Android Programming

Wirtschaftsinformatik Skiseminar
ao. Prof. Dr. Rony G. Flatscher

Seminar paper presentation

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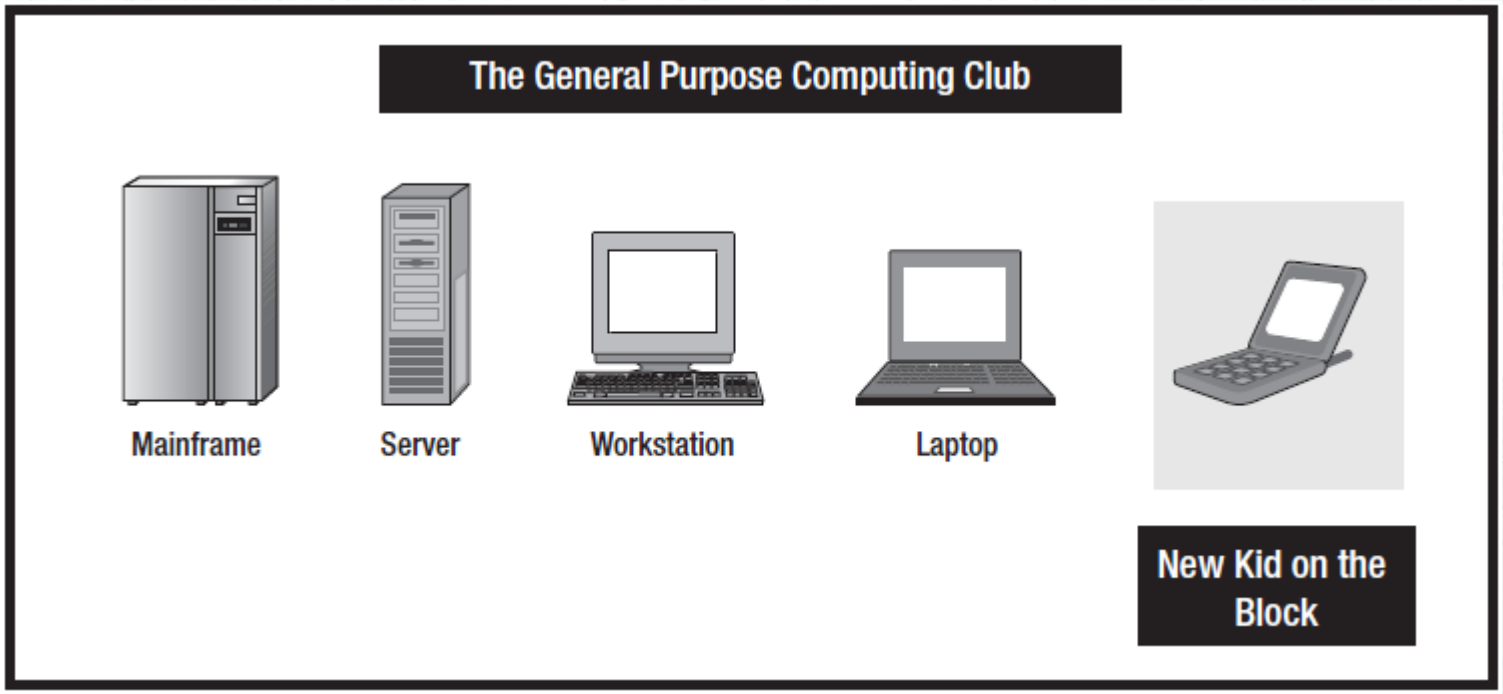
Agenda

- Introduction
- Basics of Android
- Development environment
- Programming

General-Purpose Computing

- Although built for mobile devices, the Android platform exhibits the characteristics of a full-featured desktop framework
- You rarely feel that you are writing to a mobile device when working with the Android SDK
  - ...because you have access to most of the class libraries that you use on a desktop/server (e.g. a relative database)



Source: S. Hashimi, S. Komatineni, D. MacLean:
Pro Android 2, Apress, 2010, ISBN: 9781430226604

Language

- JAVA (1.5) and some commonly used libraries (e.g. Apache Commons API)
- Except AWT/Swing – Android has its own UI framework
- Development framework in which the programs need to run in order to be „good citizens“
- Dalvik Virtual Machine
  - Optimized for low memory, multiple VM instances to run at once
  - Bytecode is not Java bytecode

Language

- All Java intrinsic types are supported: **byte**, **char**, **short**, **int**, **long**, **float**, **double**, **Object**, **String**
  - Floating point may be emulated on low-end hardware
- Multiple threads supported by time slicing
- Dalvik VM implements the **synchronized** keyword and synchronization-related library methods
  - Object.wait(), Object.notify(), Object.notifyAll()

Language

Not supported (excerpt):

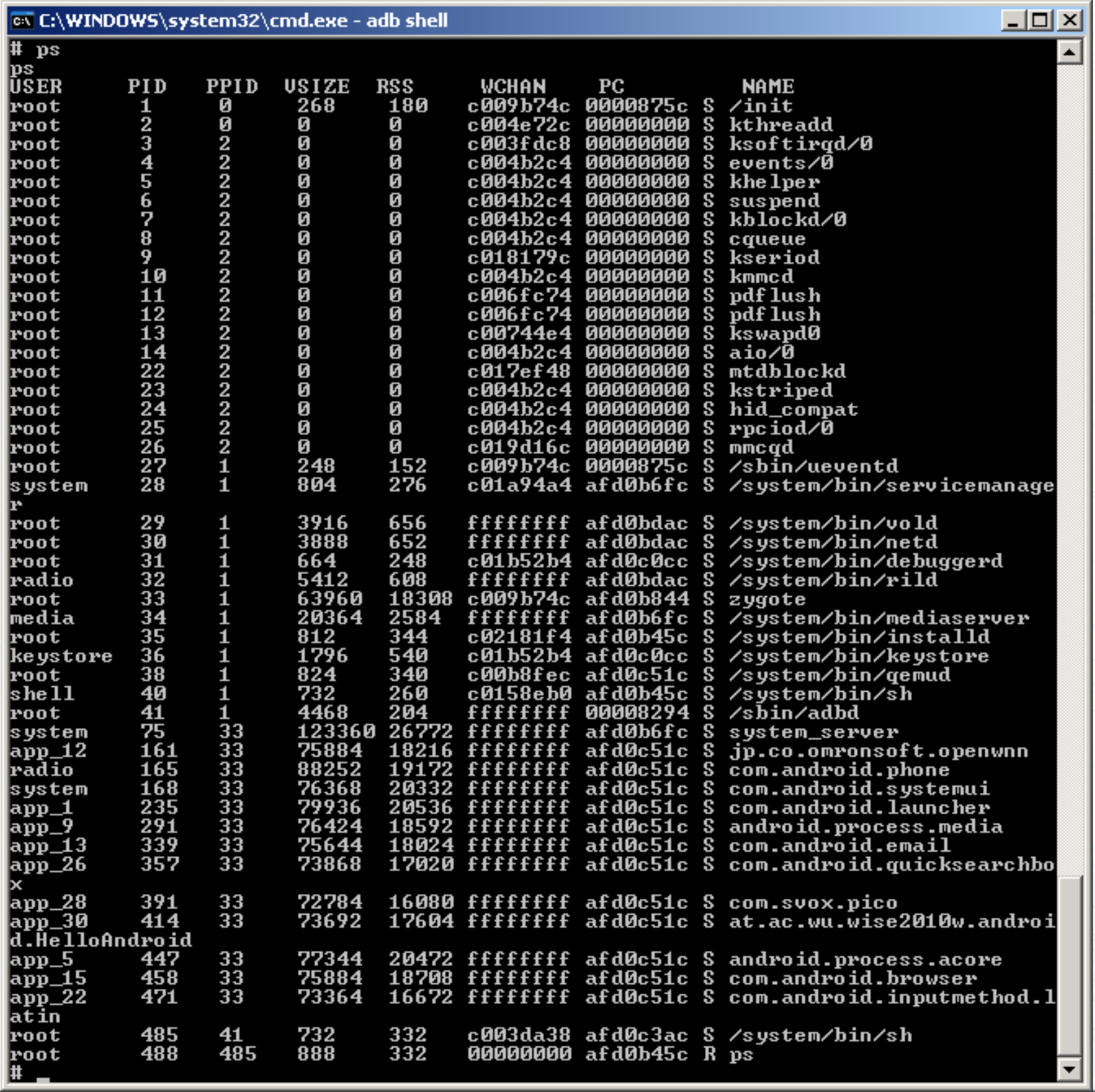
- java.applet
- java.awt
- java.lang.management
- javax.imageio
- javax.print
- javax.sound
- javax.swing
- javax.xml (except javax.xml.parsers)

Challenges

- Not tying up the CPU (calls can't be received)
- Not quietly fading into the background (e.g. when a call comes in)
- Crashing the phone's OS (e.g. by leaking memory)

