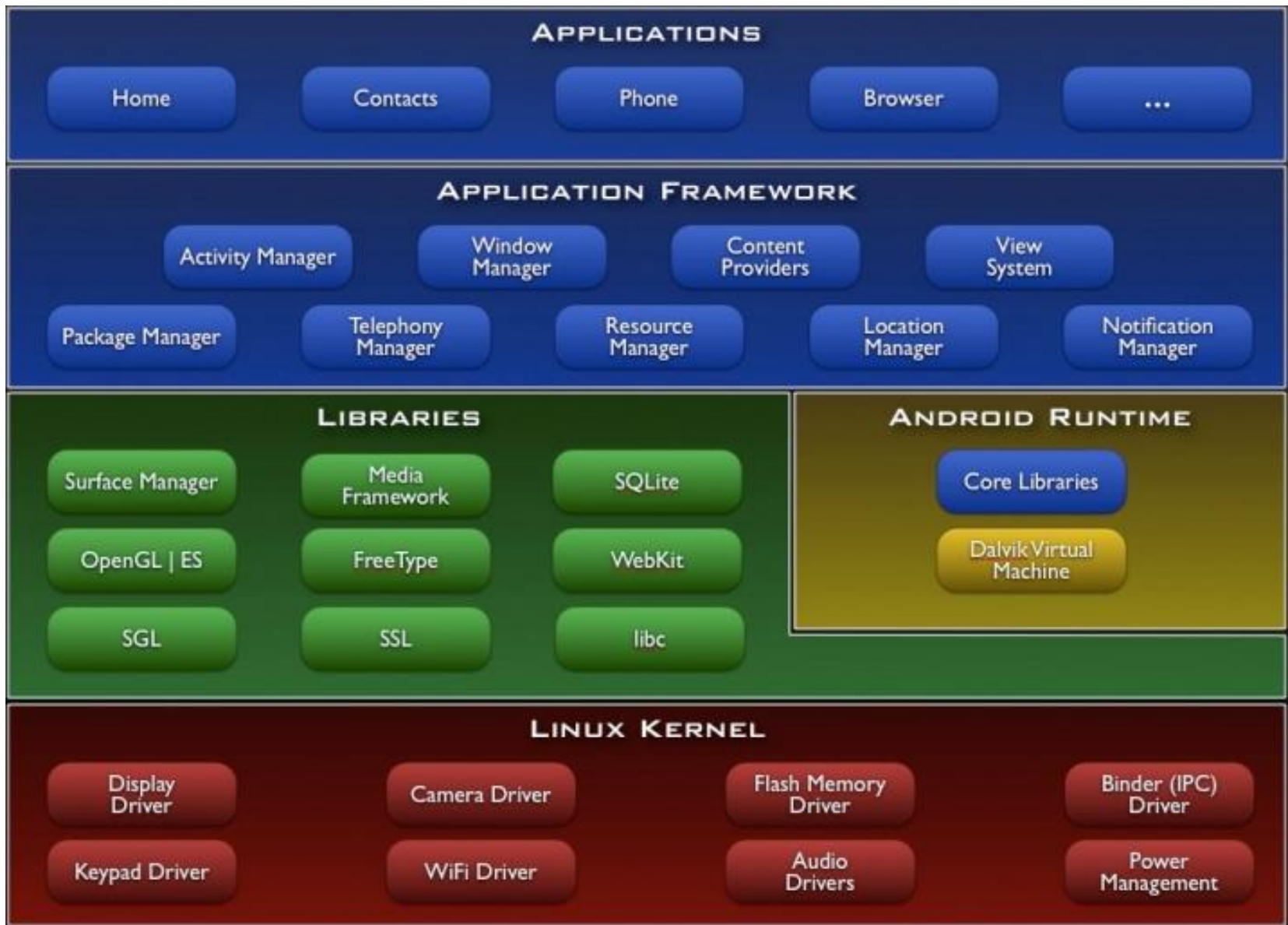


CS371m - Mobile Computing

Android Overview and Android
Development Environment

What is Android?

- A software stack for mobile devices that includes
 - An operating system
 - Middleware
 - Key Applications
- Uses Linux to provide core system services
 - Security
 - Memory management
 - Process management
 - Power management
 - Hardware drivers



<http://developer.android.com/guide/basics/what-is-android.html>

Android Versioning

- On the order of 25 versions in 8 years.
- Slowing down, current pace is one large, major release a year
 - will this slow down more?
- Android releases have a code name, version number, and API level
- Most recent:
 - Nougat, Version 7.1, API level 25
- https://en.wikipedia.org/wiki/Android_version_history

A Short History Of Android



- 2001 Palm Kyocera 6035, combining PDA and phone
 - PDA = personal data assistant, PalmPilot
- 2003 - Blackberry smartphone released
- 2005
 - Google acquires startup Android Inc. to start Android platform.
 - Work on Dalvik VM begins
- 2007
 - Open Handset Alliance announced
 - Early look at SDK
 - June, **iPhone released**
- 2008
 - Google sponsors 1st Android Developer Challenge
 - T-Mobile G1 announced, released fall
 - SDK 1.0 released
 - Android released open source (Apache License)
 - Android Dev Phone 1 released

Short History cont.

- 2009
 - SDK 1.5 (Cupcake) after Alpha and Beta
 - New soft keyboard with “autocomplete” feature
 - SDK 1.6 (Donut)
 - Support Wide VGA
 - SDK 2.0/2.0.1/2.1 (Eclair)
 - Revamped UI, browser
- 2010
 - Nexus One released to the public
 - SDK 2.2 (Froyo)
 - Flash support, tethering
 - SDK 2.3 (Gingerbread)
 - UI update, system-wide copy-paste



Short History cont.

- 2011
 - SDK 3.0 (Honeycomb) for tablets only
 - New UI for tablets, support multi-core processors, fragments
 - SDK 3.1 and 3.2
 - Hardware support and UI improvements
 - SDK 4.0 (Ice Cream Sandwich)
 - For Q4, combination of Gingerbread Honeycomb



Short History cont.

- 2012
 - Android 4.1, "Jelly Bean" released in July
- 2013
 - Android 4.4, KitKat released October 31, 2013



Top Smartphone Platforms

3 Month Avg. Ending May 2012 vs. 3 Month Avg. Ending Feb. 2012

Total U.S. Smartphone Subscribers Ages 13+

Source: comScore MobiLens

	Share (%) of Smartphone Subscribers		
	Feb-12	May-12	Point Change
<i>Total Smartphone Subscribers</i>	100.0%	100.0%	N/A
Google	50.1%	50.9%	0.8
Apple	30.2%	31.9%	1.7
RIM	13.4%	11.4%	-2.0
Microsoft	3.9%	4.0%	0.1
Symbian	1.5%	1.1%	-0.4

Short History (Getting Longer)

- November, 2014
Android 5.0 Lollipop released.

API level 21

"Material Design"

- October, 2015

Android 6.0

Marshmallow

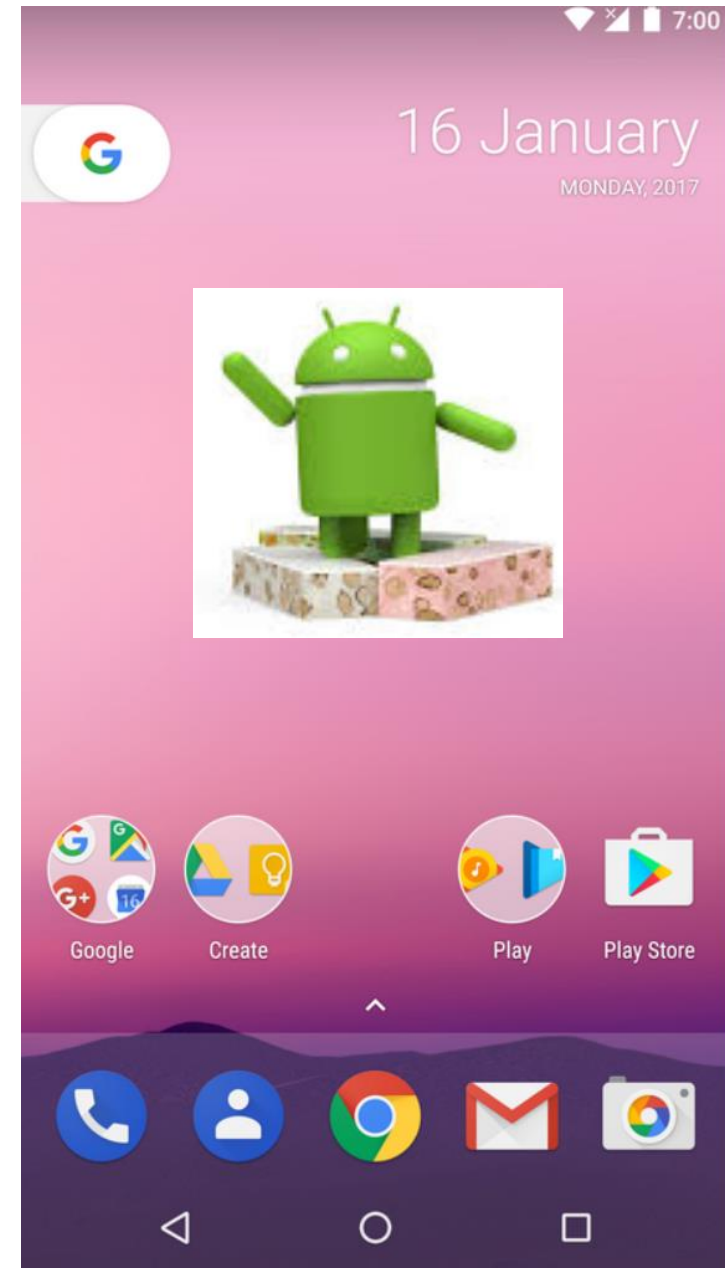
API level 23

- Runtime permissions

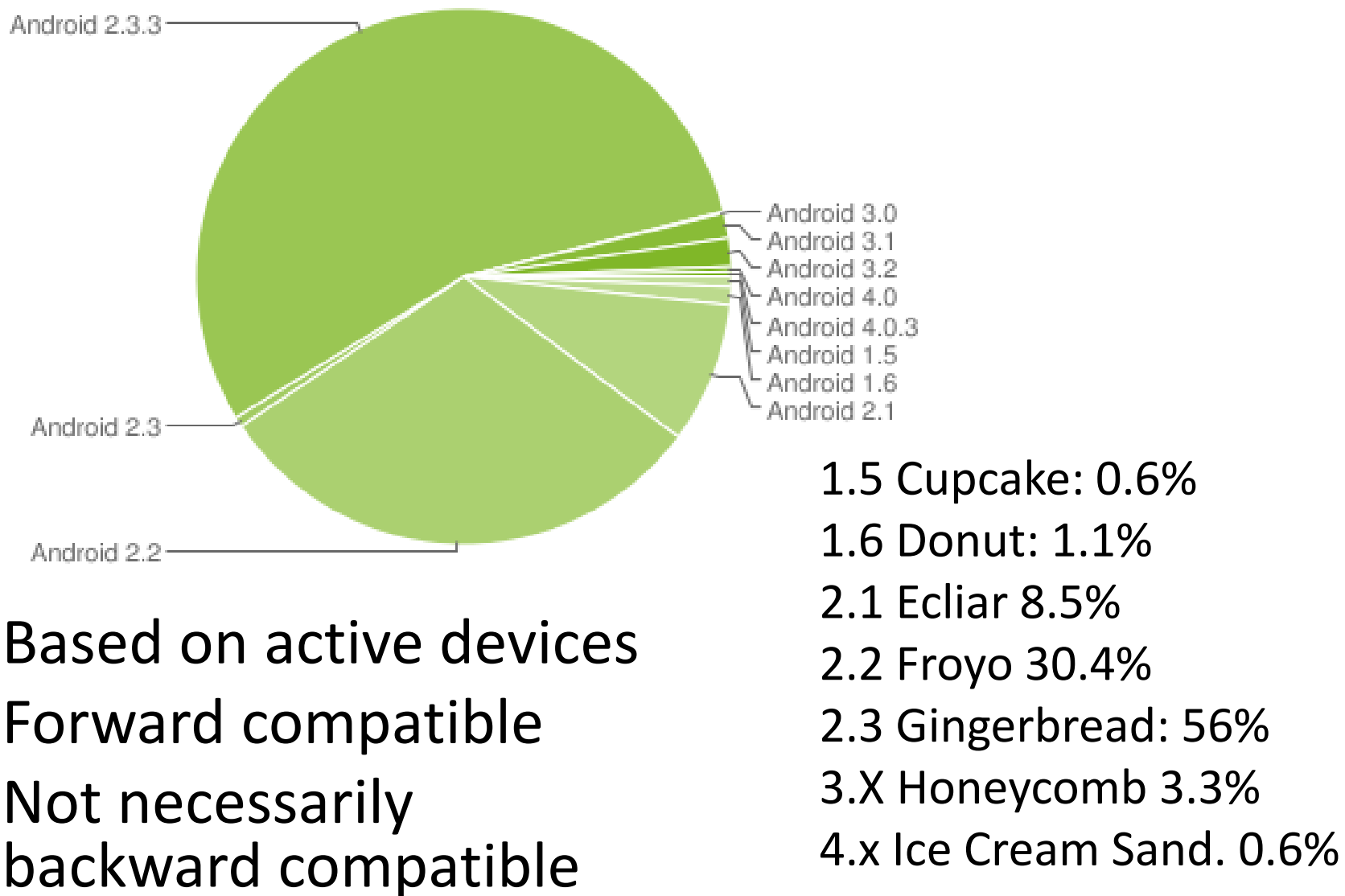


Still More

- August 2016
 - Nougat
 - Daydream Virtual Reality Interface
 - Doze functionality to improve battery life



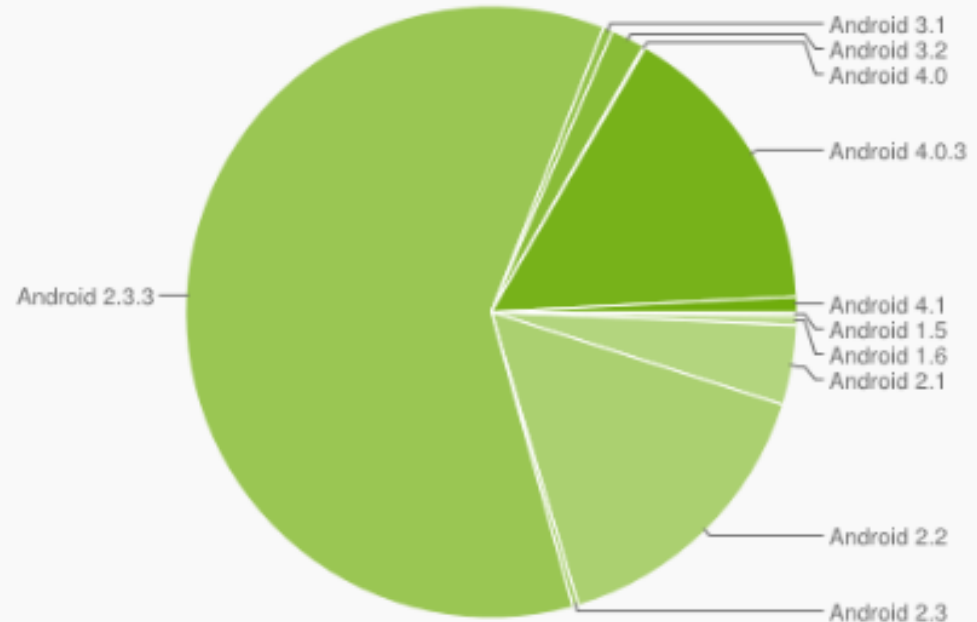
Device Distribution Jan 2012



August 1, 2012

14-day period ending on the data collection date noted below.

