" />
</AbsoluteLayout>
```



Screen Configurations

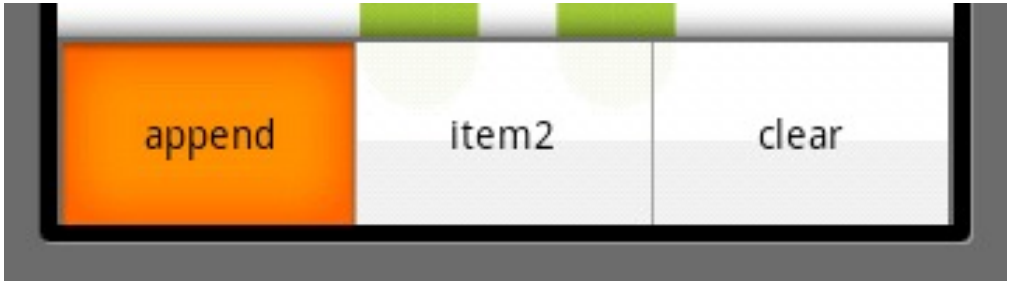
- Configurations
  - Portrait
  - Landscape
  - Square
- Different layouts for different configurations
  - Screen resolutions
- Configuration-specific resource subdirectories
  - /res/layout-port /res/drawable-port
  - /res/layout-land /res/drawable-land
  - /res/layout-square /res/drawable-square
  - /res/layout /res/drawable (default)

Menus

Menus

- An activity is associated with a single menu
- Use onCreateOptionsMenu(Menu m) to populate menu
- Creating an options menu

```
public boolean onCreateOptionsMenu(Menu menu) {
    super.onCreateOptionsMenu(menu);
    menu.add(0, 1, 0, "append"); // group, id, order, title
    menu.add(0, 2, 1, "item2");
    menu.add(0, 3, 2, "clear");
    return true; // return true to enable menu
}
```



Responding to Menu Selection

- Overriding onOptionsItemSelected

```
public boolean onOptionsItemSelected(MenuItem item) {
    Log.d("MainActivity", "menu id = " + item.getItemId() +
            ", title = " + item.getTitle().toString());
    switch (item.getItemId()) {
        case X: // id of handeled item
        // handle item X
        return true;
        ...
    }
}
```

Defining Menus in XML

- XML files in /res/menu
- /res/menu/menu1.xml

```
<menu ...>
<group android:id="@+id/menuGroup_Main">
    <item android:id="@+id/menu_clear"
      android:orderInCategory="10"
      android:title="clear" />
    <item android:id="@+id/menu_dial"
      android:orderInCategory="7"
      android:title="dial" />
  ...
</group>
</menu>
```

- Java

```
public boolean onCreateOptionsMenu(Menu menu) {
    getMenuInflater().inflate(R.menu.menu1, menu);
    return true;
}
```

Dialogs

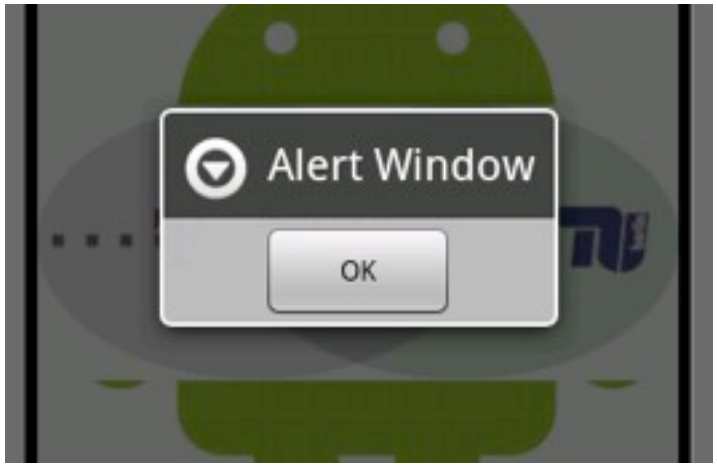
Alert Dialogs

- Alert dialog examples
  - Respond to prompt
  - Pick item or option from list
  - View progress
- Steps
  - Construct android.app.AlertDialog.Builder object
  - Set data (list of items) and parameters (e.g. number of buttons)
  - Set callback methods for buttons
  - Build and show the dialog

Example Alert Dialog

- Java

```
public boolean onOptionsItemSelected(MenuItem item) {
    if (item.getItemId() == R.id.menu_testPick) {
        AlertDialog.Builder builder = new AlertDialog.Builder(this);
        builder.setTitle("Alert Window");
        builder.setPositiveButton("OK", listener);
        AlertDialog ad = builder.create();
        ad.show();
        return true;
    }
    ...
}
```



Basic Graphics and Touch Input

Basic Graphics: Drawing

- Screen drawing in View.onDraw
- Canvas class for “draw” calls ← Graphics in Java SE
  - drawRect, drawLines, drawCircle, drawText, etc.
  - Transformation matrix
  - Clipping
- Paint class
  - Describes colors and drawing styles
  - Examples: anti-aliasing, stroke width, text size, etc.
- Bitmap class for offscreen drawing
  - Explicit creation of canvas and bitmap
  - Canvas draws into the bitmap

Method View.onDraw

```
public class MyView extends View {
    private final Rect rect = new Rect();
    private final Paint paint = new Paint();

    public MyView(Context c) {
        super(c);
        paint.setAntiAlias(false);
        paint.setARGB(255, 255, 255, 255);
    }

    protected void onDraw(Canvas c) {
        rect.set(10, 10, 310, 20);
        c.drawRect(rect, paint);
    }
    ...
```

Touch Input: MotionEvent

- Method View.onTouchEvent(MotionEvent e)
- Motion event data
  - x, y, time, action, source, pressure, size
- Sources depend on hardware
  - Mouse, pen, finger, trackball
- Actions
  - ACTION_DOWN
  - ACTION_MOVE
  - ACTION_UP
  - ACTION_CANCEL
- Motion history
  - Sequence of coordinates between events

Touch Input Painting

```
public class TouchPaint extends Activity {

    private MyView myView;

    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        myView = new MyView(this);
        setContentView(myView);
    }
}
```

Touch Input Painting

```
public class MyView extends View {
    private final Paint paint = new Paint();
    private int x = 0, y = 0;

    public MyView(Context c) {
        super(c);
        paint.setARGB(255, 255, 255, 255);
    }

    protected void onDraw(Canvas c) {
        c.drawCircle(x, y, 3, paint);
    }

    public boolean onTouchEvent(MotionEvent e) {
        x = (int)e.getX(); y = (int)e.getY();
        invalidate();
        return true;
    }
}
```

Touch Input Painting (Off-Screen Image)

```
public class MyView extends View {
...
private Bitmap bitmap;
private Canvas canvas;
protected void onSizeChanged(int w, int h, int oldw, int oldh) {
    bitmap = Bitmap.createBitmap(w, h, Bitmap.Config.RGB_565);
    canvas = new Canvas(bitmap);
}
protected void onDraw(Canvas c) {
    if (bitmap != null) c.drawBitmap(bitmap, 0, 0, null);
}
public boolean onTouchEvent(MotionEvent e) {
    if (canvas != null) {
        int x = (int)e.getX(); int y = (int)e.getY();
        canvas.drawCircle(x, y, 3, paint);
        invalidate();
    }
    return true;
}   }
```