Android Architecture

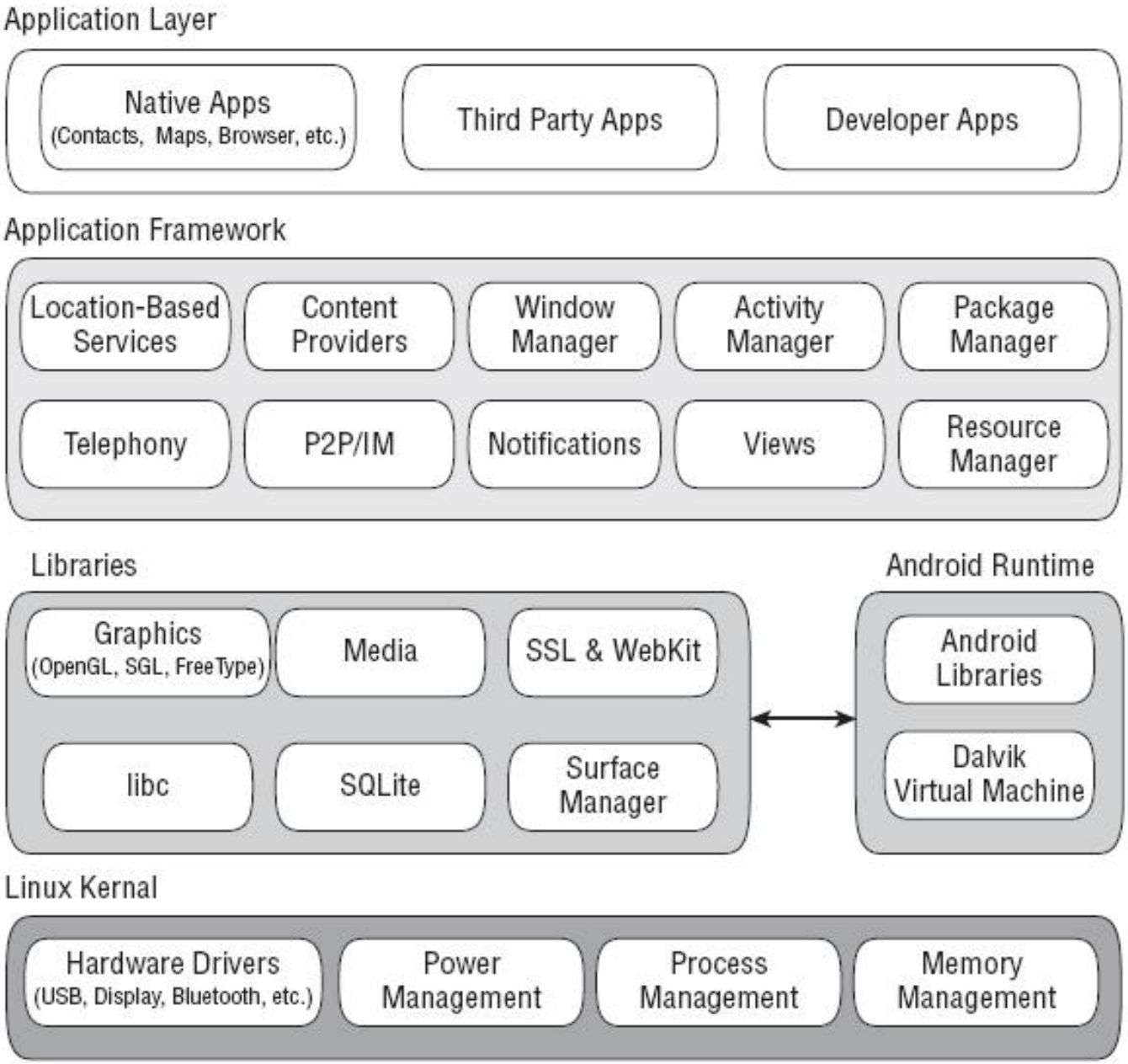
- An application runs in its own Linux process
- Each process has its own Virtual Machine (VM) and therefore runs in isolation
- Unique Linux user ID for each application


C:\WINDOWS\system32\cmd.exe - adb shell
ps
ps
USER PID PPID VSIZE RSS WCHAN PC NAME
root 1 0 268 180 c009b74c 0000875c S /init
root 2 0 0 0 c004e72c 00000000 S kthreadd
root 3 2 0 0 c003fdc8 00000000 S ksoftirqd/0
root 4 2 0 0 c004b2c4 00000000 S events/0
root 5 2 0 0 c004b2c4 00000000 S khelper
root 6 2 0 0 c004b2c4 00000000 S suspend
root 7 2 0 0 c004b2c4 00000000 S kblockd/0
root 8 2 0 0 c004b2c4 00000000 S cqueue
root 9 2 0 0 c018179c 00000000 S kseriod
root 10 2 0 0 c004b2c4 00000000 S kmmcd
root 11 2 0 0 c006fc74 00000000 S pdflush
root 12 2 0 0 c006fc74 00000000 S pdflush
root 13 2 0 0 c00744e4 00000000 S kswapd0
root 14 2 0 0 c004b2c4 00000000 S aio/0
root 22 2 0 0 c017ef48 00000000 S mtdblockd
root 23 2 0 0 c004b2c4 00000000 S kstriped
root 24 2 0 0 c004b2c4 00000000 S hid_compat
root 25 2 0 0 c004b2c4 00000000 S rpciod/0
root 26 2 0 0 c019d16c 00000000 S mmcqd
root 27 1 248 152 c009b74c 0000875c S /sbin/ueventd
system 28 1 804 276 c01a94a4 afd0b6fc S /system/bin/servicemanage
r
root 29 1 3916 656 ffffffff afd0bdac S /system/bin/vold
root 30 1 3888 652 ffffffff afd0bdac S /system/bin/netd
root 31 1 664 248 c01b52b4 afd0c0cc S /system/bin/debuggerd
radio 32 1 5412 608 ffffffff afd0bdac S /system/bin/rild
root 33 1 63960 18308 c009b74c afd0b844 S zygote
media 34 1 20364 2584 ffffffff afd0b6fc S /system/bin/mediaserver
root 35 1 812 344 c02181f4 afd0b45c S /system/bin/installd
keystore 36 1 1796 540 c01b52b4 afd0c0cc S /system/bin/keystore
root 38 1 824 340 c00b8fec afd0c51c S /system/bin/qemud
shell 40 1 732 260 c0158eb0 afd0b45c S /system/bin/sh
root 41 1 4468 204 ffffffff 00008294 S /sbin/adbd
system 75 33 123360 26772 ffffffff afd0b6fc S system_server
app_12 161 33 75884 18216 ffffffff afd0c51c S jp.co.omronsoft.openwnn
radio 165 33 88252 19172 ffffffff afd0c51c S com.android.phone
system 168 33 76368 20332 ffffffff afd0c51c S com.android.systemui
app_1 235 33 79936 20536 ffffffff afd0c51c S com.android.launcher
app_9 291 33 76424 18592 ffffffff afd0c51c S android.process.media
app_13 339 33 75644 18024 ffffffff afd0c51c S com.android.email
app_26 357 33 73868 17020 ffffffff afd0c51c S com.android.quicksearchbo
x
app_28 391 33 72784 16080 ffffffff afd0c51c S com.svox.pico
app_30 414 33 73692 17604 ffffffff afd0c51c S at.ac.wu.wise2010w.androi
d.HelloAndroid
app_5 447 33 77344 20472 ffffffff afd0c51c S android.process.acore
app_15 458 33 75884 18708 ffffffff afd0c51c S com.android.browser
app_22 471 33 73364 16672 ffffffff afd0c51c S com.android.inputmethod.l
atin
root 485 41 732 332 c003da38 afd0c3ac S /system/bin/sh
root 488 485 888 332 00000000 afd0b45c R ps
#

Android Architecture

- Central feature: One application can make use of elements of other applications
- System/Android must be able to start an application process when any part of it is needed
- Therefore, Android applications do not have a single entry point (e.g. no main() method)

Android Software Stack

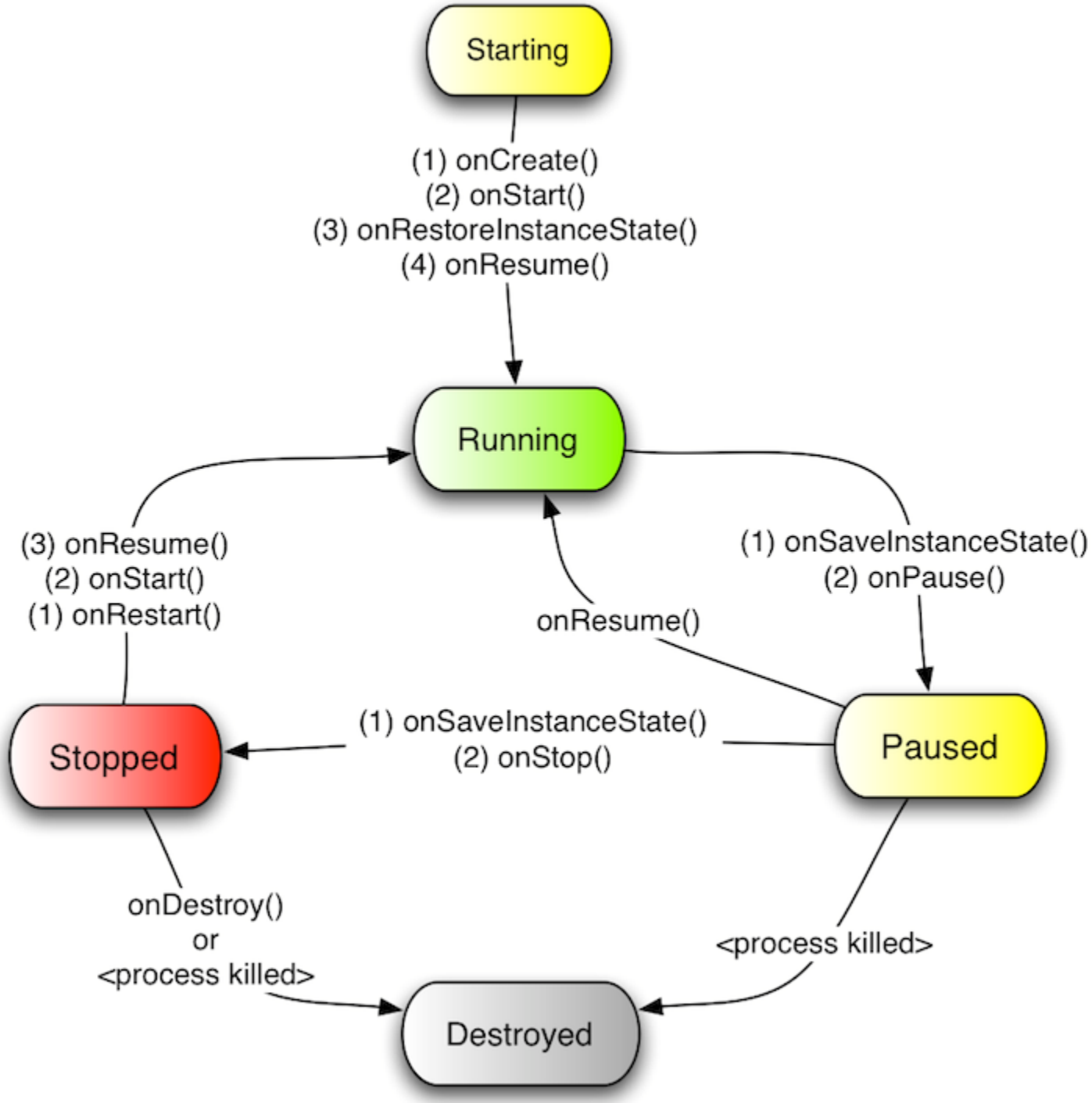


Source: http://mobileorchard.com/wp-content/uploads/2010/11/Android_Software_stack.jpg, as of January 17th, 2011

Building Blocks of an Application

- Activity
- Intent
- Service
- Content Provider
- Broadcast Receiver

Source: http://www.vogella.de/articles/AndroidIntent/article.html, as of January 17th, 2011