Version	Codename	API Level	Distribution
1.5	Cupcake	3	0.2%
1.6	Donut	4	0.5%
2.1	Eclair	7	4.2%
2.2	Froyo	8	15.5%
2.3 - 2.3.2	Gingerbread	9	0.3%
2.3.3 - 2.3.7		10	60.3%
3.1	Honeycomb	12	0.5%
3.2		13	1.8%
4.0 - 4.0.2	Ice Cream Sandwich	14	0.1%
4.0.3 - 4.0.4		15	15.8%
4.1	Jelly Bean	16	0.8%



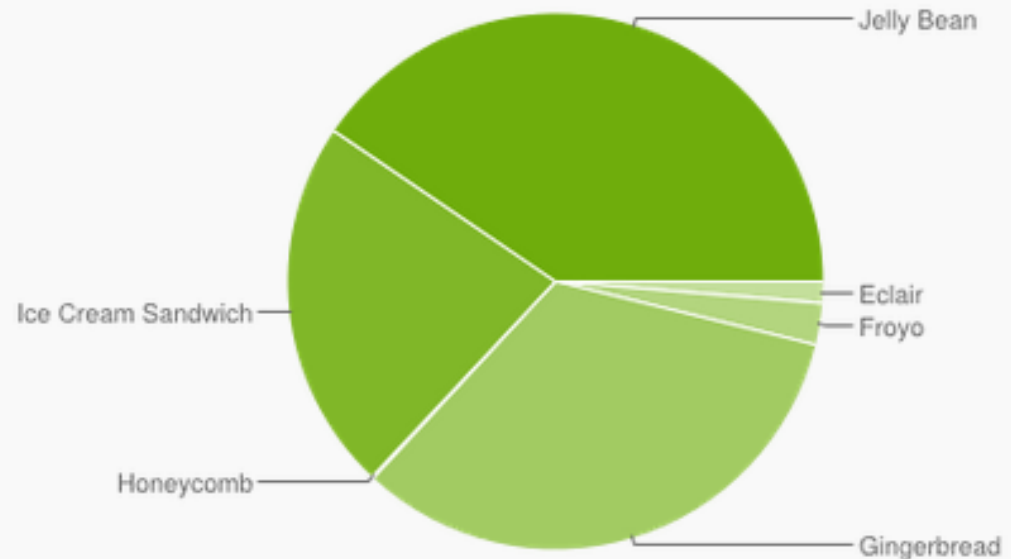
OS Version, API Level, Nickname
4.1, API Level 16, Jelly Bean

Data collected during a 14-day period ending on August 1, 2012

August 1, 2013

- Based on device visits to Google Play

Version	Codename	API	Distribution
1.6	Donut	4	0.1%
2.1	Eclair	7	1.2%
2.2	Froyo	8	2.5%
2.3 - 2.3.2	Gingerbread	9	0.1%
2.3.3 - 2.3.7		10	33.0%
3.2	Honeycomb	13	0.1%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	22.5%
4.1.x	Jelly Bean	16	34.0%
4.2.x		17	6.5%

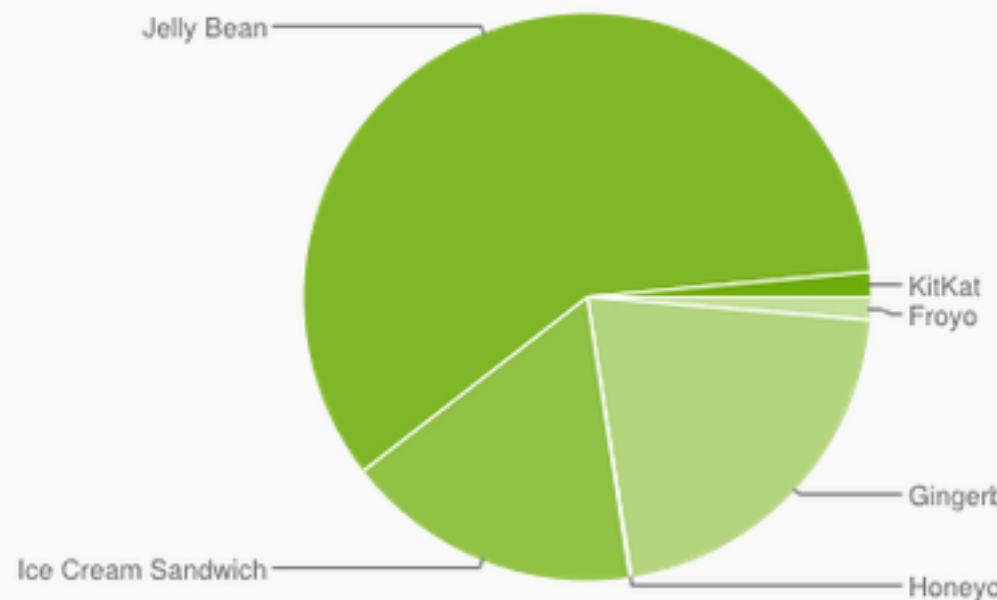


*Data collected during a 14-day period ending on August 1, 2013.
Any versions with less than 0.1% distribution are not shown.*

January 8, 2014

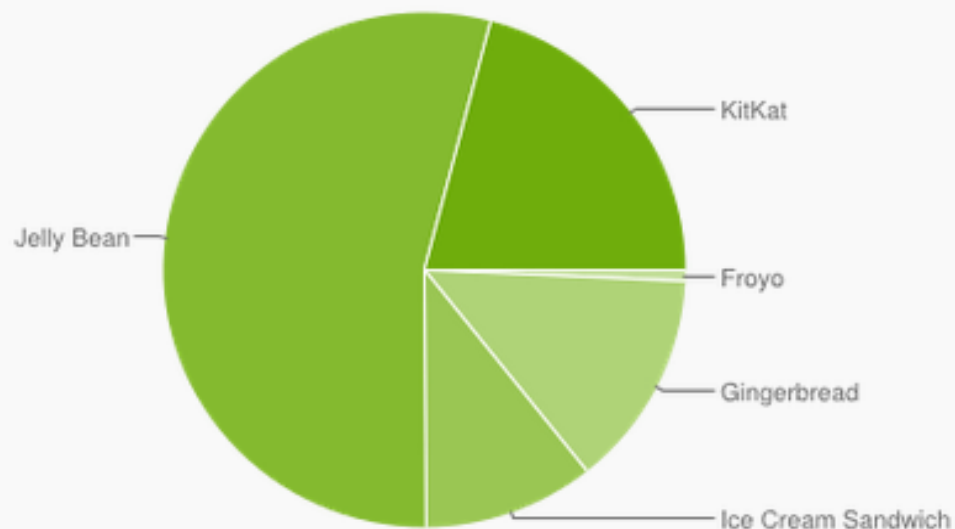
- Based on device visits to Google Play

Version	Codename	API	Distribution
2.2	Froyo	8	1.3%
2.3.3 - 2.3.7	Gingerbread	10	21.2%
3.2	Honeycomb	13	0.1%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	16.9%
4.1.x	Jelly Bean	16	35.9%
4.2.x		17	15.4%
4.3		18	7.8%
4.4	KitKat	19	1.4%



August, 2014

Version	Codename	API	Distribution
2.2	Froyo	8	0.7%
2.3.3 - 2.3.7	Gingerbread	10	13.6%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	10.6%
4.1.x	Jelly Bean	16	26.5%
4.2.x		17	19.8%
4.3		18	7.9%
4.4	KitKat	19	20.9%



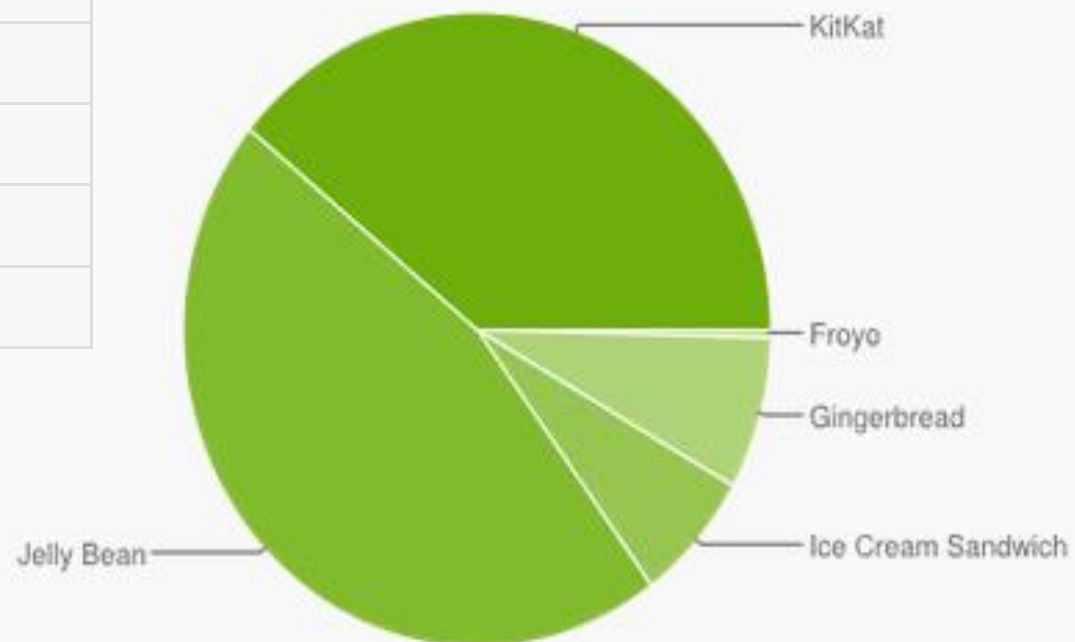
*Data collected during a 7-day period ending on August 12, 2014.
Any versions with less than 0.1% distribution are not shown.*

Based on unique devices that visit the Google Play Store.

January 2015

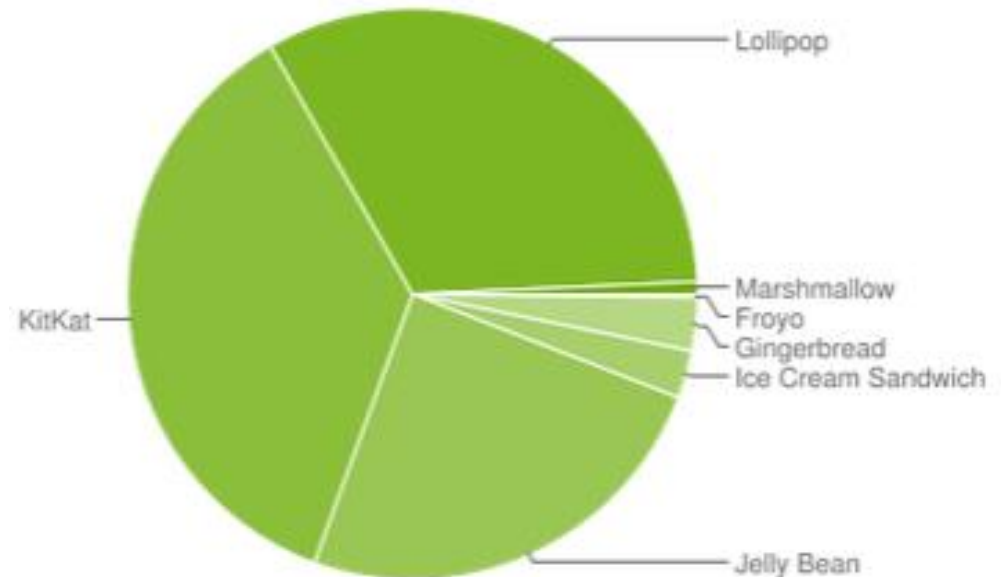
Version	Codename	API	Distribution
2.2	Froyo	8	0.4%
2.3.3 - 2.3.7	Gingerbread	10	7.8%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	6.7%
4.1.x	Jelly Bean	16	19.2%
4.2.x		17	20.3%
4.3		18	6.5%
4.4	KitKat	19	39.1%

Where is Lollipop?



