What else can you do with Android?

Making use of Android

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Overview

- Creating a project
- Writing the app
- Writing native code libraries
- Other native code

Create a project

- Android build system requires a particular layout
- Use the android command or Eclipse ADT
  - Giving the target, class name (Hello), initial activity (HelloWorld) and package name (domain name):

```
android create project --target 1 --name Hello \
--path ./helloworld --activity HelloWorld \
--package com.example.HelloWorld
```

This is what you get

```
`-- helloworld
    |-- AndroidManifest.xml
    |-- bin
    |-- build.properties
    |-- build.xml
    |-- default.properties
    |-- libs
    |-- local.properties
    |-- res
    |   |-- drawable-hdpi
    |   |   `-- icon.png
    |   |-- drawable-ldpi
    |   |   `-- icon.png
    |   |-- drawable-mdpi
    |   |   `-- icon.png
    |   |-- layout
    |   |   `-- main.xml
    |   `-- values
    |       `-- strings.xml
    `-- src
        `-- com
            `-- example
                `-- HelloWorld
                    `-- HelloWorld.java
```

Display icon in 3 resolutions

Java source code

HelloWorld.java

This code is generated for you:

```
package com.example.HelloWorld;

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

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

A hello world app

It is easy to make it print a message:

```
package com.example.HelloWorld;

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

public class HelloWorld extends Activity
{
    /** Called when the activity is first created. */
    @Override
    public void onCreate(Bundle savedInstanceState)
    {
        super.onCreate(savedInstanceState);
        TextView tv = new TextView(this);
        tv.setText("Life, don't talk to me about life");
        setContentView(tv);
    }
}
```

Build

- Build using *ant*, a tool similar to *make*
  - The options are *debug* or *release*

```
$ ant debug
Buildfile: build.xml
...
BUILD SUCCESSFUL
Total time: 1 second
```

Install

- Install on the target using adb
  - The -r option replaces any existing version

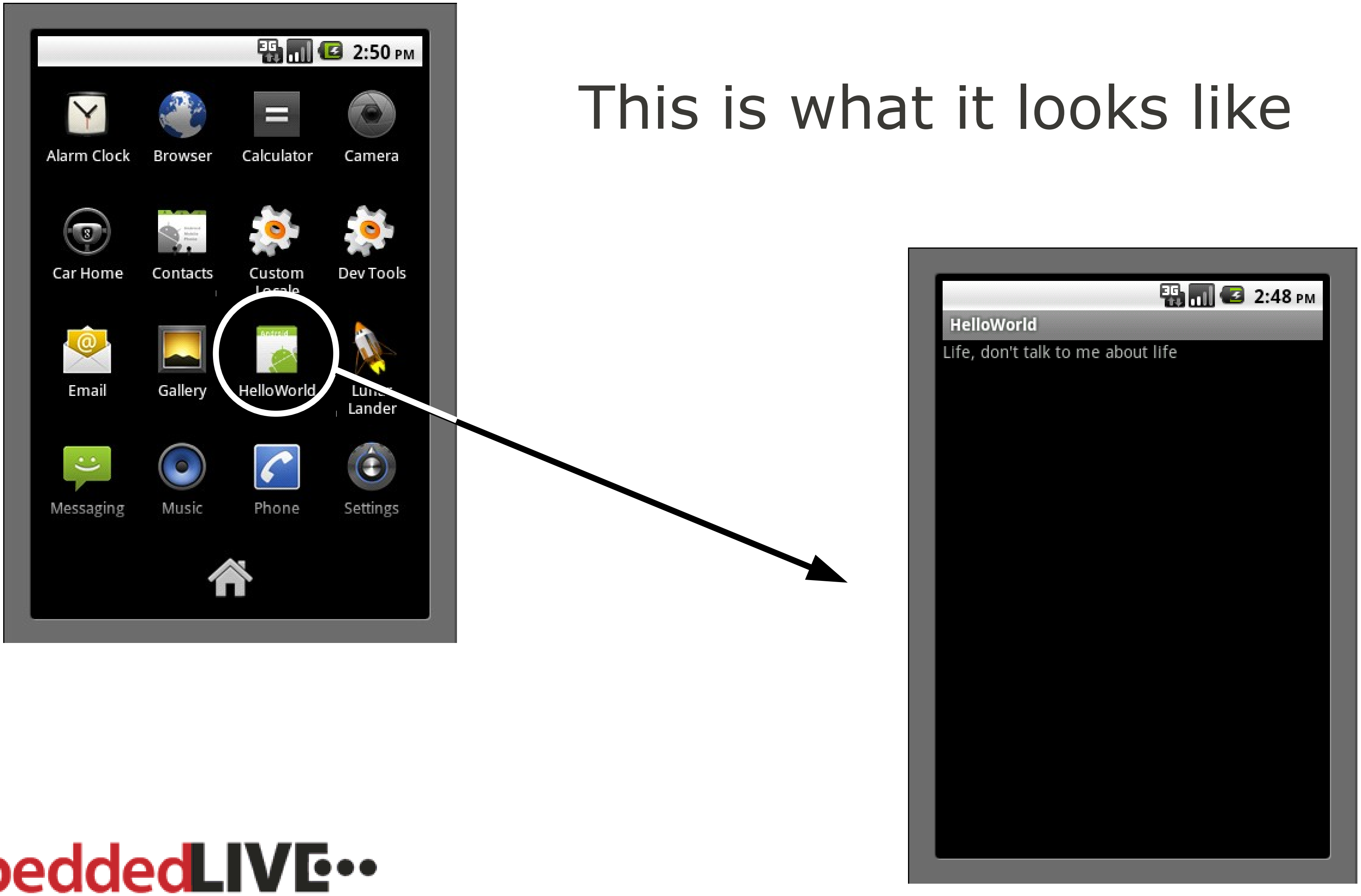
```
$ adb install -r bin/Hello-debug.apk
217 KB/s (13335 bytes in 0.059s)
    pkg: /data/local/tmp/Hello-debug.apk
Success
```

- Note: you can remove the app entirely with adb uninstall and the Java class