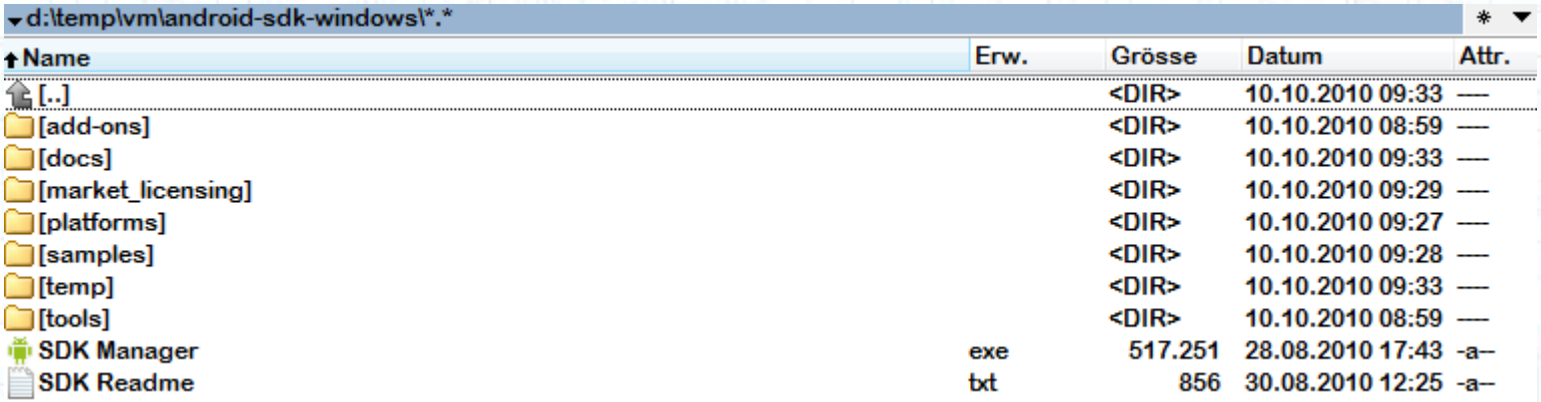


Source: http://ofps.oreilly.com/static/titles/9781449390501/images/04-ActivityLifecycle.png, as of January 17th, 2011

Android SDK

- http://developer.android.com/sdk/index.html

Platform	Package	Size	MD5 Checksum
Windows	android-sdk_r07-windows.zip	23669664 bytes	69c40c2d2e408b623156934f9ae574f0
Mac OS X (intel)	android-sdk_r07-mac_x86.zip	19229546 bytes	0f330ed3ebb36786faf6dc72b8acf819
Linux (i386)	android-sdk_r07-linux_x86.tgz	17114517 bytes	e10c75da3d1aa147ddd4a5c58bfc3646



Android SDK

d:\temp\vm\android-sdk-windows\platforms*.*

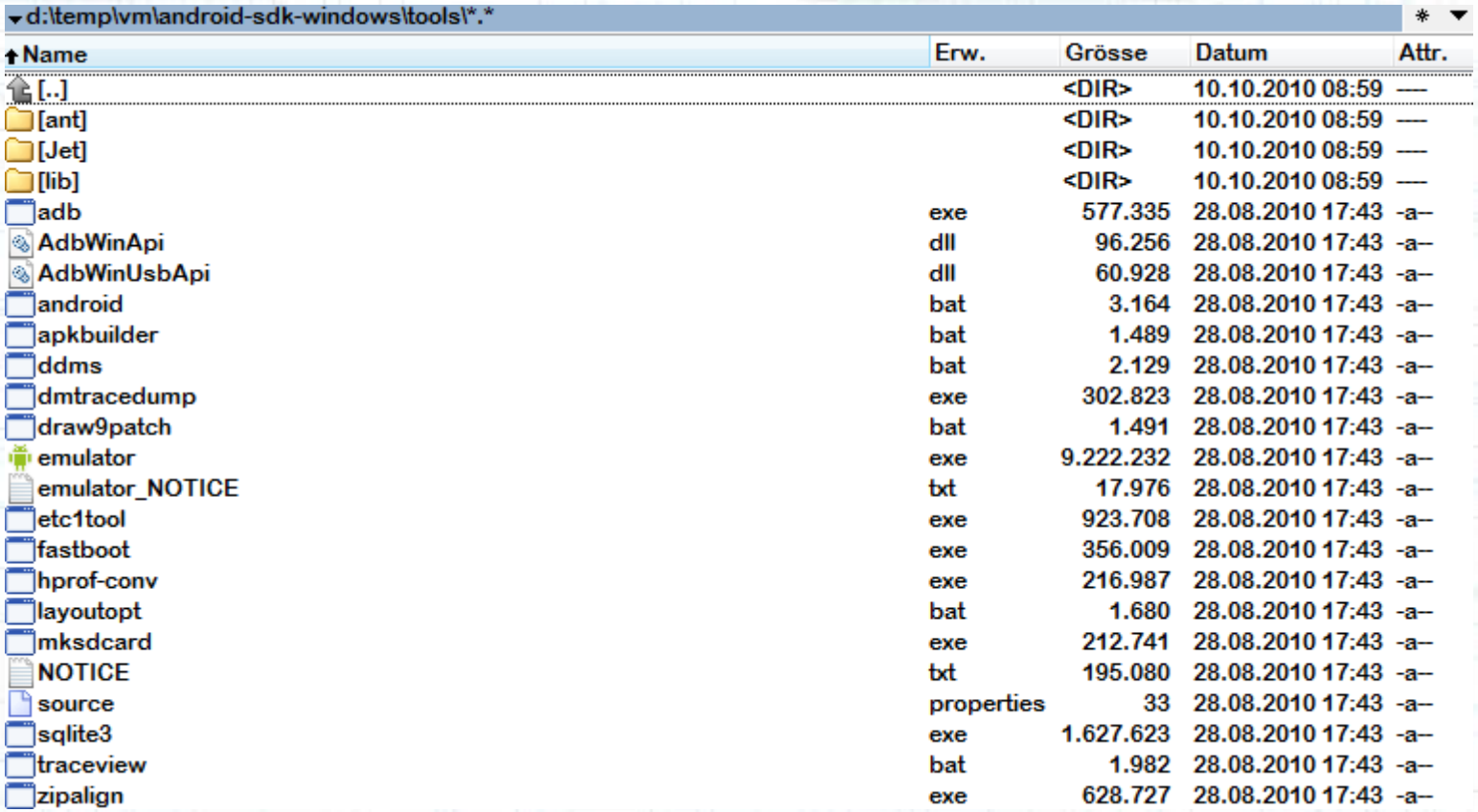
Name
[..]
[android-2]
[android-3]
[android-4]
[android-5]
[android-6]
[android-7]
[android-8]

d:\temp\vm\android-sdk-windows\platforms\android-2*.*

Name	Erw.	Grösse	Datum	Attr.
[..]		<DIR>	10.10.2010 09:27	----
[data]		<DIR>	10.10.2010 09:27	----
[images]		<DIR>	10.10.2010 09:27	----
[samples]		<DIR>	10.10.2010 09:27	----
[skins]		<DIR>	10.10.2010 09:27	----
[templates]		<DIR>	10.10.2010 09:27	----
[tools]		<DIR>	10.10.2010 09:27	----
android	jar	2.810.669	10.10.2010 09:26	-a--
build	prop	1.165	10.10.2010 09:27	-a--
framework	aidl	1.608	10.10.2010 09:27	-a--
source	properties	390	10.10.2010 09:27	-a--