January 2016

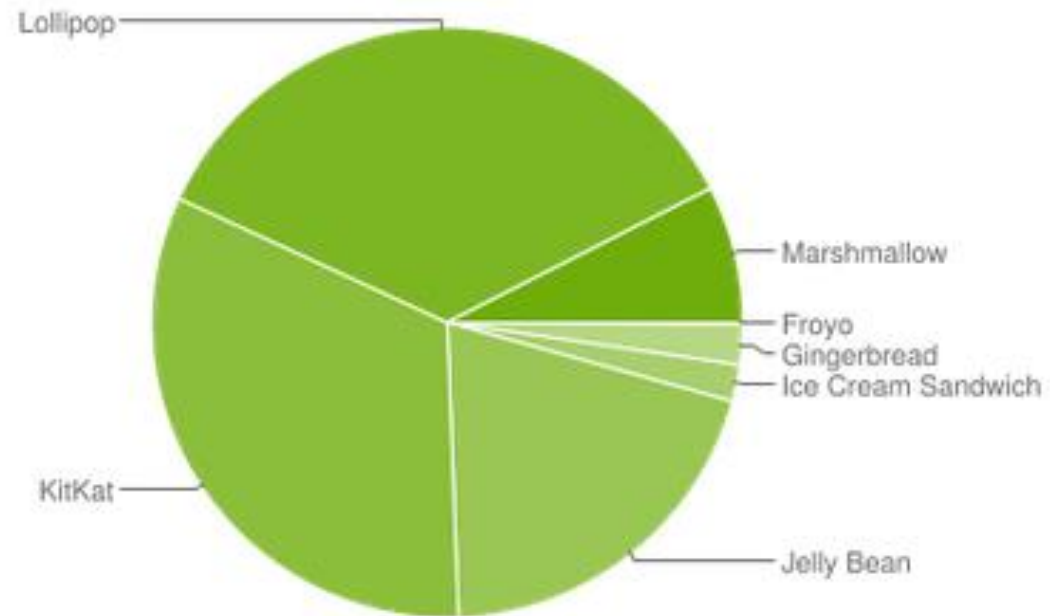
Version	Codename	API	Distribution
2.2	Froyo	8	0.2%
2.3.3 - 2.3.7	Gingerbread	10	3.0%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	2.7%
4.1.x	Jelly Bean	16	9.0%
4.2.x		17	12.2%
4.3		18	3.5%
4.4	KitKat	19	36.1%
5.0	Lollipop	21	16.9%
5.1		22	15.7%
6.0	Marshmallow	23	0.7%



Took a year for Lollipop to gain roughly a third of device share.

May 2016

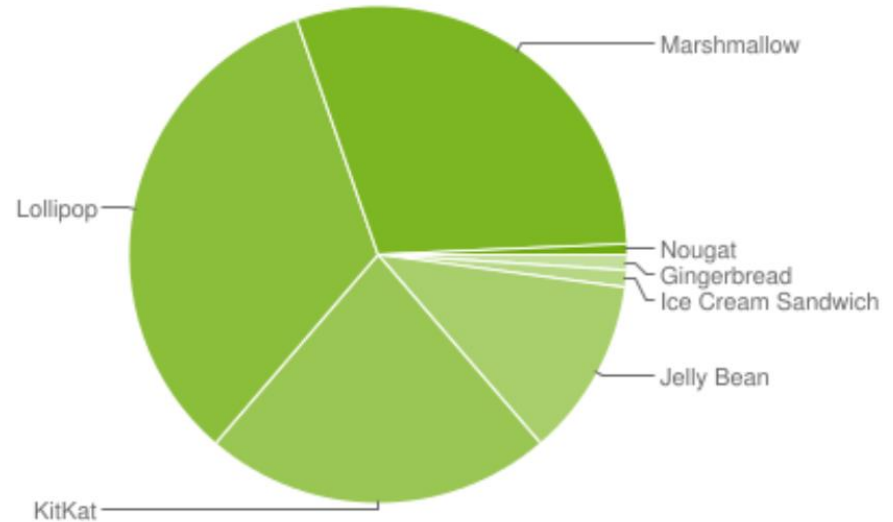
Version	Codename	API	Distribution
2.2	Froyo	8	0.1%
2.3.3 - 2.3.7	Gingerbread	10	2.2%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	2.0%
4.1.x	Jelly Bean	16	7.2%
4.2.x		17	10.0%
4.3		18	2.9%
4.4	KitKat	19	32.5%
5.0	Lollipop	21	16.2%
5.1		22	19.4%
6.0	Marshmallow	23	7.5%



Marshmallow not in the weeds any more.

January 2017

Version	Codename	API	Distribution
2.3.3 - 2.3.7	Gingerbread	10	1.0%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	1.1%
4.1.x	Jelly Bean	16	4.0%
4.2.x		17	5.9%
4.3		18	1.7%
4.4	KitKat	19	22.6%
5.0	Lollipop	21	10.1%
5.1		22	23.3%
6.0	Marshmallow	23	29.6%
7.0	Nougat	24	0.5%
7.1		25	0.2%



- Developer decision?

Clicker Question

- Do you own an Android device?
 - A. yes
 - B. no
- What version of Android are you running?
 - A. Kit Kat
 - B. Lollipop
 - C. Marshmallow
 - D. Nougat
 - E. Other, don't know, or don't own Android device

Android Fragmentation

- August 2014
- Report from <http://opensignal.com/reports/2014/android-fragmentation/>
- open signal app for Android and iOS
- 5m - 10m Android downloads

18,796

Distinct Android devices seen this year

11,868

Distinct Android devices seen last year

682,000

Devices surveyed for this report.

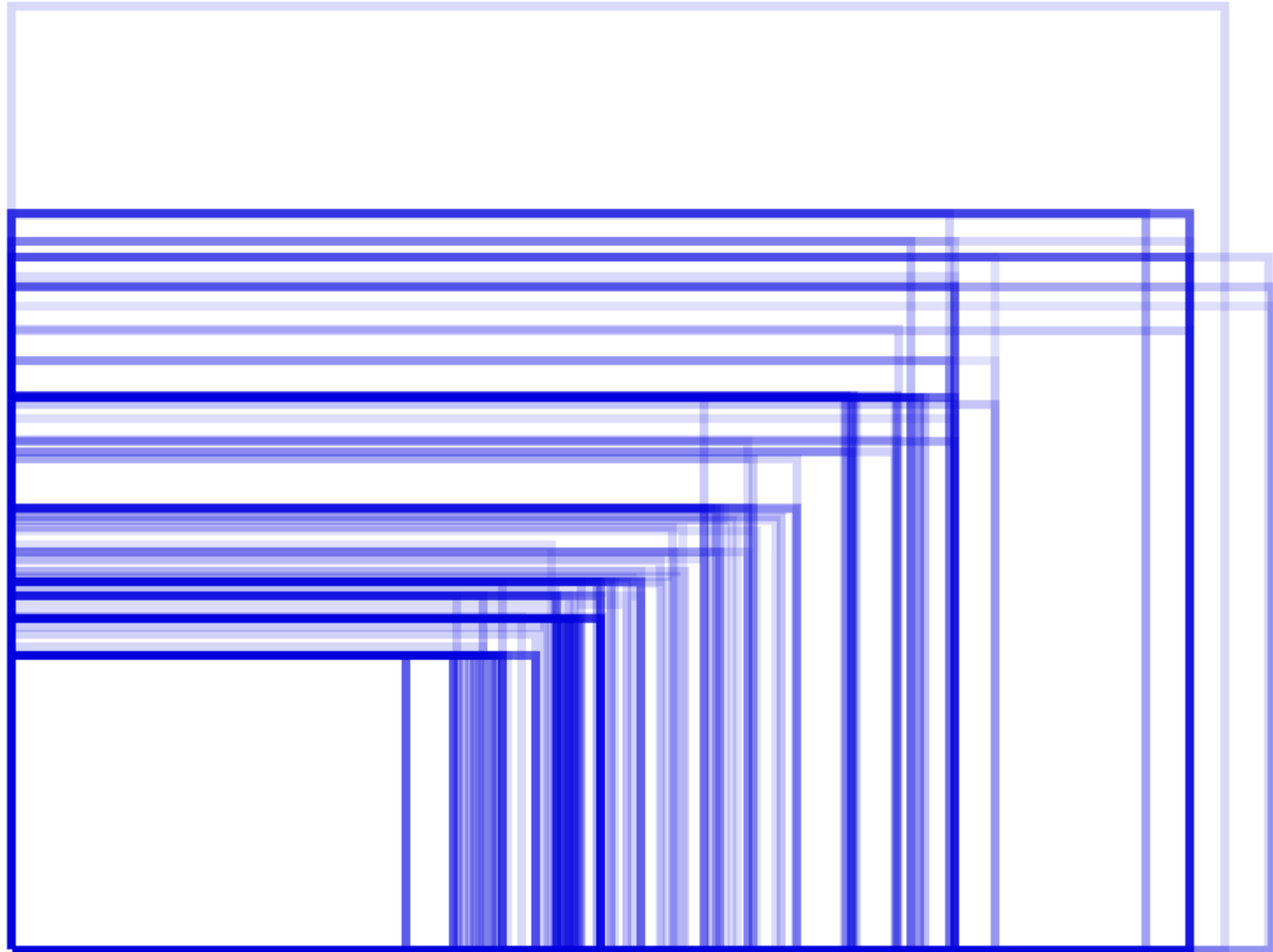
43%

Samsung's share of those devices.

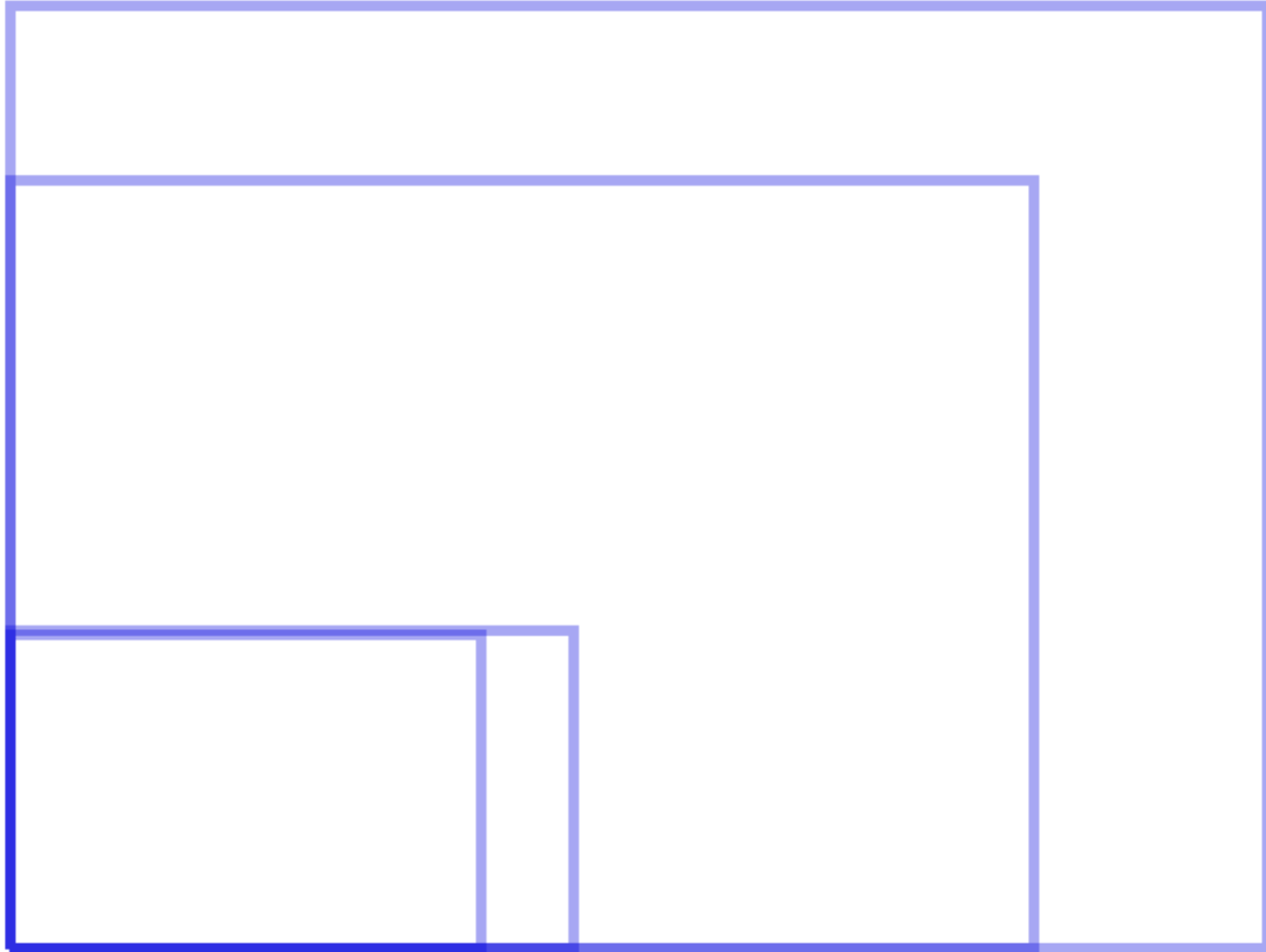
20.9%

Android users on KitKat

Android Screen Sizes - August 2014



iOS Screen Sizes - August 2014



Android Fragmentation

- August 2015
- Report from [http://opensignal.com/reports/2015/08/android-fragmentation/open signal app for](http://opensignal.com/reports/2015/08/android-fragmentation/open%20signal%20app%20for)
- 10m - 50m Android downloads

24,093

Distinct Android devices seen this
year

18,796

Distinct Android devices seen last
year

682,000

Devices surveyed for this report.

37.8%

Samsung's share of those
devices.