```
$ adb uninstall com.example.HelloWorld
Success
```

Test

This is what it looks like



HelloWorld

Life, don't talk to me about life

Dalvik: processes and users

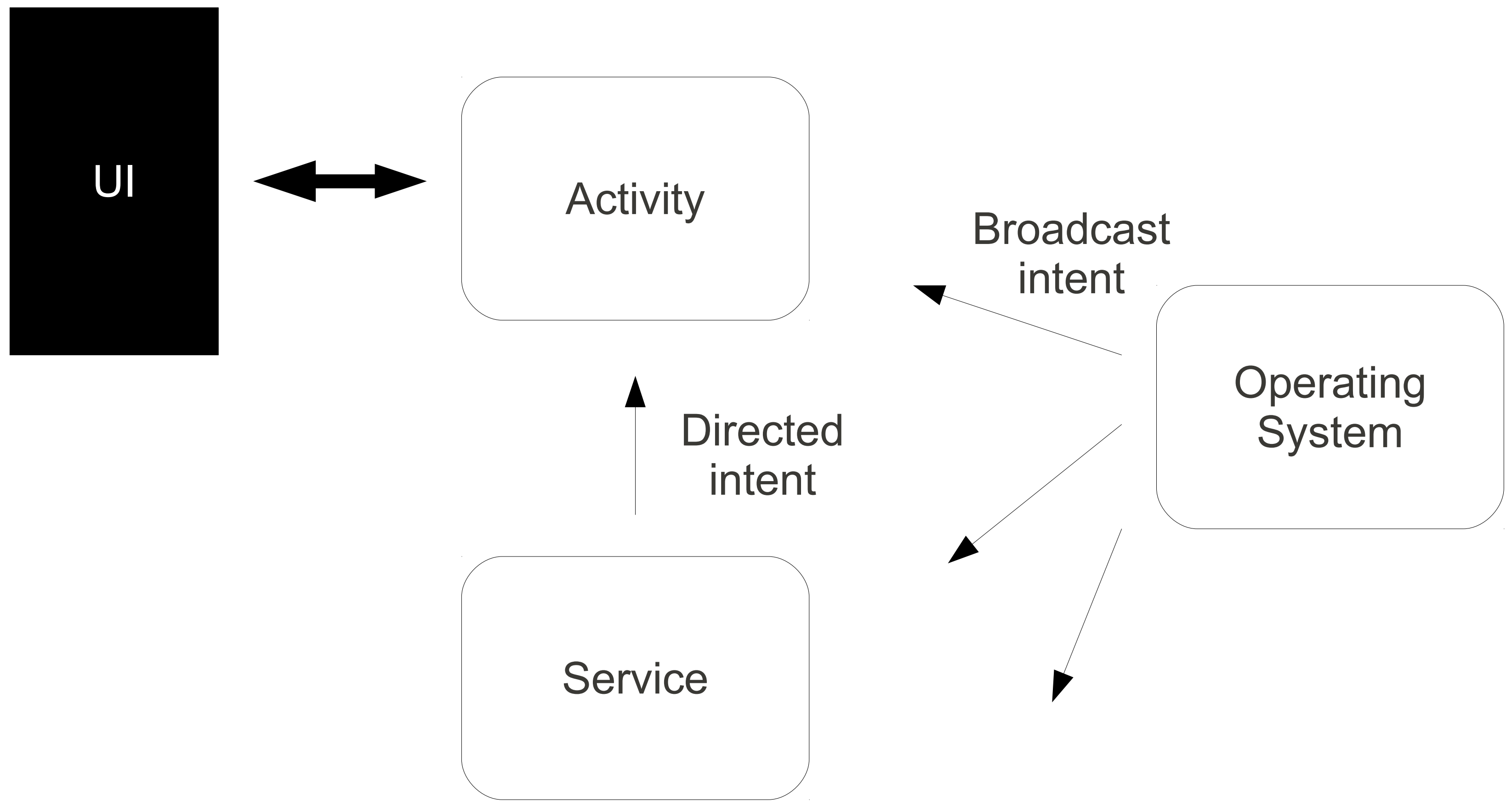
- Each app runs in separate process with a unique user name