Android SDK

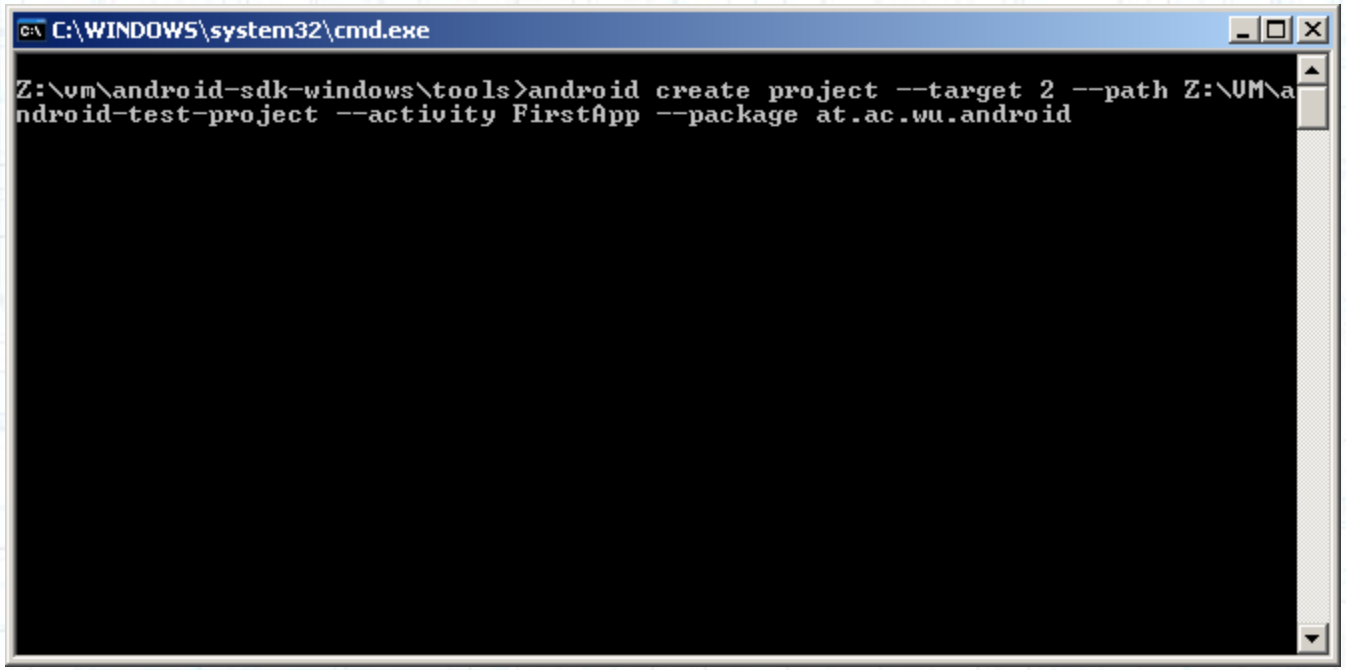
- Build tools



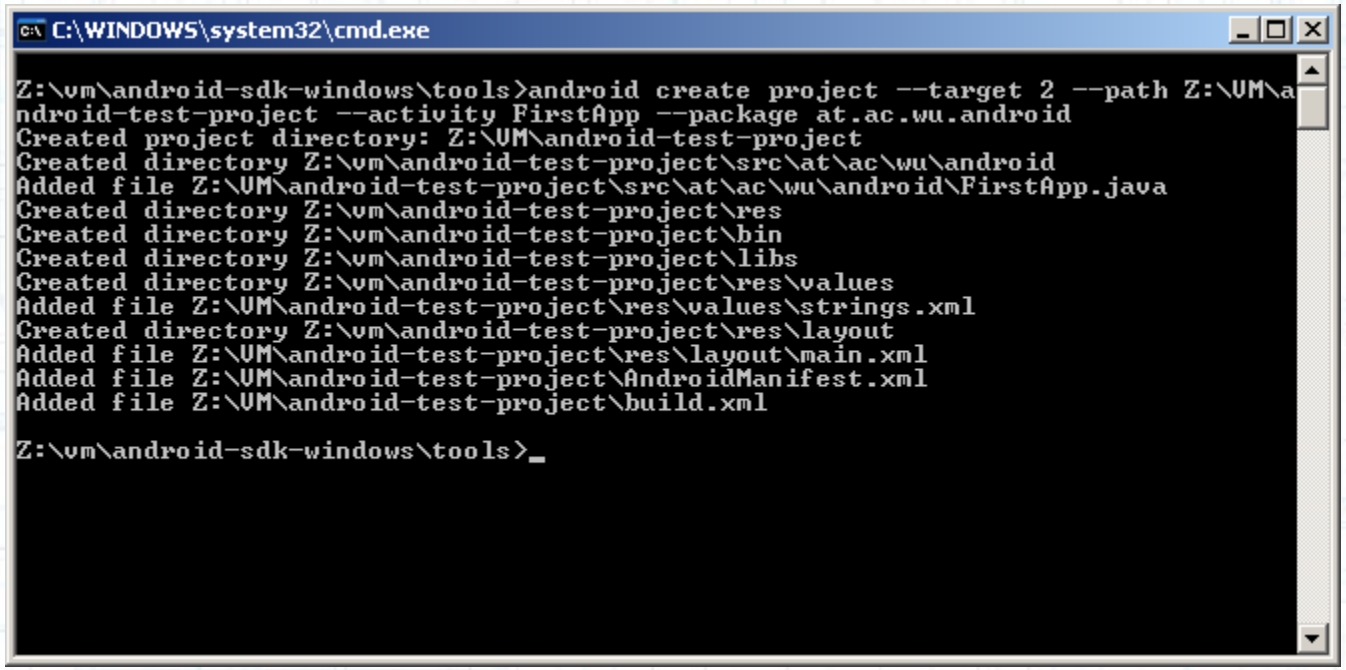
d:\temp\vm\android-sdk-windows\tools*.*

Name	Erw.	Grösse	Datum	Attr.
[..]		<DIR>	10.10.2010 08:59	----
[ant]		<DIR>	10.10.2010 08:59	----
[Jet]		<DIR>	10.10.2010 08:59	----
[lib]		<DIR>	10.10.2010 08:59	----
adb	exe	577.335	28.08.2010 17:43	-a--
AdbWinApi	dll	96.256	28.08.2010 17:43	-a--
AdbWinUsbApi	dll	60.928	28.08.2010 17:43	-a--
android	bat	3.164	28.08.2010 17:43	-a--
apkbuilder	bat	1.489	28.08.2010 17:43	-a--
ddms	bat	2.129	28.08.2010 17:43	-a--
dmtracedump	exe	302.823	28.08.2010 17:43	-a--
draw9patch	bat	1.491	28.08.2010 17:43	-a--
emulator	exe	9.222.232	28.08.2010 17:43	-a--
emulator_NOTICE	txt	17.976	28.08.2010 17:43	-a--
etc1tool	exe	923.708	28.08.2010 17:43	-a--
fastboot	exe	356.009	28.08.2010 17:43	-a--
hprof-conv	exe	216.987	28.08.2010 17:43	-a--
layoutopt	bat	1.680	28.08.2010 17:43	-a--
mksdcard	exe	212.741	28.08.2010 17:43	-a--
NOTICE	txt	195.080	28.08.2010 17:43	-a--
source	properties	33	28.08.2010 17:43	-a--
sqlite3	exe	1.627.623	28.08.2010 17:43	-a--
traceview	bat	1.982	28.08.2010 17:43	-a--
zipalign	exe	628.727	28.08.2010 17:43	-a--

Creating a New Project



Creating a New Project



Project Directory

AndroidManifest	xml	620	10.10.2010 14:57 -a--
build	properties	833	10.10.2010 14:57 -a--
build	xml	3.287	10.10.2010 14:57 -a--
default	properties	364	10.10.2010 14:57 -a--
FirstApp	java	356	10.10.2010 14:57 -a--
local	properties	420	10.10.2010 14:57 -a--
main	xml	404	10.10.2010 14:57 -a--
strings	xml	114	10.10.2010 14:57 -a--

Eclipse

- Eclipse: IDE („software dev. environment“)
  - Developed for Java in Java
    - Ancestor: IBM Vistual Age (2001)
  - **Open-source** and **platform-independent**
  - **Widely developed** and **adopted**
  - Highly modular, extensible via **plugins**
    - From version 3.0 on Eclipse is only the core, which loads all the plugins
  - Uses SWT (developed by IBM for Eclipse)

Compare Packages | Older Versions | **Eclipse Helios (3.6.1) Packages** for Windows

Eclipse IDE for Java Developers, 99 MB
Downloaded 594,157 Times Details
Windows 32 Bit
Windows 64 Bit

Eclipse Classic 3.6.1, 170 MB
Downloaded 447,464 Times Details Other Downloads
Windows 32 Bit
Windows 64 Bit

Eclipse IDE for Java EE Developers, 206 MB
Downloaded 380,087 Times Details
Windows 32 Bit
Windows 64 Bit

Eclipse IDE for C/C++ Developers, 88 MB
Downloaded 171,902 Times Details
Windows 32 Bit
Windows 64 Bit

Eclipse for PHP Developers, 141 MB
Downloaded 86,226 Times Details
Windows 32 Bit
Windows 64 Bit

Eclipse IDE for JavaScript Web Developers, 108 MB
Downloaded 25,888 Times Details
Windows 32 Bit
Windows 64 Bit

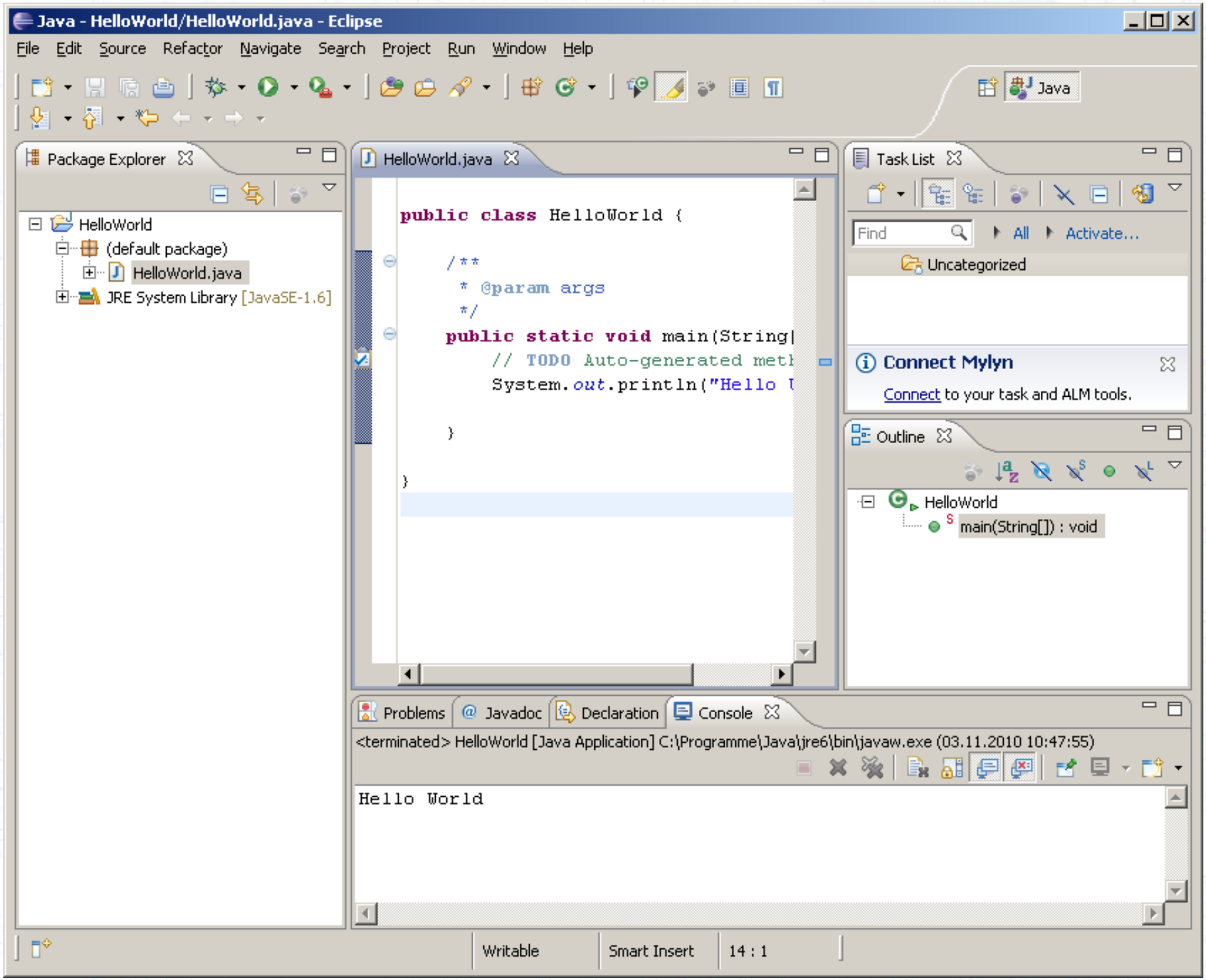
Eclipse Modeling Tools (includes Incubating components), 249 MB
Downloaded 19,857 Times Details
Windows 32 Bit
Windows 64 Bit

Pulsar for Mobile Developers, 122 MB
Downloaded 15,125 Times Details
Windows 32 Bit
Windows 64 Bit

Eclipse IDE for Java and Report Developers, 241 MB
Downloaded 14,521 Times Details
Windows 32 Bit
Windows 64 Bit