1,294

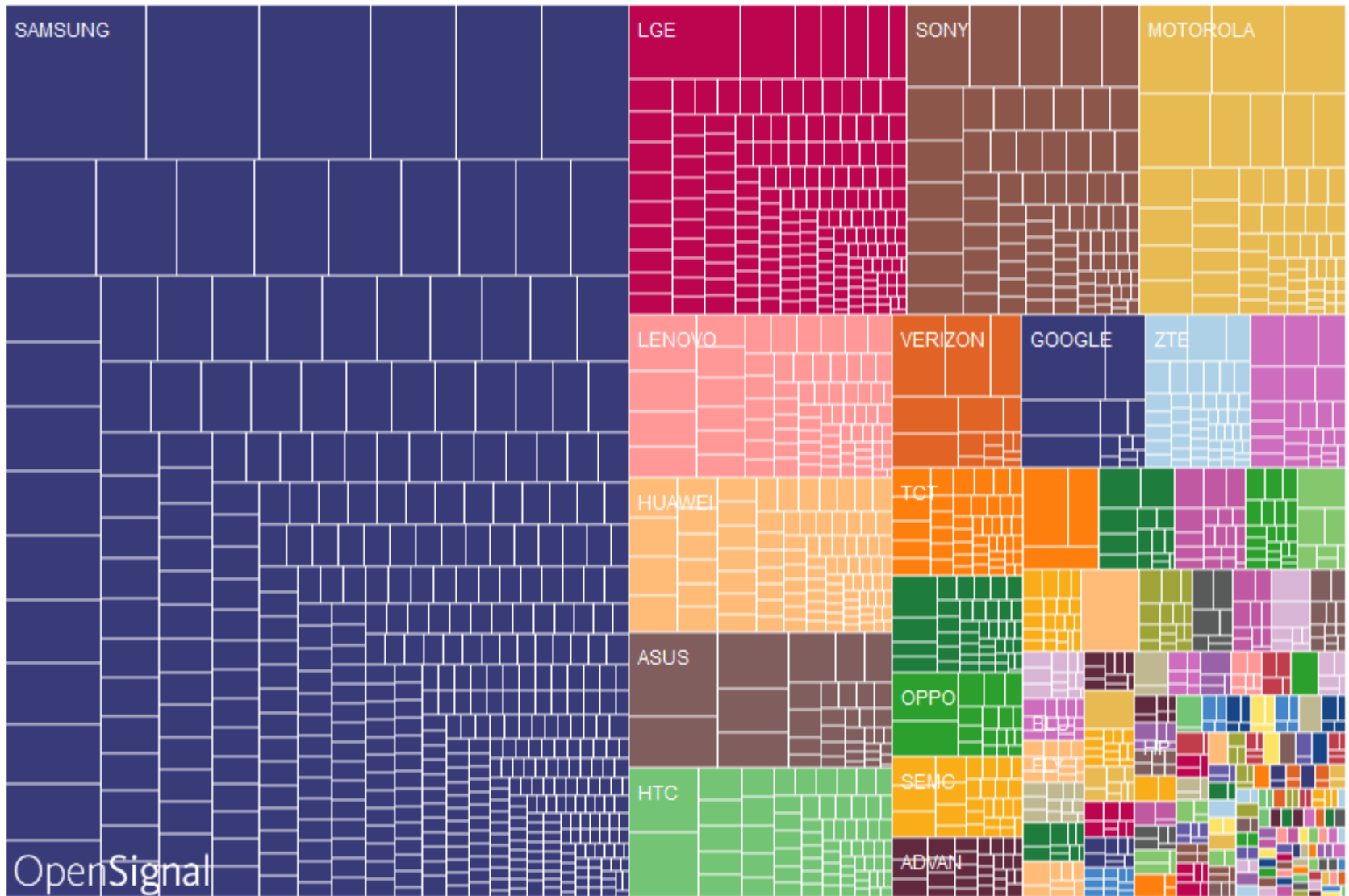
Device brands seen this year

Device Fragmentation

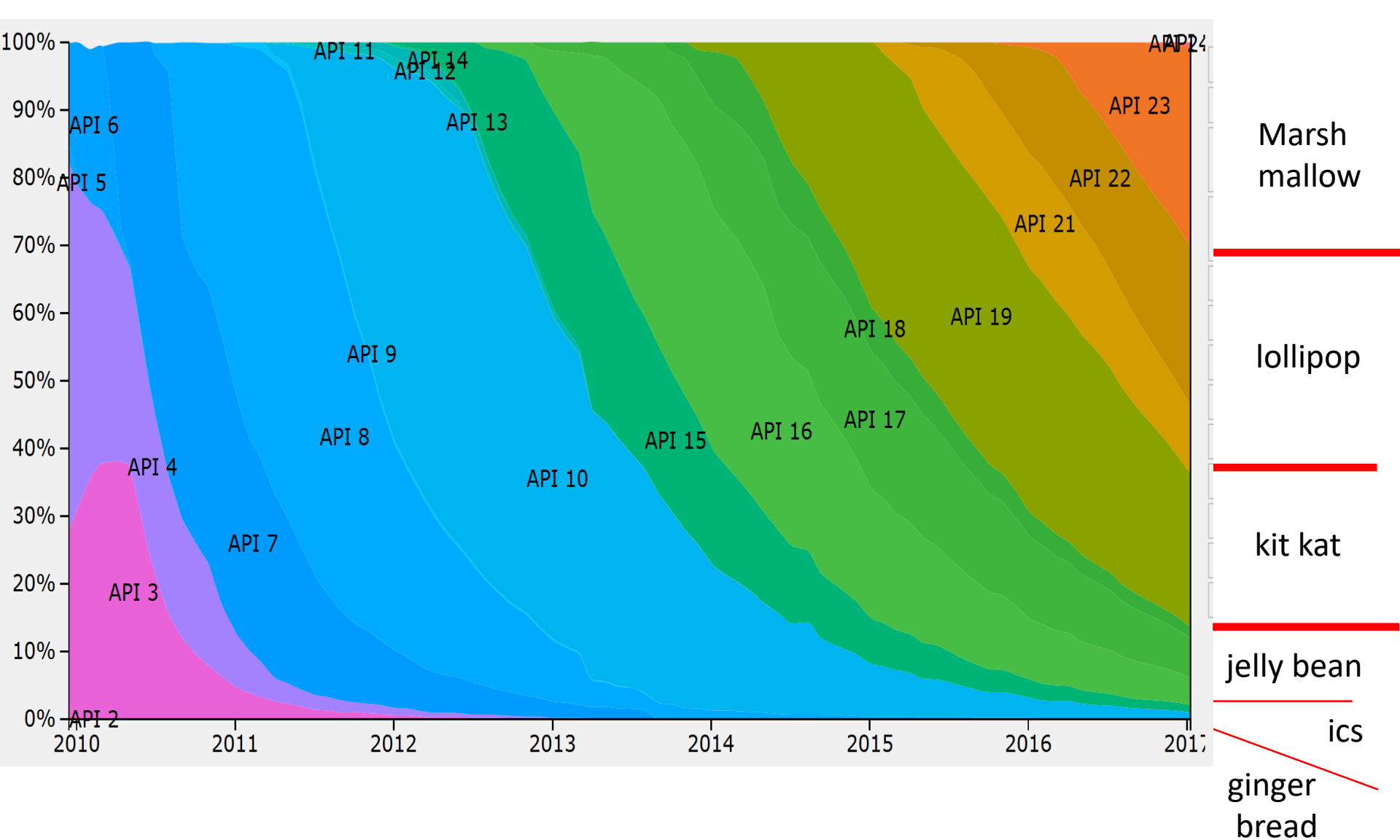


<http://opensignal.com/reports/2015/08/android-fragmentation/>

BRAND FRAGMENTATION

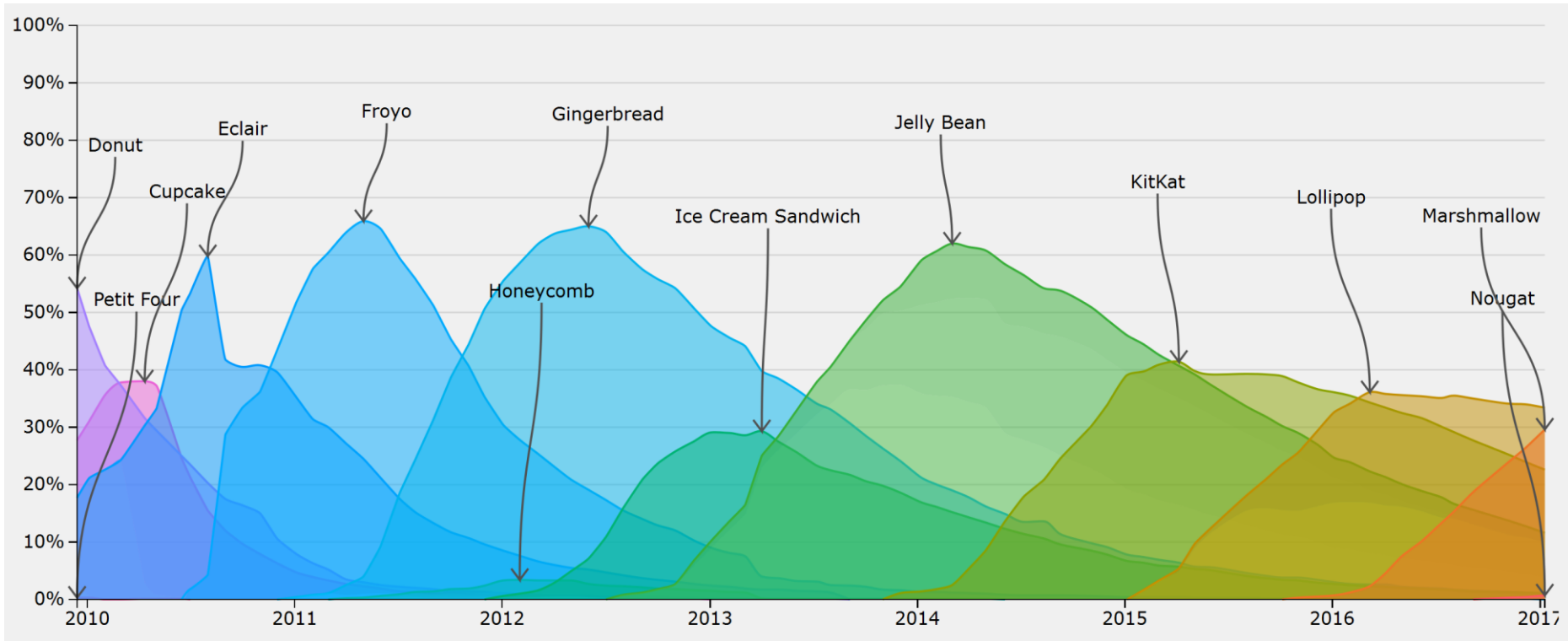


<http://opensignal.com/reports/2015/08/android-fragmentation/>



January 2017

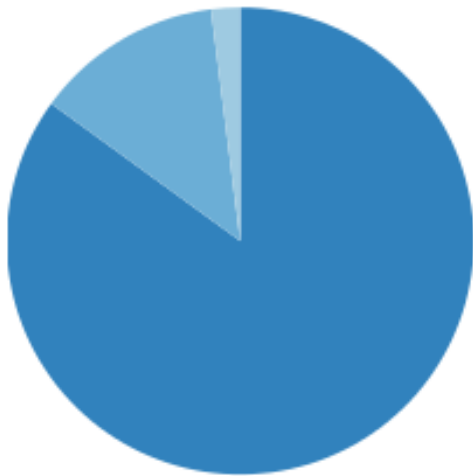
Dominant Version



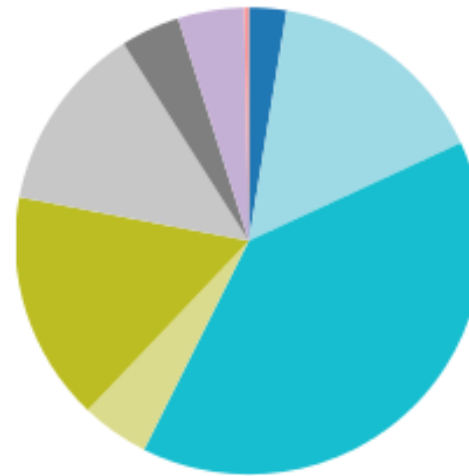
- <http://www.bidouille.org/misc/androidcharts>

Android - iOS comparison

COMPARISON WITH IOS



iOS 8 (85%)
iOS 7 (13%)
Earlier Version (2%)



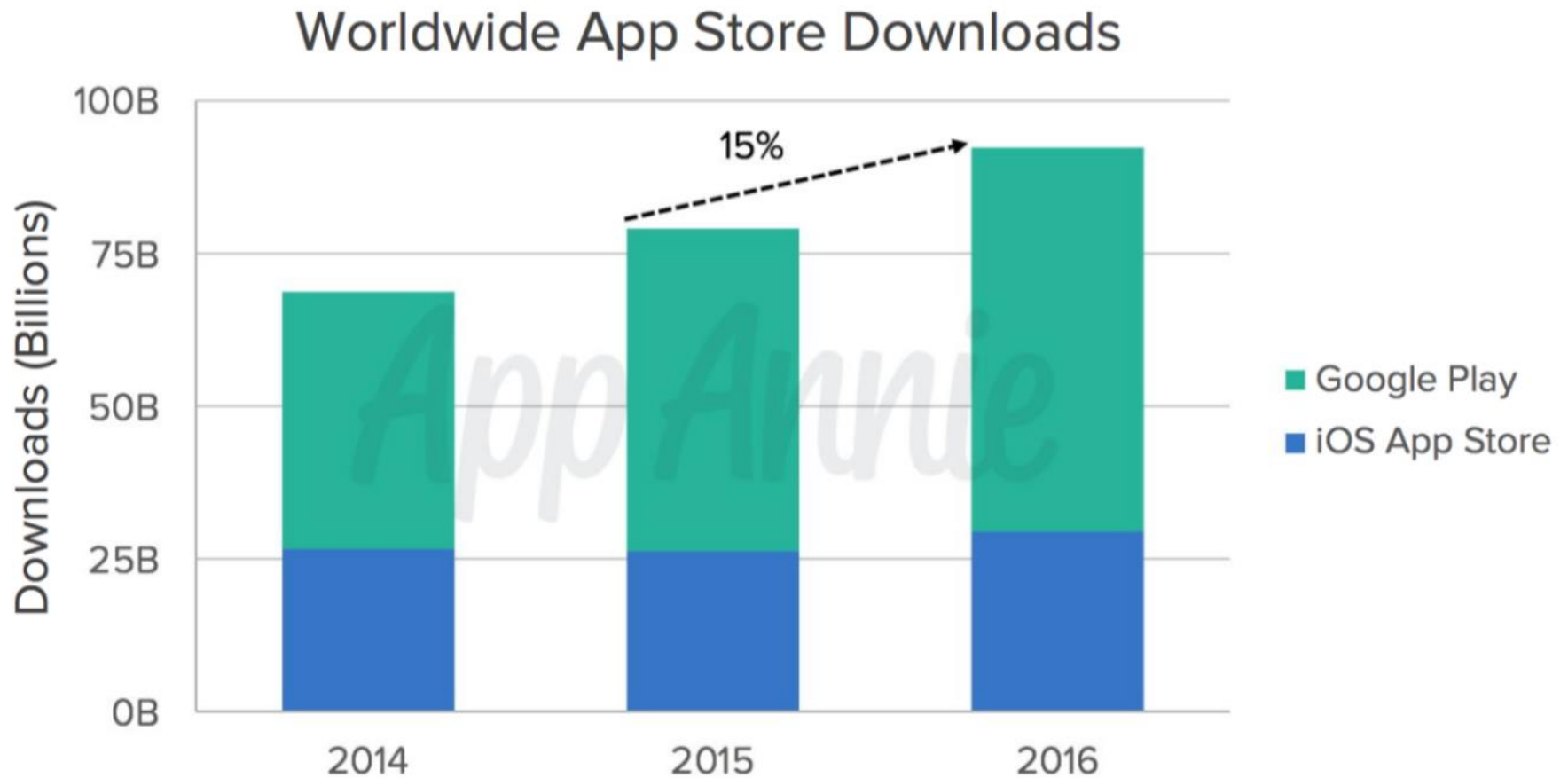
5.1 (Lollipop) (2.6%)
5.0 (Lollipop) (15.5%)
4.4 (Kit Kat) (39.3%)
4.3 (Jelly Bean) (4.7%)
4.2 (Jelly Bean) (15.9%)
4.1 (Jelly Bean) (13%)
4.0.3 - 4.0.4 (ICS) (4.1%)
2.3.3-2.3.7 (Gingerbread) (4.6%)
2.2 (Froyo) (0.3%)