```
# ps
USER     PID   PPID  VSIZE  RSS     WCHAN    PC         NAME
root      1     0     296    204   c009b74c 0000ca4c S /init

<snip>

app_9     193   32    108460 17624 ffffffff afd0eb08 S android.process.media
app_26    203   32    119608 18072 ffffffff afd0eb08 S com.android.mms
app_18    220   32    110136 18520 ffffffff afd0eb08 S com.android.email
app_5     228   32    105844 16368 ffffffff afd0eb08 S com.android.protips
app_6     259   32    106260 17624 ffffffff afd0eb08 S com.example.HelloWorld
root      265   252   892    336   00000000 afd0d8ac R ps
#
```

Activities, services and intents



Activities, services and intents

- Activity: process with user interface
- Service: process without a user interface
- Intent: notification from one process to another
  - directed intent: has one specific recipient
  - broadcast intent: can be received by anyone
  - intent filter: a list of intents an activity/service is interested in

Native code

- Java Native Interface: JNI
  - allows Java code to call C/C++ functions
- The Android Native Development Kit, NDK contains the tools to create libraries of functions that are called from Java

Installing the NDK

- Download from
  - http://developer.android.com/sdk/ndk/index.html
- Extract to a local directory
- The next few slides show the simplest example of calling a native method: the HelloJni sample code

The C code

- This is a C function that returns a string

```
#include <string.h>
#include <jni.h>

jstring
Java_com_example_hellojni_HelloJni_stringFromJNI( JNIEnv* env,
                                                  jobject thiz )
{
    return (*env)->NewStringUTF(env, "Hello from JNI !");
}
```

The Java code

```
package com.example.hellojni;

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

public class HelloJni extends Activity
{
    @Override
    public void onCreate(Bundle savedInstanceState)
    {
        super.onCreate(savedInstanceState);
        TextView  tv = new TextView(this);
        tv.setText( stringFromJNI() );
        setContentView(tv);
    }

    public native String  stringFromJNI();

    static {
        System.loadLibrary("hello-jni");
    }
}
```

Build

- You build the native code using the ndk-build script (a small wrapper round make):

```
$ ~/android-ndk-r4b/ndk-build
Gdbserver      : [arm-eabi-4.4.0] /home/chris/projects/android-2.2/android-
ndk-r4b/my-samples/hello-jni/libs/armeabi/gdbserver
Gdbsetup       : /home/chris/projects/android-2.2/android-ndk-r4b/my-
samples/hello-jni/libs/armeabi/gdb.setup
Gdbsetup       : + source directory /home/chris/projects/android-2.2/android-
ndk-r4b/my-samples/hello-jni/jni
Compile thumb  : hello-jni <= /home/chris/projects/android-2.2/android-ndk-
r4b/my-samples/hello-jni/jni/hello-jni.c
SharedLibrary  : libhello-jni.so
Install        : libhello-jni.so => /home/chris/projects/android-2.2/android-
ndk-r4b/my-samples/hello-jni/libs/armeabi
```

Incorporate into a project

- The ndk sample code does not include all the project files
- You need to create a project with the appropriate name and Java class
- Build and install as before
  - details in the handout in section 3.

Installed files

Three files are installed this time

The package:

```
/data/app/com.example.HelloJni.apk
```

The dex (compiled Java) file:

```
/data/dalvik-cache/data@app@com.example.HelloJni.apk@classes.dex
```

The library:

```
/data/data/com.example.HelloJni/lib/libhello-jni.so
```

Officially-sanctioned native libraries

- These libraries form a stable API that should be on all Android platforms:

Library	Header	API level	Notes
libc	stdlib.h, etc	3	“Bionic” C library
libpthread	pthread.h	3	Simplified threads
libm	math.h	3	Maths library
libstdc++	cstddef, etc	3	Minimal C++. No exceptions or RTTI
liblog	android/log.h	3	Logging
libz	zlib.h	3	Compression
libdl	dlfcn.h	3	Dynamic linker library
libGLESv1	GLES/gl.h	4	OpenGL ES 1.x rendering
libGLESv2	GLES2/gl2.h	5	OpenGL ES 2.0 rendering
libjnigraphics	android/bitmap.h	8	Access Java bitmap objects

Adding your own libraries

- Should you want to use a library not on the official list, then
- It may be part of the build already
  - e.g. libsqlite, libjpeg
- Otherwise you will have to cross-compile using the Android tool chain
  - Outside the scope of this presentation

Integrating non-Android C/C++ code

- For example some kind of middle-ware
- Cross-compiling for Android is hard because
  - bionic is not a standard libc
  - limited libsdtcc++
  - limited selection of other libraries
- Two other options
  - static link - no library dependencies
  - chroot - create your own root for your program

Using a chroot

To launch *myprog* with root = /data/myroot

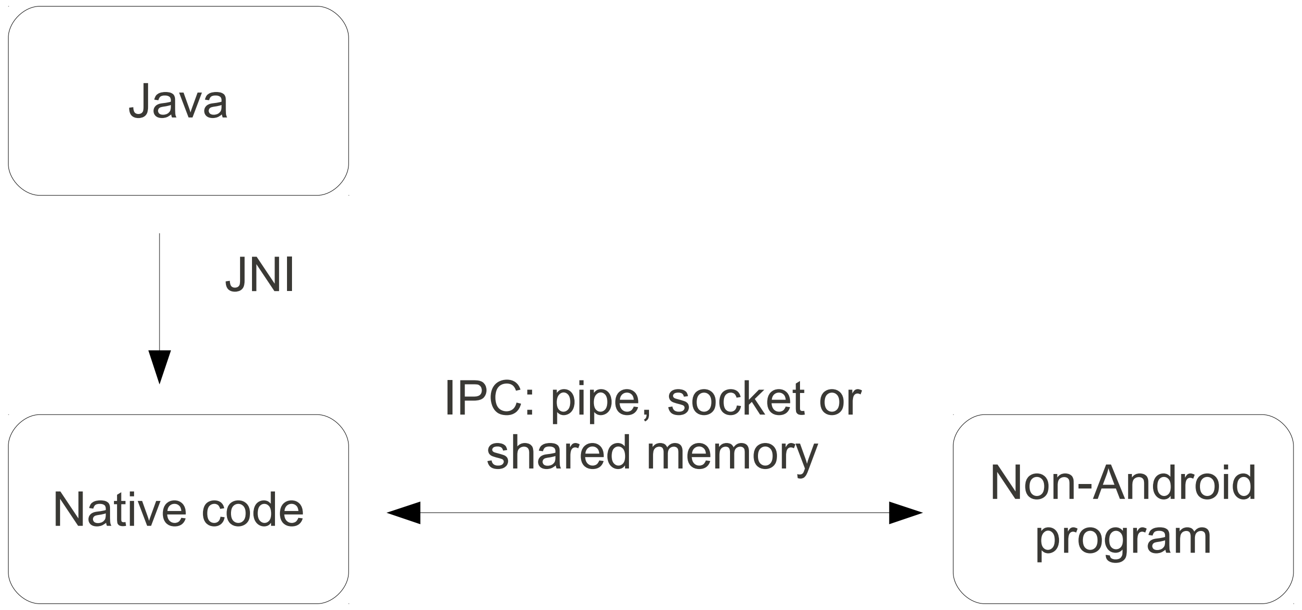
```
chroot /data/myroot /bin/myprog
```

```
      /data/myroot
             |
             |- /bin/myprog
             |- /etc/my.conf
             |- /lib/libmylibs.so
             |- /proc
```

Note that the chroot command is not in Android. You could use busybox or write your own simplified chroot

Communicating with non-Android code

- Non-Android code cannot communicate with Java code via JNI
- Have to use another form of IPC:



Summary

- Android applications are written in Java which is compiled into a Dalvik executable and packaged for the target
- The principle event mechanism is the intent
  - Activities and services can listen for intents
- Java code can call C/C++ functions in shared libraries by using the NDK