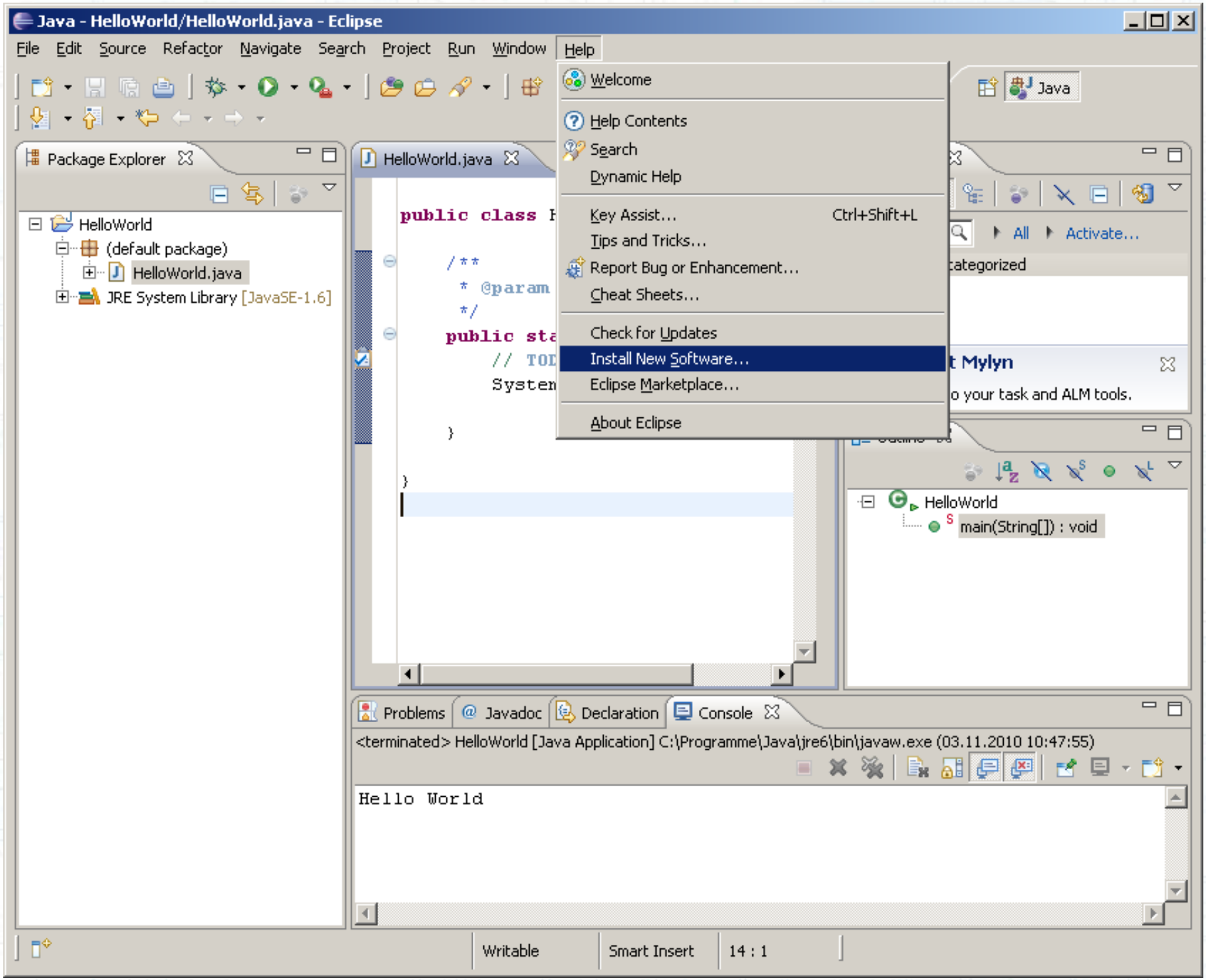
Eclipse for RCP and RAP Developers, 188 MB
Downloaded 11,718 Times Details
Windows 32 Bit
Windows 64 Bit

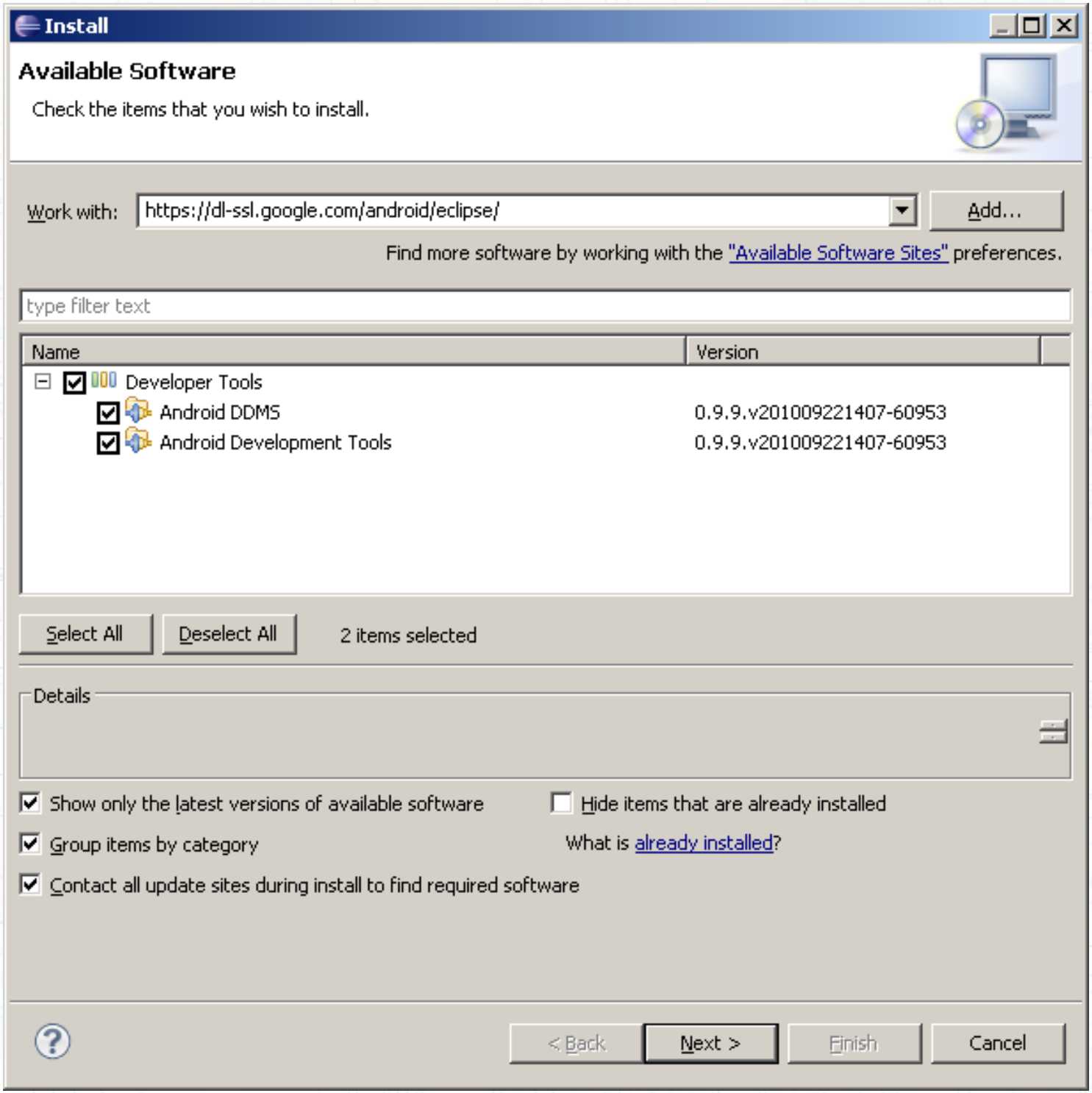
Eclipse SOA Platform for Java and SOA Developers (includes Incubating components), 188 MB
Downloaded 0 Times Details
Windows 32 Bit
Windows 64 Bit


Java - HelloWorld/HelloWorld.java - Eclipse
File Edit Source Refactor Navigate Search Project Run Window Help
Java
Package Explorer
HelloWorld
(default package)
HelloWorld.java
JRE System Library [JavaSE-1.6]
HelloWorld.java
public class HelloWorld {
/**
* @param args
*/
public static void main(String
// TODO Auto-generated meth
System.out.println("Hello
}
}
Task List
Find
All
Activate...
Uncategorized
Connect Mylyn
Connect to your task and ALM tools.
Outline
HelloWorld
main(String[]) : void
Problems
Javadoc
Declaration
Console
<terminated> HelloWorld [Java Application] C:\Programme\Java\jre6\bin\javaw.exe (03.11.2010 10:47:55)
Hello World
Writable
Smart Insert
14 : 1

Installing the ADT Plugin

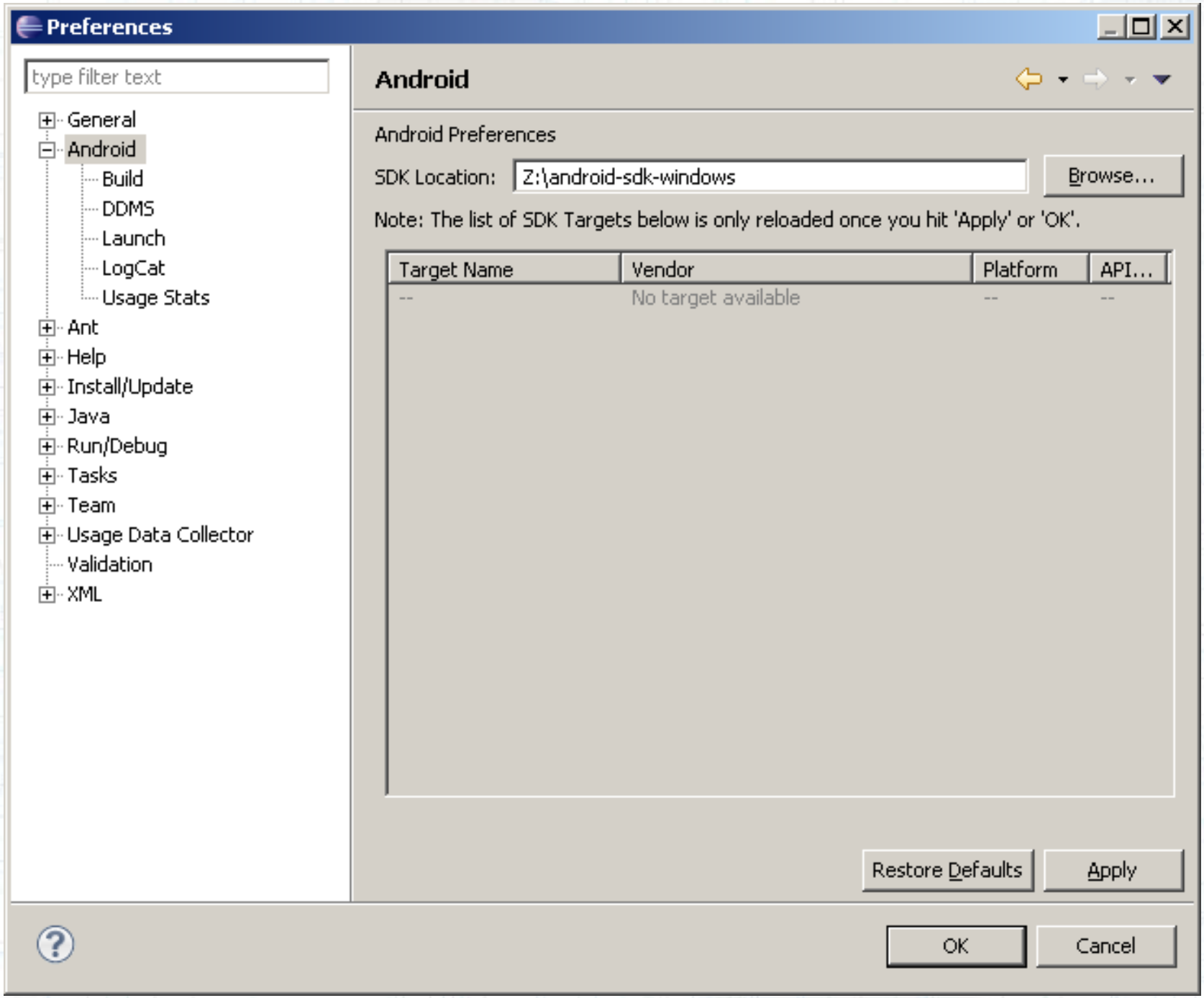
- Start Eclipse
- Help > Install New Software
- Add Site
  - https://dl-ssl.google.com/android/eclipse/
- Check „Developer Tools“
- Install