August 2015

Android Version Fragmentation

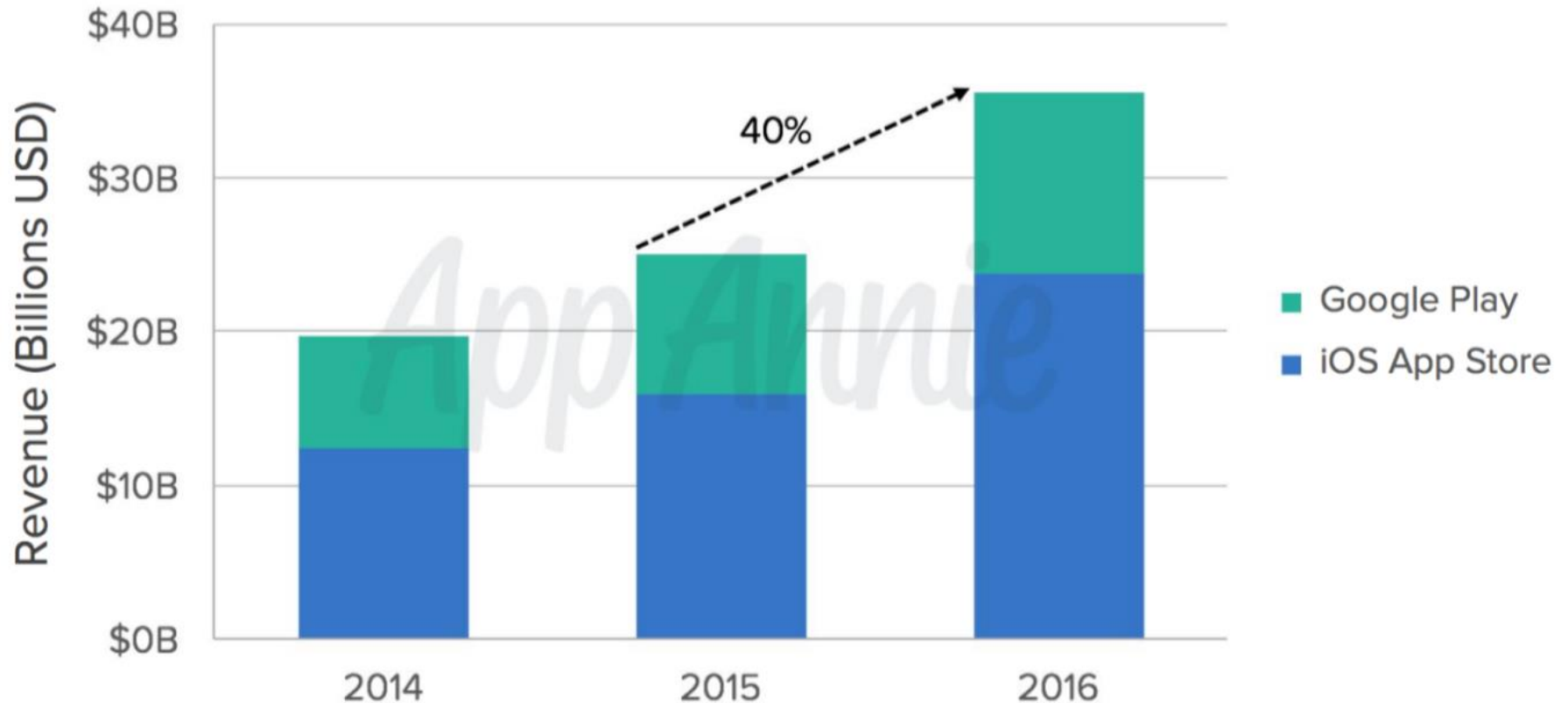
- Why as a developer do you care about the fragmentation of
 - Android versions, API level
 - screen sizes
 - manufacturers

Android vs iOS



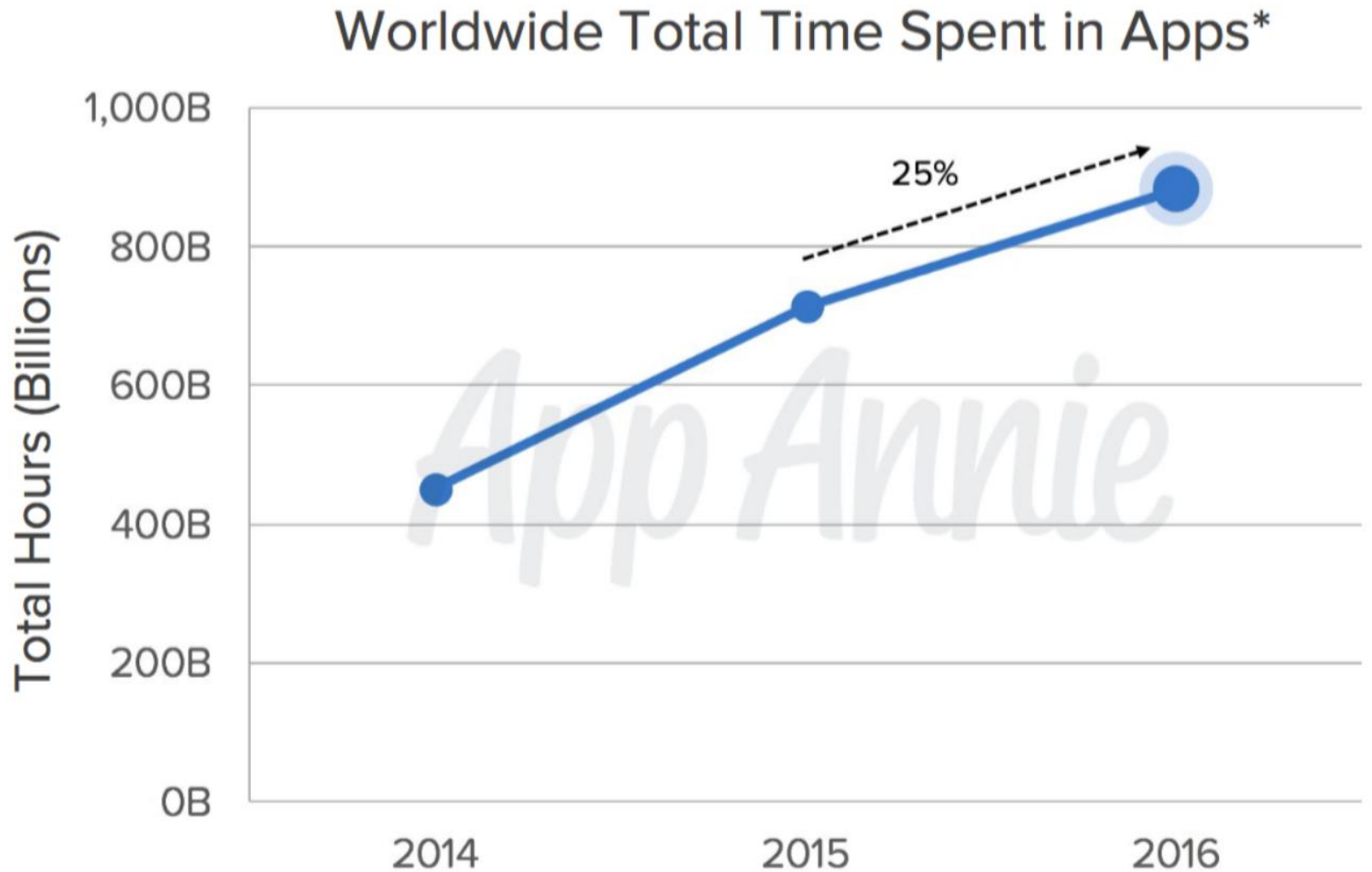
Revenue

Worldwide App Store Revenue



- Strategy: attract developers with comparison of revenue generated by applications, average revenue per user, etc.

Shift to Mobile Still Underway



*Android phone total time, excluding China

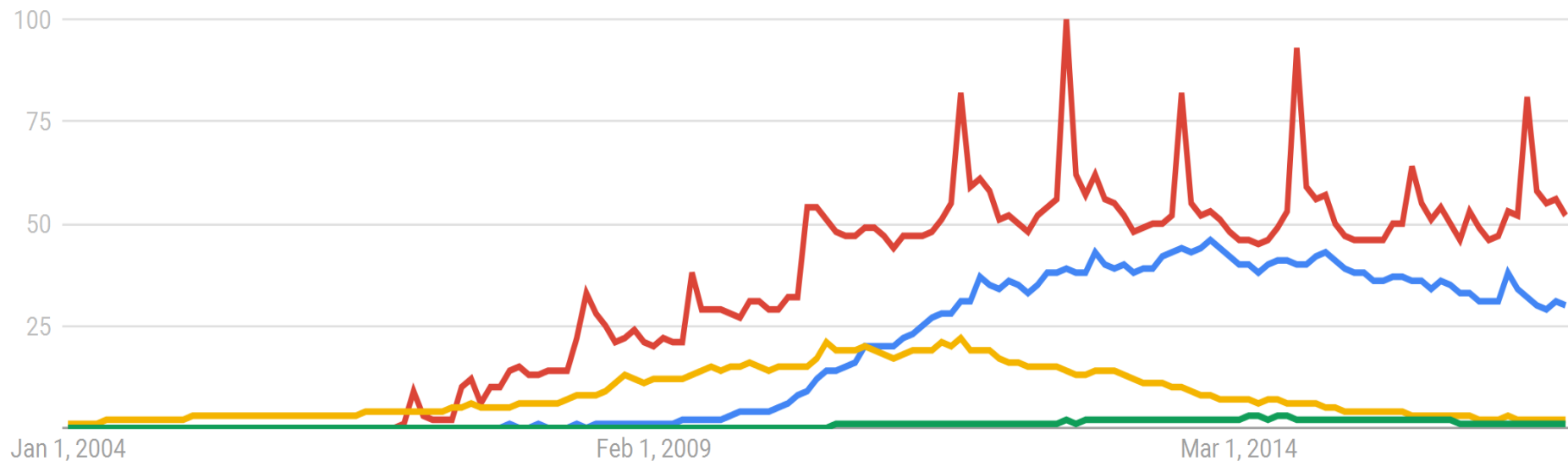
Search Trends January 2017

● android

● iPhone

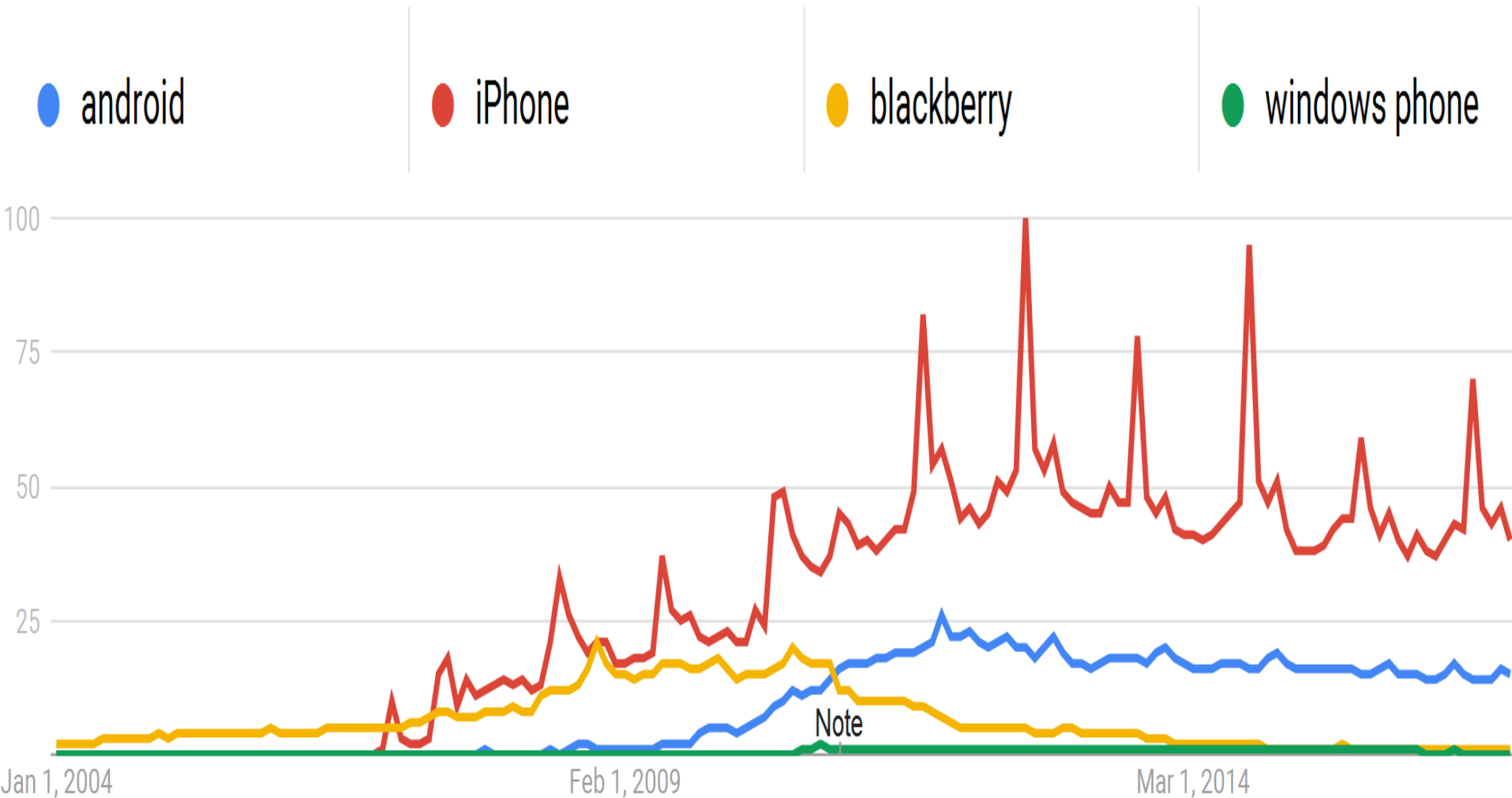
● blackberry

● windows phone



World wide (Add term galaxy?)