Java - HelloWorld/HelloWorld.java - Eclipse
File Edit Source Refactor Navigate Search Project Run Window Help
Welcome
Help Contents
Search
Dynamic Help
Key Assist... Ctrl+Shift+L
Tips and Tricks...
Report Bug or Enhancement...
Cheat Sheets...
Check for Updates
Install New Software...
Eclipse Marketplace...
About Eclipse
Java
Package Explorer
HelloWorld
(default package)
HelloWorld.java
JRE System Library [JavaSE-1.6]
HelloWorld.java
public class H
/**
* @param
*/
public sta
// TOD
System
}
}
All
Activate...
categorized
t Mylyn
o your task and ALM tools.
HelloWorld
main(String[]) : void
Problems
Javadoc
Declaration
Console
<terminated> HelloWorld [Java Application] C:\Programme\Java\jre6\bin\javaw.exe (03.11.2010 10:47:55)
Hello World
Writable
Smart Insert
14 : 1


Install
Available Software
Check the items that you wish to install.
Work with:
https://dl-ssl.google.com/android/eclipse/
Add...
Find more software by working with the "Available Software Sites" preferences.
type filter text
Name
Version
Developer Tools
Android DDMS
0.9.9.v201009221407-60953
Android Development Tools
0.9.9.v201009221407-60953
Select All
Deselect All
2 items selected
Details
Show only the latest versions of available software
Hide items that are already installed
Group items by category
What is already installed?
Contact all update sites during install to find required software
< Back
Next >
Finish
Cancel

Configurating the ADT Plugin

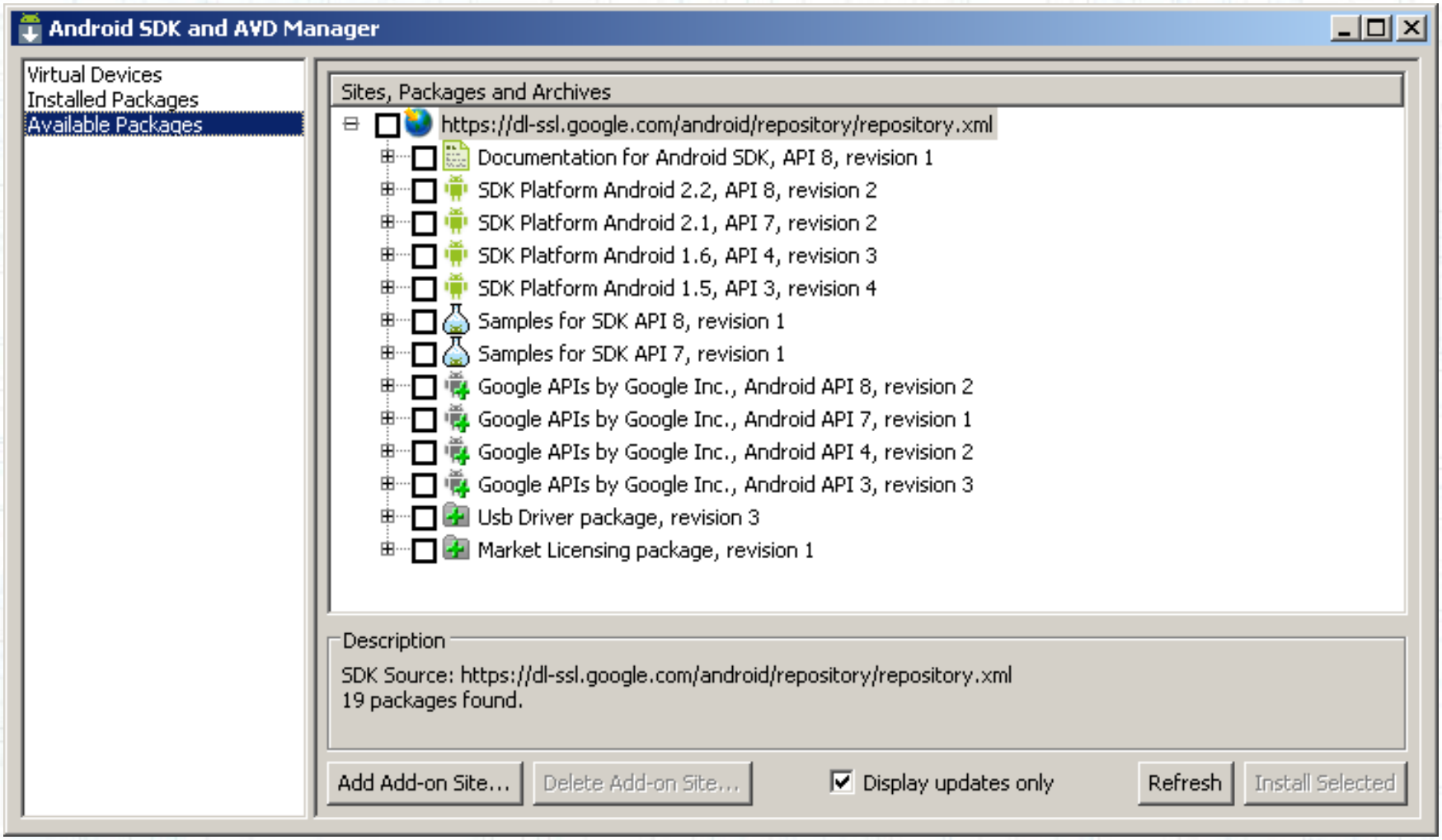
- The Android SDK has to be downloaded and installed separately
- Eclipse ADT plugin must be told the path to the Android SDK


Preferences
type filter text
General
Android
Build
DDMS
Launch
LogCat
Usage Stats
Ant
Help
Install/Update
Java
Run/Debug
Tasks
Team
Usage Data Collector
Validation
XML
Android
Android Preferences
SDK Location:
Z:\android-sdk-windows
Browse...
Note: The list of SDK Targets below is only reloaded once you hit 'Apply' or 'OK'.
Target Name
Vendor
Platform
API...
--
No target available
--
--
Restore Defaults
Apply
OK
Cancel