Search Trends January 2017



US only

Mobile Development

- Mobile "shops" (contract to develop mobile apps)
 - Mutual Mobile, Chaotic Moon, Nerd Ranch
- Companies tied to mobile
 - Bee Cave Games, Waze, Snapchat, Instagram
- Companies with major mobile apps
 - Facebook, Ebay
- Companies that want mobile apps for customers
 - banks, everybody??
- Companies that want mobile apps for internal use
 - everybody?

ANDROID DEVELOPMENT TOOLS

Setup Development Environment

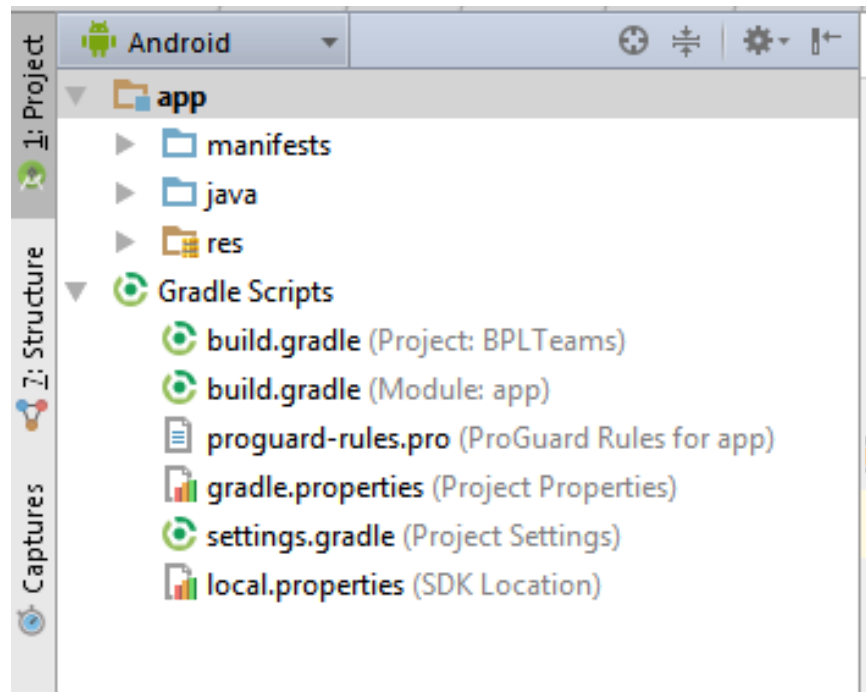
- Install JDK 8
- Install [Android Studio](#)
 - includes API level 25
- Use SDK manager to download lower API levels
 - I suggest down to 16
- Detailed install instructions available on Android site
<http://developer.android.com/sdk/installing.html>

Elements of Android Projects

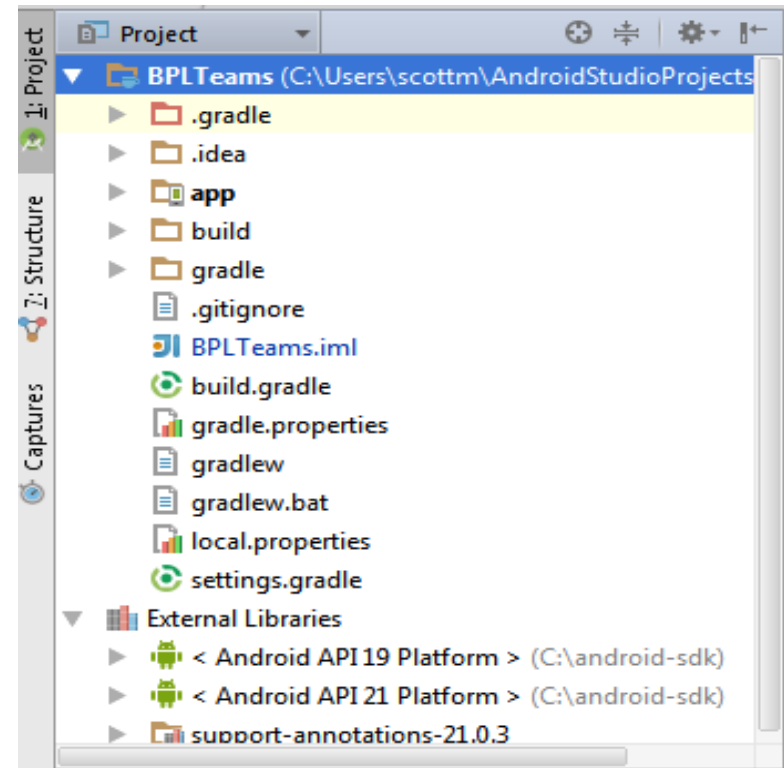
- ***Application Name***
 - seen by users on app chooser, app list, store
- ***Project Name***
 - in IDE, can be different, often directory
- ***Package Name***
 - Java package name, not using default package
- ***Minimum SDK Level***
 - how far back do you support, ~16 as of Jan 2017
- ***Target SDK Level***
 - device / api you had in mind for app, most recent?
- ***Theme***
 - look and feel of app, color scheme, various built in themes such as Theme, Holo, Material (Design)

Android Projects

- Creating a project results in multiple files and resources being created



Android Project View



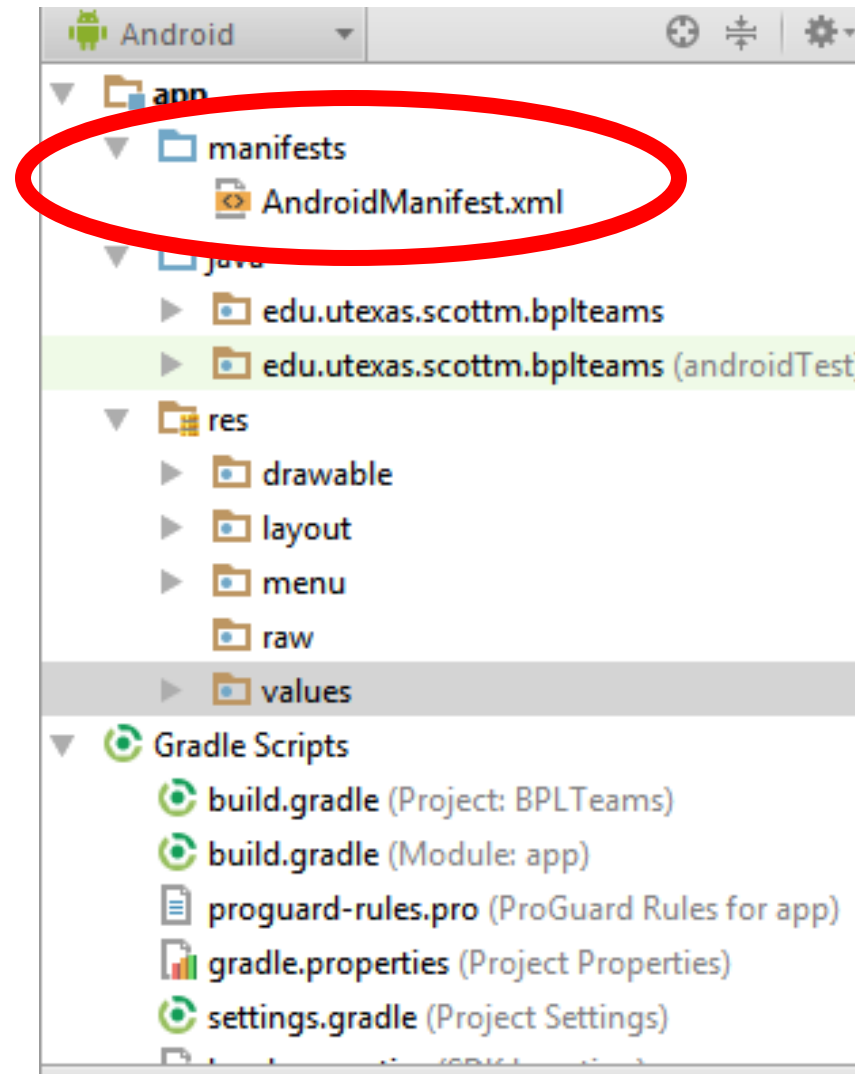
Classic Project View

ANDROID PROJECT COMPONENTS

Android Projects - Components

Manifest

- AndroidManifest.xml
- Like a table of contents for your app
- Main activity
- Target and min SDK
- Declare all the parts of your apps:
 - activities, services
- Request permissions
 - network, location, ...



Android Manifest - Sample

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="edu.utexas.scottm.bplteams" >
```



defines Android namespace

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

```
<application
    android:allowBackup="true"
    android:icon="@drawable/ic_launcher"
    android:label="BPL Teams"
    android:theme="@style/AppTheme" >
```

Android Manifest - Sample

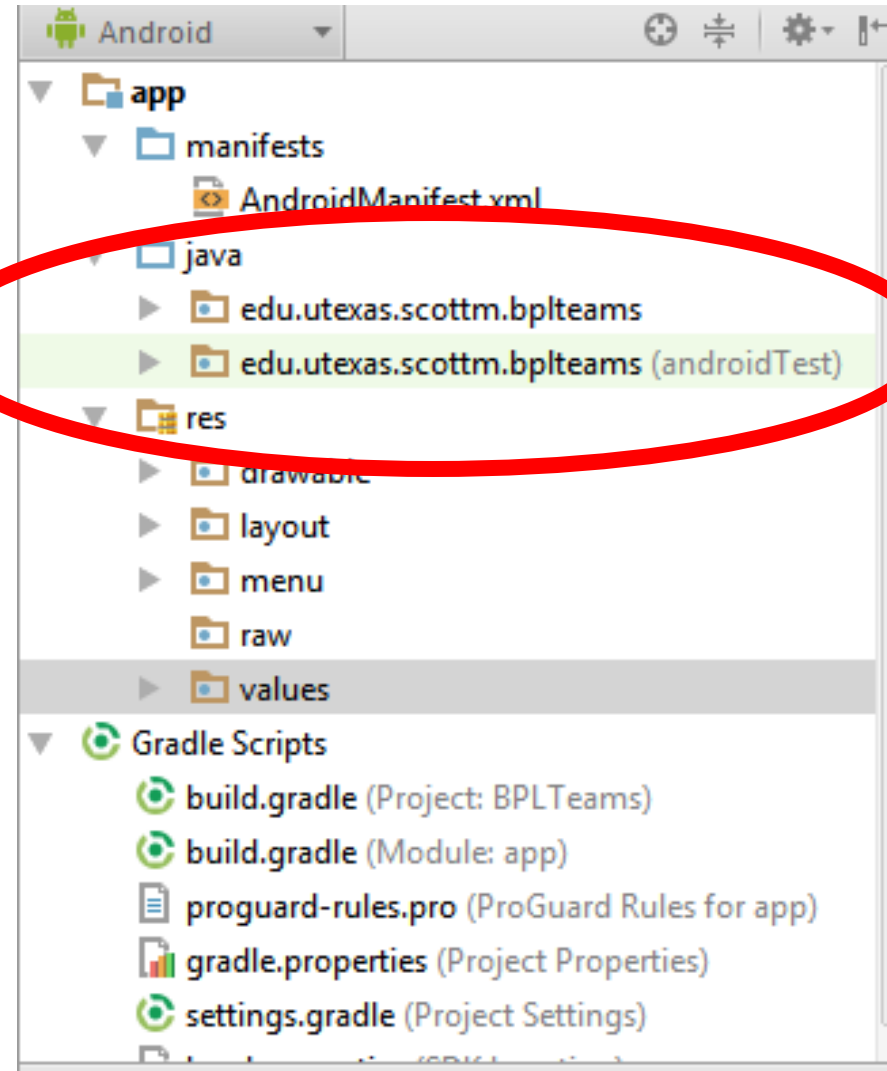
```
<application
    android:allowBackup="true"
    android:icon="@drawable/ic_launcher"
    android:label="BPL Teams"
    android:theme="@style/AppTheme" >
    <activity
        android:name=".BPL_Activity"
        android:label="BPL Teams" >
        <intent-filter>
            <action android:name="android.intent.action.MAIN" />
            <category android:name="android.intent.category.LAUNCHER" />
        </intent-filter>
    </activity>
</application>

</manifest>
```

Android Projects - Components

Java Source Code

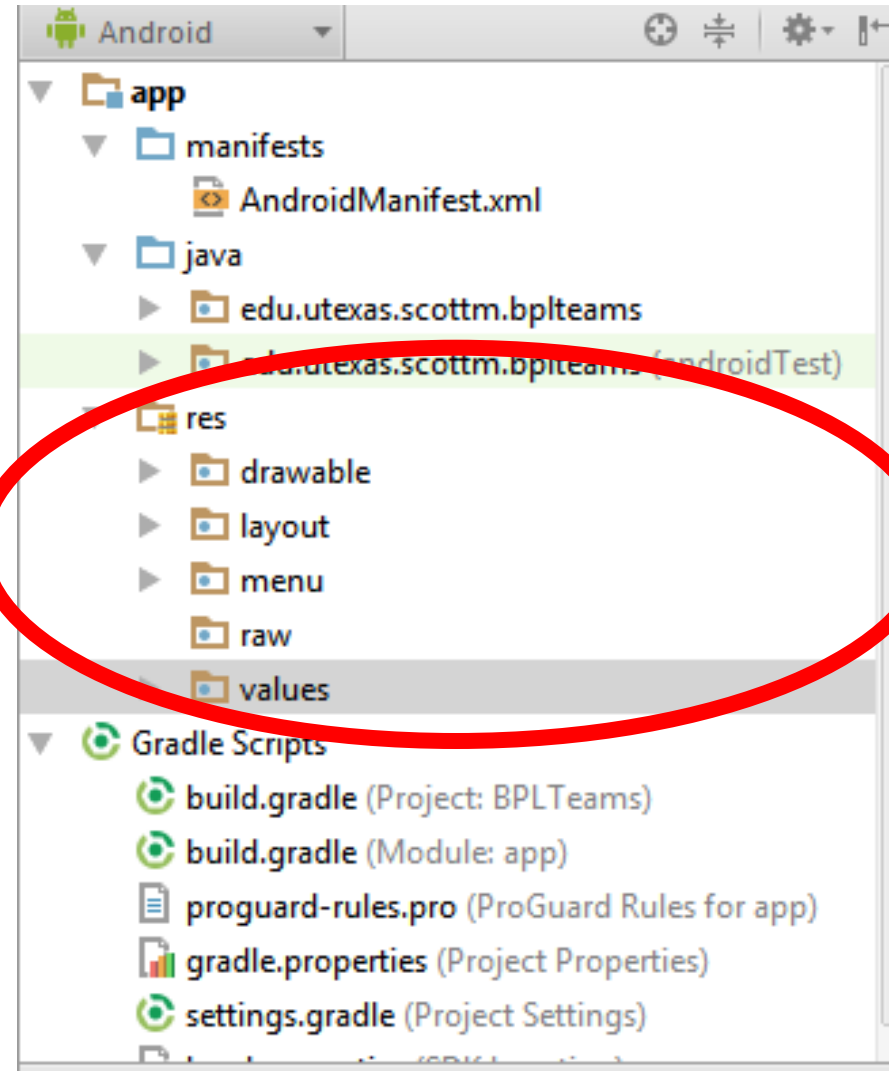
- Source Code:
- In java directory in Android Project View
- Actually in src directory on system



Android Projects - Components

Resources

- Resources or the res directory
- non source code resources for the app
- packaged up with app
- important role and use in development of app



Resource Directories

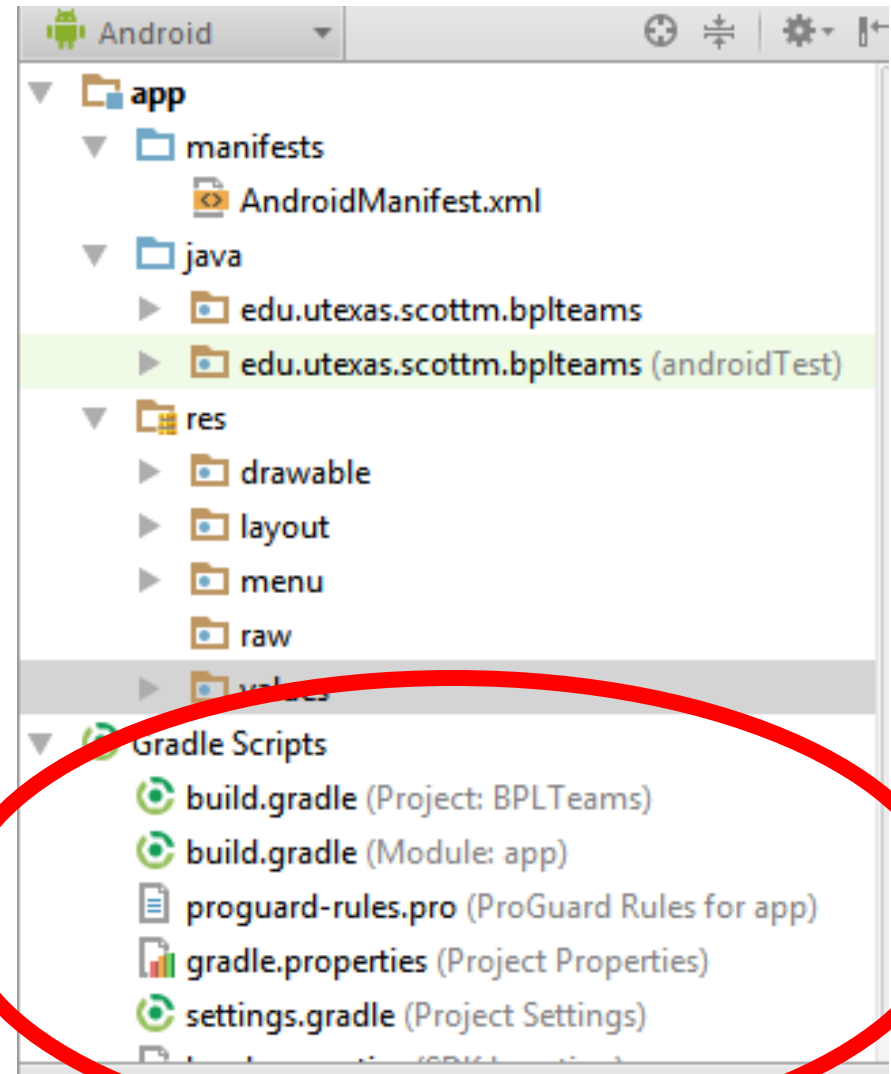
- res/drawable for graphic images such as png, jpeg
- res/layout for xml files that define the layout of user interfaces inside the app
- res/menu for xml based menu specifications
- res/values for lists of strings, dimensions, colors, lists of data
- res/raw for other kinds of files such as audio clips, video clips, csv files, raw text
- res/xml for other general purpose xml files

Gradle

- .apk files, Android Package Kit
 - Android executables
- Development environment takes, source code, manifest, libraries, resources, etc and packages them together in an APK
- some things known and set
- some things variable and configurable
- Gradle

Gradle

- Gradle is the build engine that Android Studio uses to convert your project into an APK
- What needs to be created and how to do it
- Like
 - make for C/C++
 - Ant/Maven for Java
- build.gradle file



sample build.gradle file - PROJECT

```
// Top-level build file where you can add
// configuration options common to all sub-projects/modules.

buildscript {
    repositories {
        jcenter()
    }
    dependencies {
        classpath 'com.android.tools.build:gradle:1.0.0'

        // NOTE: Do not place your application dependencies here
        // in the individual module build.gradle files
    }
}

allprojects {
    repositories {
        jcenter()
    }
}
```

sample build.gradle file - MODULE / APP

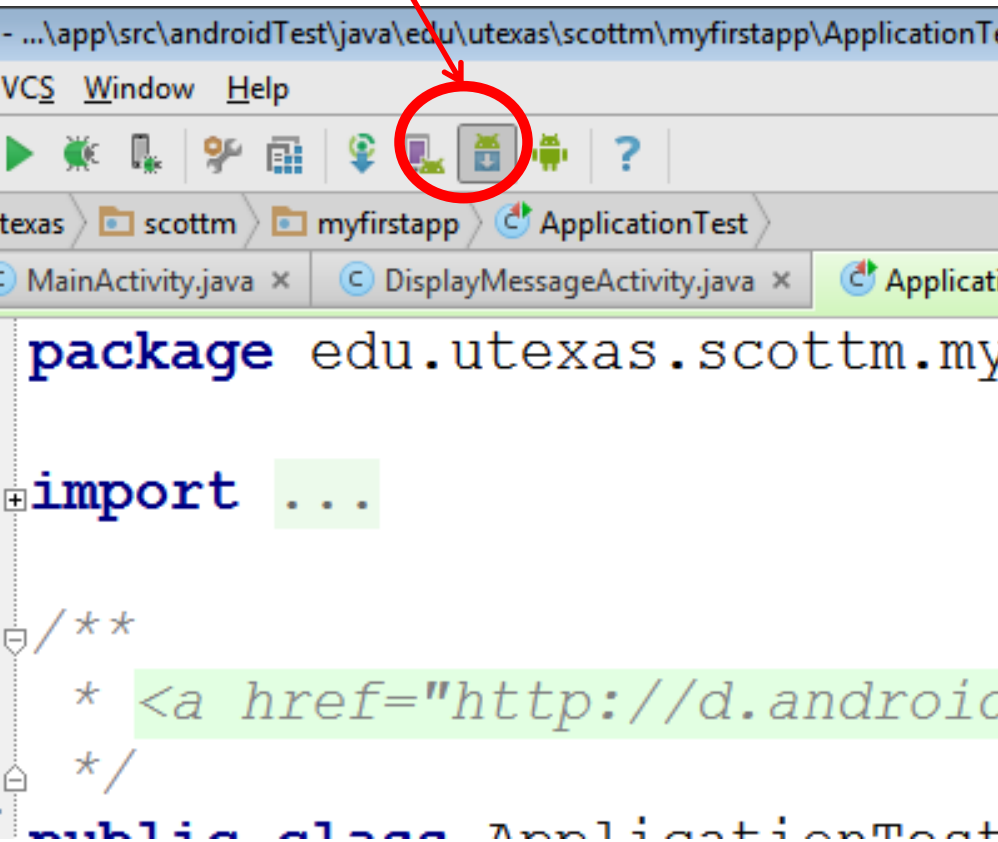
```
apply plugin: 'com.android.application'

android {
    compileSdkVersion 21
    buildToolsVersion "19.1.0"