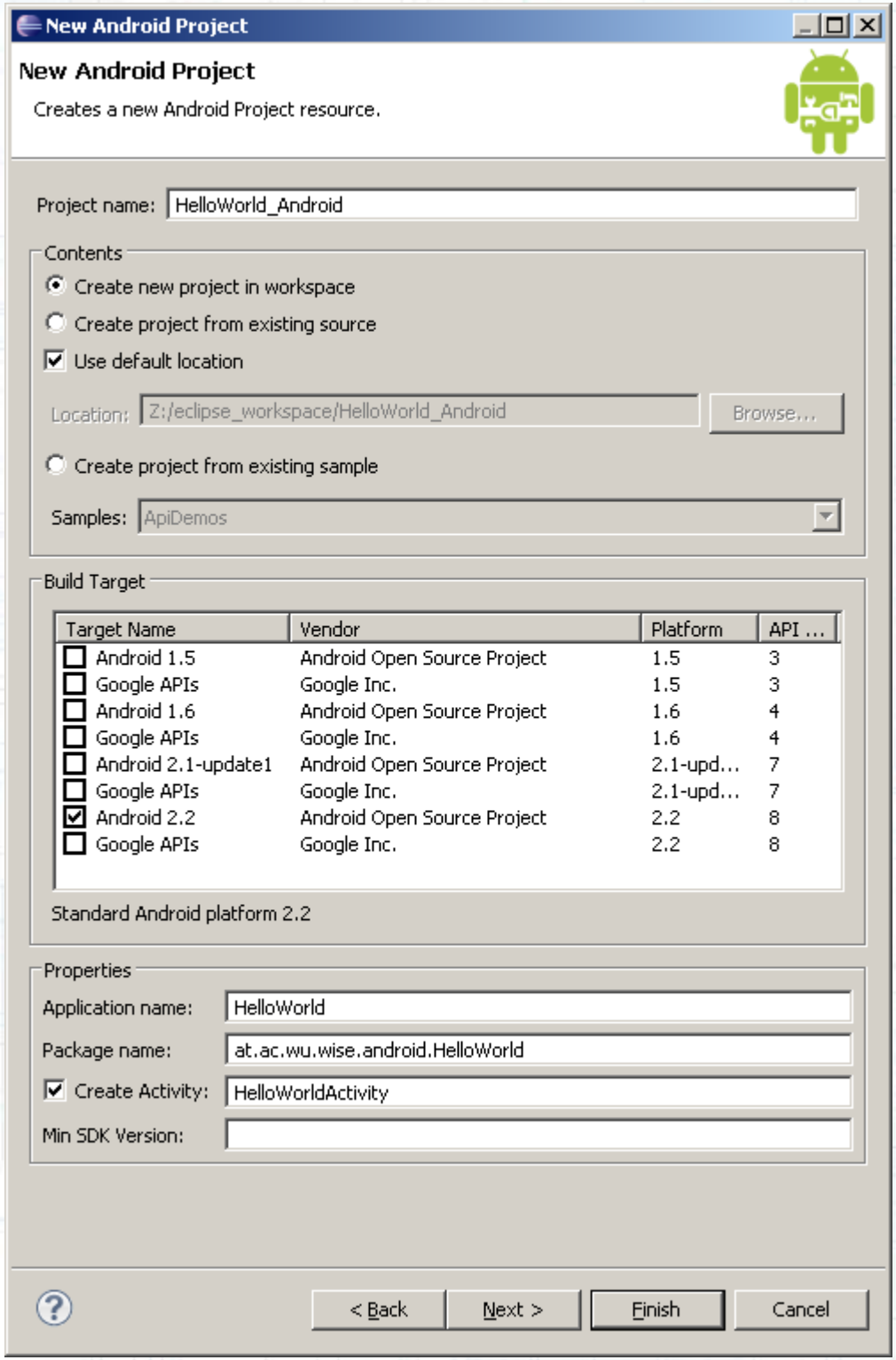
Android SDK and AVD Manager

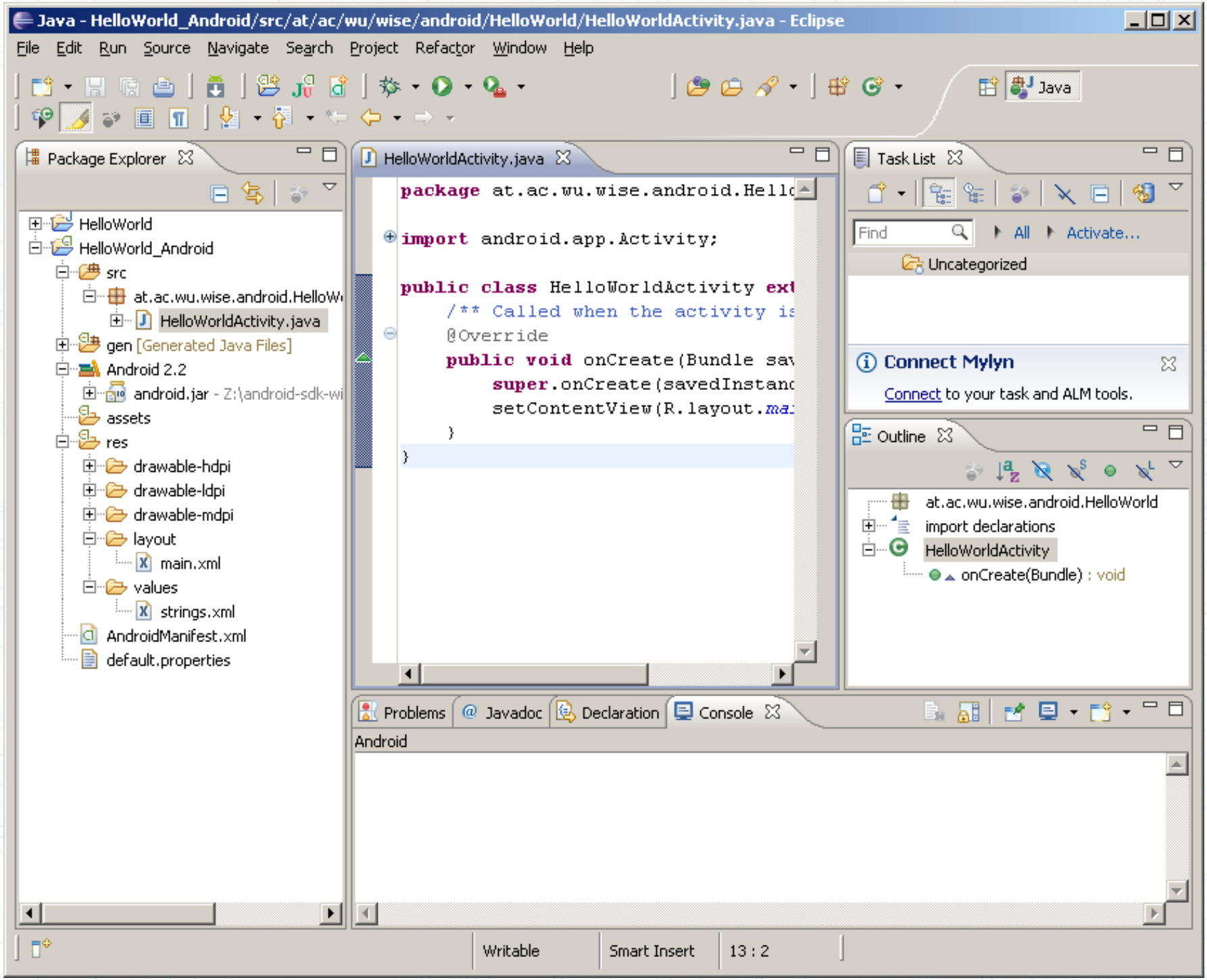
- Allows to download, install and manage Android SDK versions and components
- Also available
  - Documentation
  - Samples
  - USB Drivers
  - Android Market License

Android SDK and AVD Manager



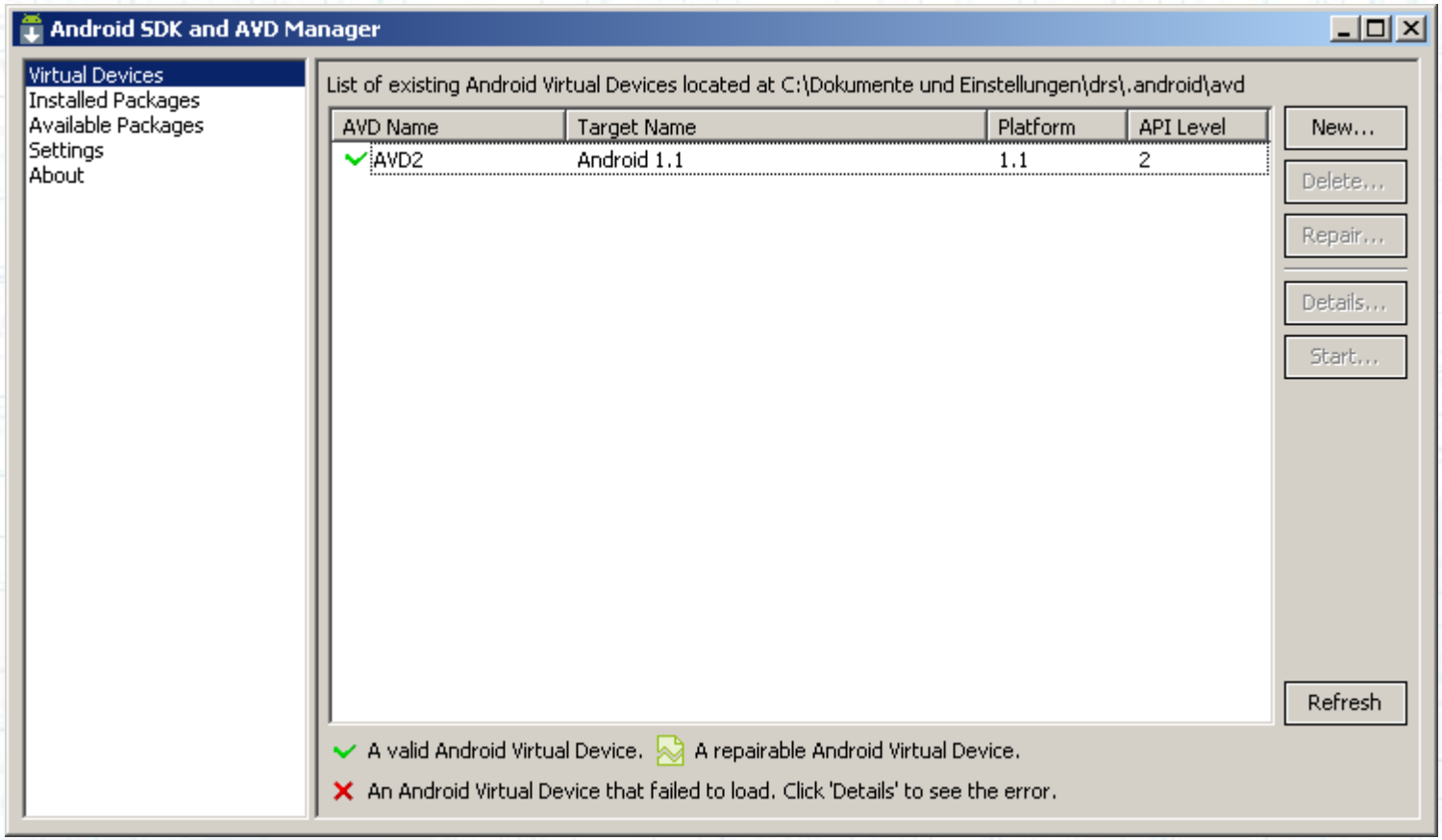
Hello World


New Android Project
New Android Project
Creates a new Android Project resource.
Project name: HelloWorld_Android
Contents
Create new project in workspace
Create project from existing source
Use default location
Location: Z:/eclipse_workspace/HelloWorld_Android
Browse...
Create project from existing sample
Samples: ApiDemos
Build Target
Target Name | Vendor | Platform | API ...
Android 1.5 | Android Open Source Project | 1.5 | 3
Google APIs | Google Inc. | 1.5 | 3
Android 1.6 | Android Open Source Project | 1.6 | 4
Google APIs | Google Inc. | 1.6 | 4
Android 2.1-update1 | Android Open Source Project | 2.1-upd... | 7
Google APIs | Google Inc. | 2.1-upd... | 7
Android 2.2 | Android Open Source Project | 2.2 | 8
Google APIs | Google Inc. | 2.2 | 8
Standard Android platform 2.2
Properties
Application name: HelloWorld
Package name: at.ac.wu.wise.android.HelloWorld
Create Activity: HelloWorldActivity
Min SDK Version:
< Back
Next >
Finish
Cancel

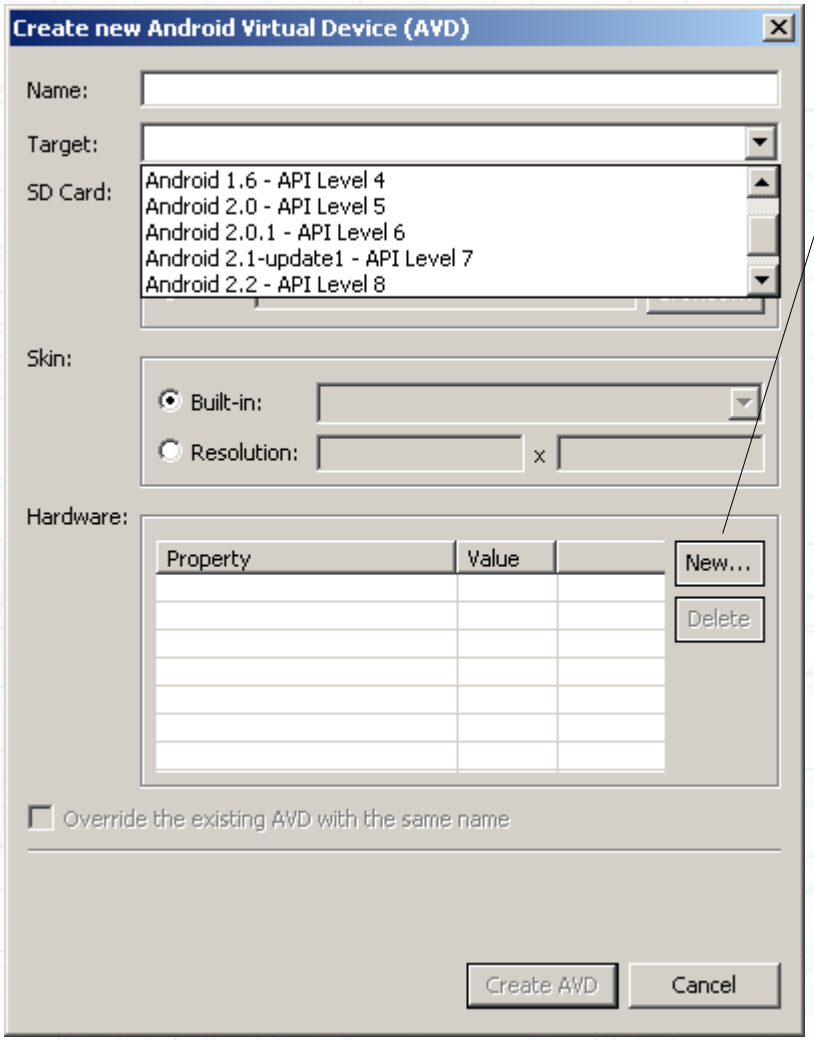

Java - HelloWorld_Android/src/at/ac/wu/wise/android/HelloWorld/HelloWorldActivity.java - Eclipse
File Edit Run Source Navigate Search Project Refactor Window Help
Java
Package Explorer
HelloWorld
HelloWorld_Android
src
at.ac.wu.wise.android.HelloW
HelloWorldActivity.java
gen [Generated Java Files]
Android 2.2
android.jar - Z:\android-sdk-wi
assets
res
drawable-hdpi
drawable-ldpi
drawable-mdpi
layout
main.xml
values
strings.xml
AndroidManifest.xml
default.properties
HelloWorldActivity.java
package at.ac.wu.wise.android.Hello
import android.app.Activity;
public class HelloWorldActivity ext
/** Called when the activity is
@Override
public void onCreate(Bundle sav
super.onCreate(savedInstanc
setContentView(R.layout.ma
}
}
Task List
Find
All
Activate...
Uncategorized
Connect Mylyn
Connect to your task and ALM tools.
Outline
at.ac.wu.wise.android.HelloWorld
import declarations
HelloWorldActivity
onCreate(Bundle) : void
Problems
Javadoc
Declaration
Console
Android
Writable
Smart Insert
13 : 2

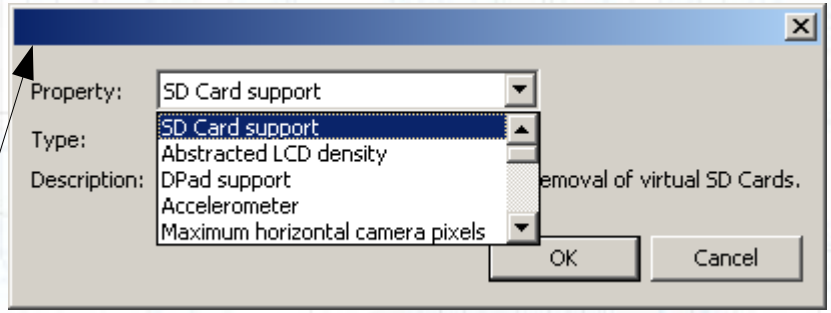
Android Virtual Devices

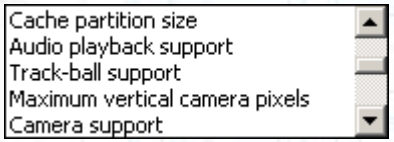
- Android SDK/AVD Manager

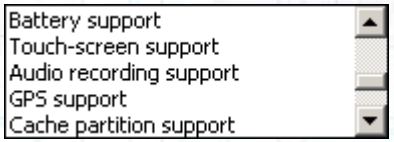


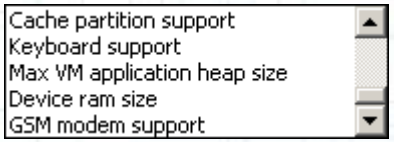
Android Virtual Devices



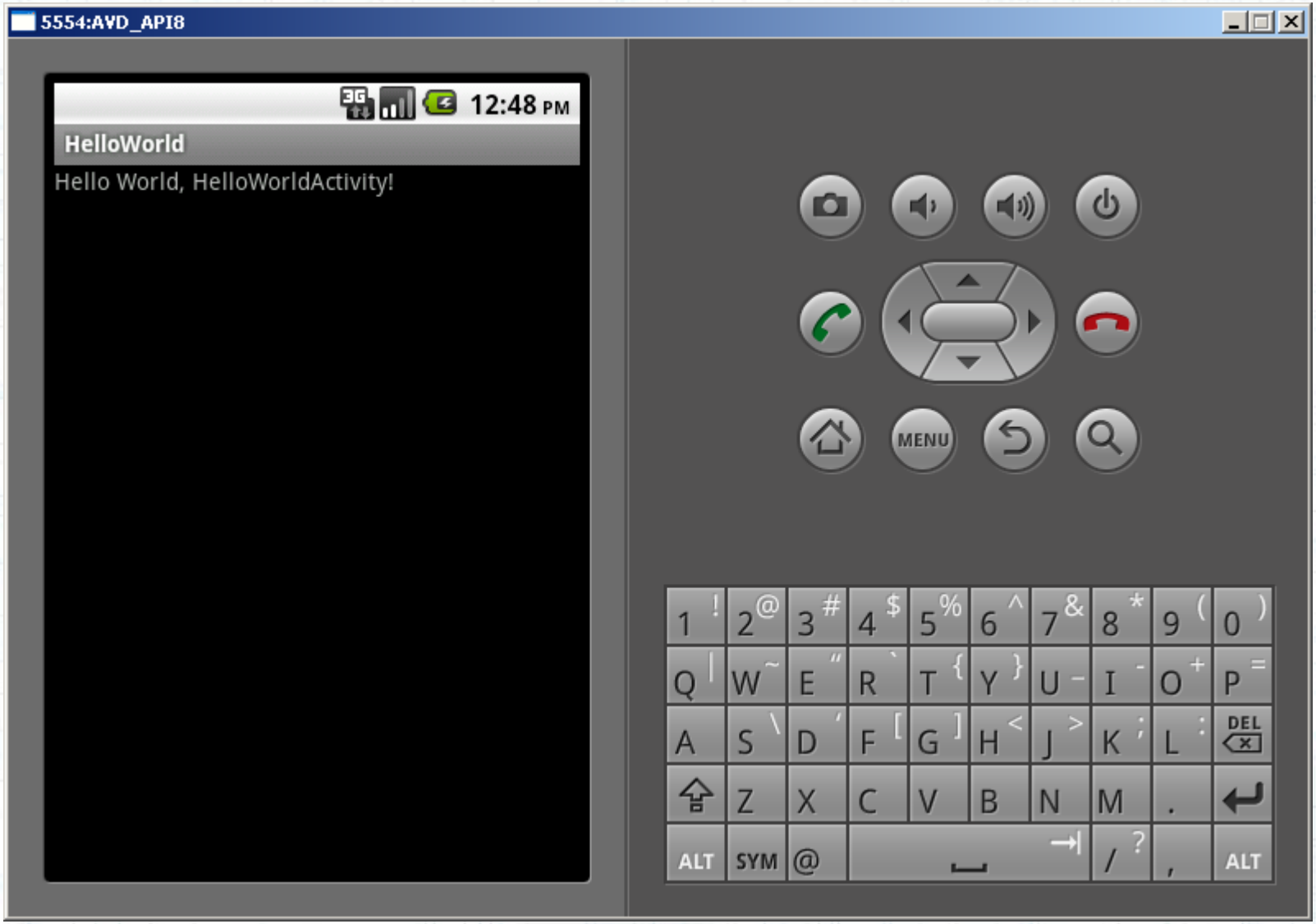








Android Virtual Devices


5554:AVD_API8
12:48 PM
HelloWorld
Hello World, HelloWorldActivity!
MENU
1 ! 2 @ 3 # 4 $ 5 % 6 ^ 7 & 8 * 9 (0)
Q | W ~ E " R ` T { Y } U - I - O + P =
A S \ D ' F [G] H < J > K ; L : DEL
Z X C V B N M .
ALT SYM @ / ? , ALT

AndroidManifest.xml

- „Table of contents“ of an application
  - Name, version
  - Activities, intents, services...
  - Permissions

Lister - [Z:\vm\android-test-project\AndroidManifest.xml]

Datei Bearbeiten Optionen Codierung Hilfe 100 %

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
      package="at.ac.wu.android"
      android:versionCode="1"
      android:versionName="1.0">
    <application android:label="@string/app_name">
        <activity android:name=".FirstApp"
                  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>
```

- used by Android at runtime and also by the Android Market
  - e.g. applications that need Android 2.0 will not be presented to Android 1.5 devices

AndroidManifest.xml

- Elements underneath <manifest>
  - uses-permission
  - permission
  - instrumentation
  - uses-library
  - uses-sdk
  - application

<uses-permission/>

```
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
  package="com.commonsware.android">
  <uses-permission
    android:name="android.permission.ACCESS_LOCATION" />
  <uses-permission
    android:name="android.permission.ACCESS_GPS" />
  <uses-permission
    android:name="android.permission.ACCESS_ASSISTED_GPS" />
  <uses-permission
    android:name="android.permission.ACCESS_CELL_ID" />
  <application>
...
  </application>
</manifest>
```

src/.../FirstApp.java

Lister - [Z:\vm\android-test-project\src\at\ac\wu\android\FirstApp.java]

Datei Bearbeiten Optionen Codierung Hilfe 100 %

```
package at.ac.wu.android;

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

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

res/layout/main.xml

Lister - [Z:\vm\android-test-project\res\layout\main.xml]

Datei Bearbeiten Optionen Codierung Hilfe 100 %

```
<?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="Hello World, FirstApp"
    />
</LinearLayout>
```

Resources and Assets

- Resources (IDs, R.java for resolving references)
  - Strings
  - Layout (defines views)
  - Color
  - Dimensions (pixels, inches and points)
  - Image
  - Color-drawable
- Assets (no ID, relative path necessary, accessible via AssetManager)

Android Debug Bridge

- Managing the state of an device / emulator
- adb -s <serialNumber> <command>
  - adb shell
    - ls, ps, ifconfig, mount, top, telnetd...
  - adb logcat
  - adb install <path_to_apk>
  - adb pull / push
  - adb forward tcp:6100 tcp:7100

On the Shell

```
# sqlite3
/data/data/com.example.google.rss.rsse
xample/databases/rssitems.db

SQLite version 3.3.12

Enter ".help" for instructions

.... enter commands, then quit...

sqlite> .exit
```