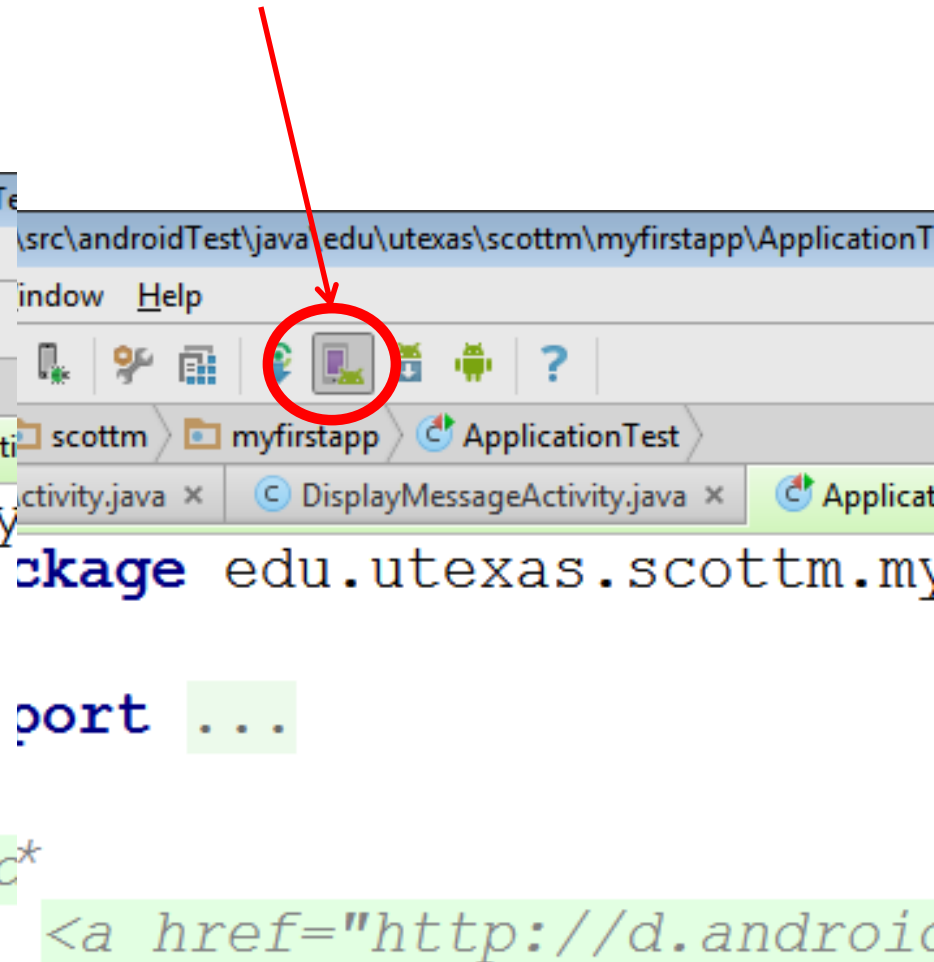
    defaultConfig {
        applicationId "edu.utexas.scottm.bplteams"
        minSdkVersion 15
        targetSdkVersion 21
        versionCode 1
        versionName "1.0"
    }
    buildTypes {
        release {
            minifyEnabled false
            proguardFiles getDefaultProguardFile('proguard-android.
        }
    }
}
```

EMULATORS

SDK Manager



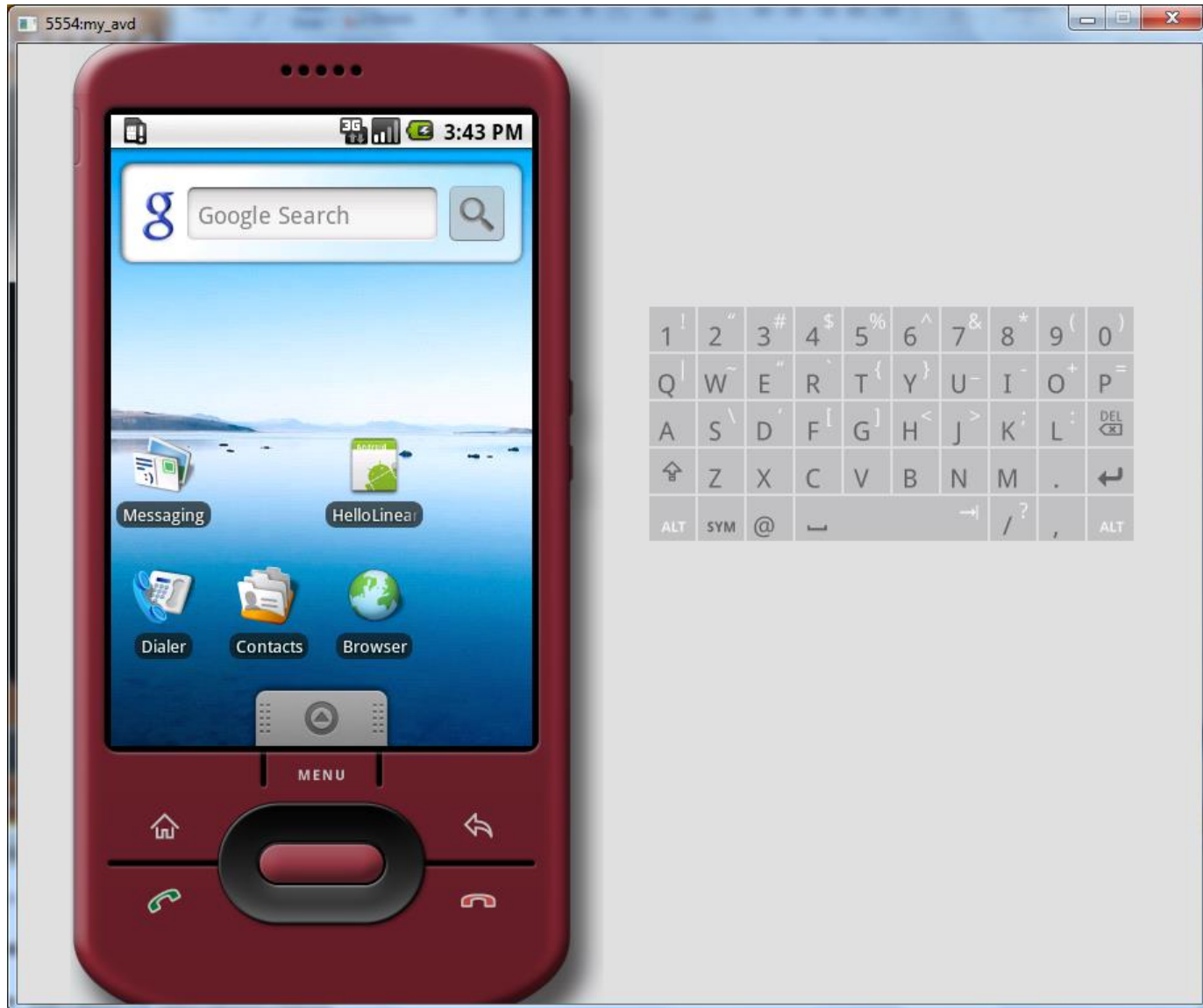
AVD Manager



Android Emulator or AVD

- Emulator is useful for testing apps but is not a substitute for a real device
- Emulators are called **Android Virtual Devices** (AVDs)
- Android SDK and AVD Manager allows you to create AVDs that target any Android API level
- AVD have configurable resolutions, RAM, SD cards, skins, and other hardware

Android Emulator: 1.6



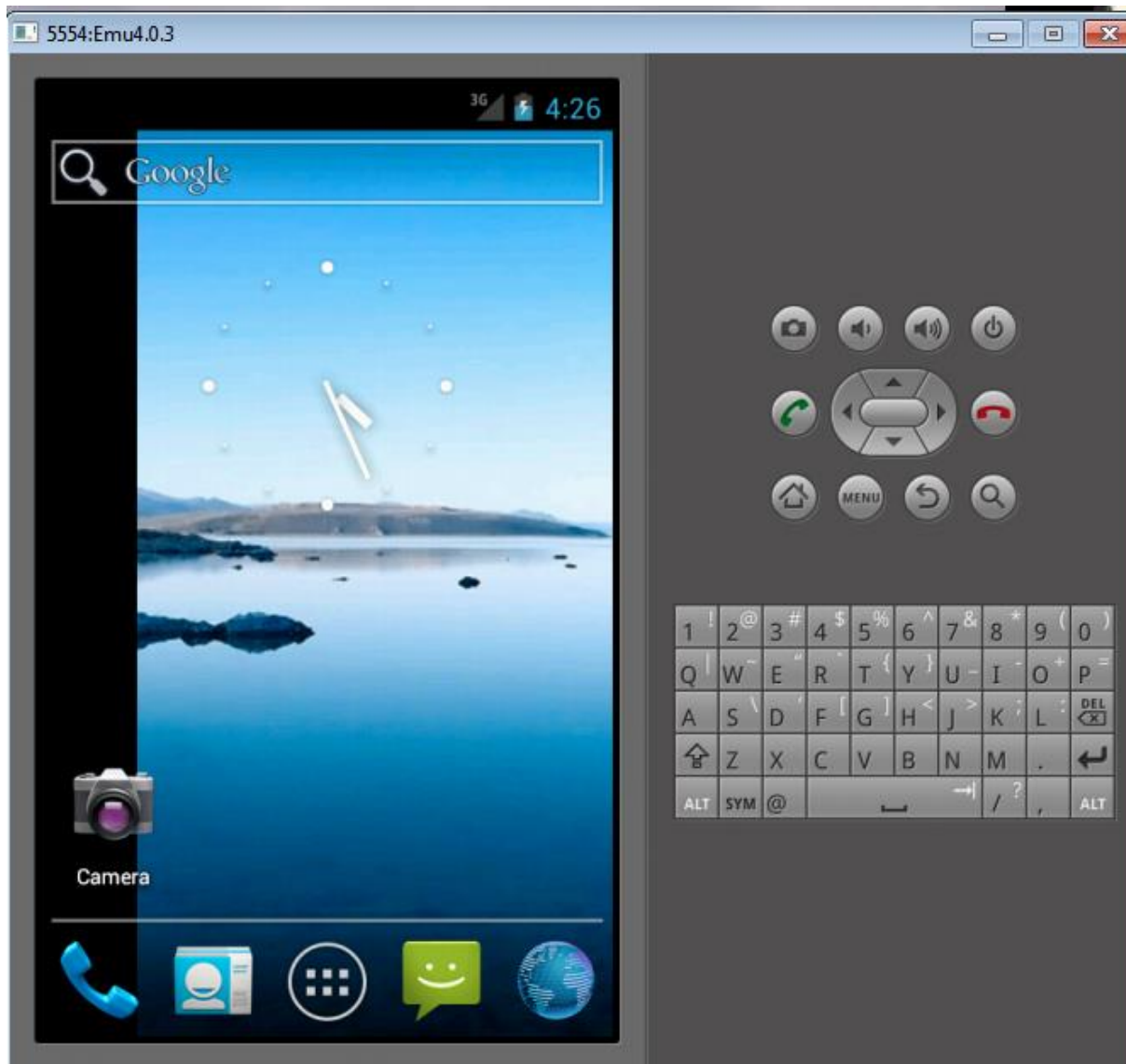
Android Emulator: 2.2



Android Emulator: 3.0



Android Emulator: 4.0



Android Emulator: 5.0



Controls

Emulator Basics

- Host computer's keyboard can be used
- Host's mouse acts as finger
- Uses host's Internet connection
- Other buttons work: Home, Back, Search, volume up and down, etc.
- More info at <https://developer.android.com/studio/run/managing-avds.html>

Emulator Limitations

- No support for placing or receiving actual phone calls
 - Simulate phone calls (placed and received)
- No support for USB connections
- No support for camera/video capture (input)
- No support for device-attached headphones
- No support for determining connected state
- No support for determining battery charge level and AC charging state
- No support for determining SD card insert/eject
- No support for Bluetooth
- No support for simulating the accelerometer
 - Use OpenIntents's Sensor Simulator

That's why we need the dev phones and tablets!

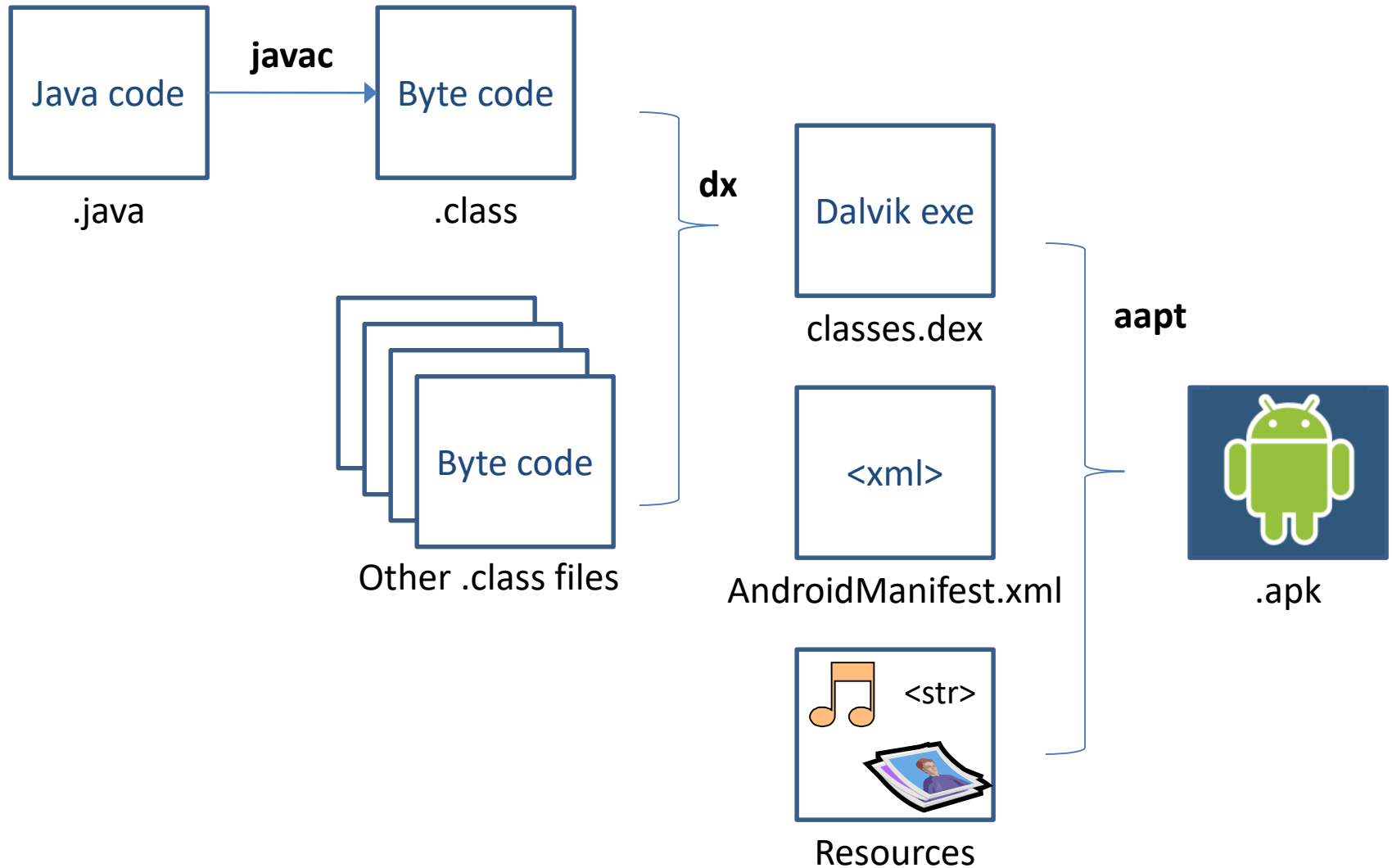
Android Runtime: Dalvik VM

- Subset of Java developed by Google
- Optimized for mobile devices (better memory management, battery utilization, etc.)
- Dalvik runs .dex files that are compiled from .class files
- Introduces new libraries
- Does not support some Java libraries like AWT, Swing
- <http://developer.android.com/reference/packages.html>

Applications Are Boxed

- By default, each app is run in its own Linux process
 - Process started when app's code needs to be executed
 - Threads can be started to handle time-consuming operations
- Each process has its own Dalvik VM
- By default, each app is assigned unique Linux ID
 - Permissions are set so app's files are only visible to that app

Producing an Android App



Other Dev Tools

- Android Debug Bridge
- Part of SDK
- command line tool to communicate with an emulator or connected Android device
 - check devices attached / running
 - install apk's, **Android PacKage** files, "executables", can find samples on places besides Google Play (security?)
 - and more!

<https://developer.android.com/studio/command-line/adb.html>

Dalvik Debug Monitor Server

- DDMS
- debugging tool
- "provides, screen capture on the device, thread and heap information on the device, logcat, process, and radio state information, incoming call and SMS spoofing, location data spoofing, and more."
- can interact with DDMS via Android Studio

DDMS

DDMS - AndroidTicTacToe-Tutorial2/res/layout/main.xml - Eclipse SDK

File Edit Refactor Run Navigate Search Project Window Help

Devices

Name			
com.android.settings	147	8605	
android.process.acore	169	8606	
com.android.deskclock	184	8607	
com.android.protips	203	8608	
com.android.music	214	8609	
com.android.quicksearchbo	230	8612	
com.android.defcontainer	238	8614	
android.process.media	246	8616	
com.android.mms	261	8618	
com.android.email	282	8620	
com.svox.pico	302	8622	
scottmd3.tictactoe	322	8624 / 8700	
scott.examples.lifeCycleTest	333	8625	

Threads Heap Allocation Tracker File Explorer

Heap updates will happen after every GC for th

ID	Heap Size	Allocated	Free	% Used	# Objects
1	5,254 MB	2,551 MB	2,703 MB	48.56%	48,634

Cause GC

Display: Stats

Type	Count	Total Size	Smallest	Largest	Median	Average
free	5,338	2,691 MB	16 B	78,516 KB	176 B	528 B
data object	33,061	996,391 KB	16 B	672 B	32 B	30 B
class object	2,042	586,086 KB	168 B	26,836 KB	168 B	293 B
1-byte array (byte[], boolean[])	1,563	228,414 KB	24 B	1,977 KB	40 B	149 B
2-byte array (short[], char[])	8,957	564,203 KB	24 B	28,023 KB	48 B	64 B
4-byte array (object[], int[], float[])	2,789	227,836 KB	24 B	16,023 KB	40 B	83 B
8-byte array (long[], double[])	222	9,352 KB	32 B	1,000 KB	32 B	43 B

Allocation count per size

Emulator Control

Telephony Status

Voice: home Speed: Full

Data: home Latency: None

Telephony Actions

Incoming number:

Message:

LogCat

Search for messages. Accepts Java regexes. Prefix with pid, app, tag; or text to limit scope.

verbose

L...	Time	PID	Application	Tag	Text
W	01-29 19:31:23.124	61	sys...	InputManagerService	Window already focused, ignoring focus gain of: c...
D	01-29 19:31:24.194	322	scott...	TicTacToeGame	Computer moving to 5 as a random move.
D	01-29 19:31:27.865	322	scott...	TicTacToeGame	Computer moving to 6 to block win.
D	01-29 19:31:29.875	322	scott...	TicTacToeGame	Computer moving to 1 to block win.
D	01-29 19:32:26.682	322	scott...	dalvikvm	+++ active profiler count now 1
I	01-29 19:32:26.682	322	scott...	dalvikvm	TRACE STARTED: '[DDMS]' 8192KB
I	01-29 19:32:32.656	322	scott...	dalvikvm	dvmDdmHandleHpsgChunk(when 1, what 0, heap 0)

iPhone vs. Android

