



Google

ANDROID

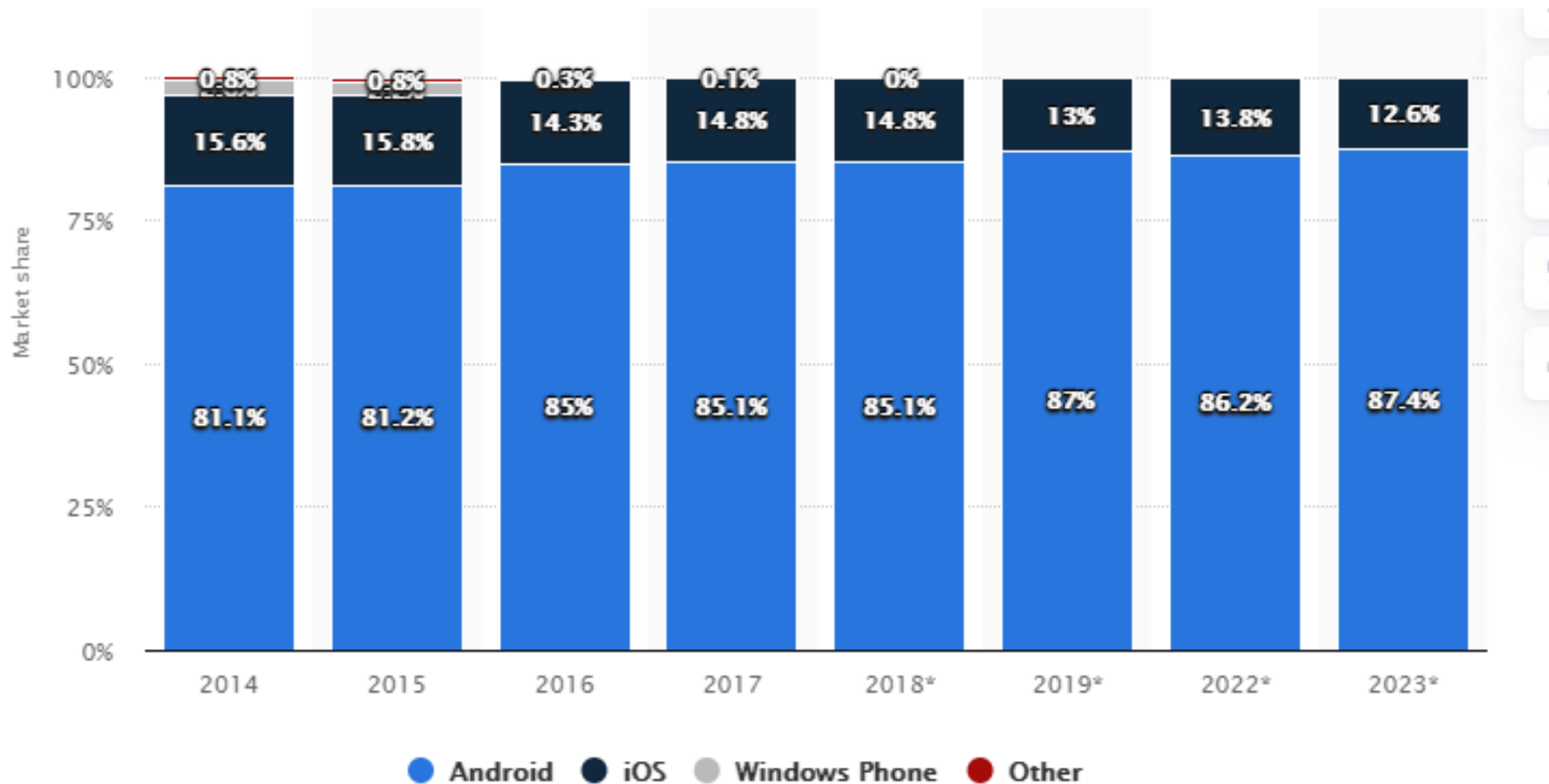
Everybody wants **Smart Phone** to act as

- Phone
- Pager
- PDA Organizer
- High quality camera (still and video)
- Portable TV/ radio/ audio-video player
- Laptop
- Play station
- GPS
- Book Reader
- Car/Home/Office key
- Remote control
- Cash on demand
- Mentor/advisor
-

What makes a **Smart Phone** so smart?

- Operating System
- Web Access
- Apps
 - Web apps: run in a web browser
 - HTML, JavaScript, Flash, server-side components etc.
 - Native: compiled binaries for the device
 - Often make use of web services
- Data Syncs
- Hardware sensors like GPS, compass, accelerometer,, gyroscope, proximity sensor
- Cameras

Major Operating systems for Smart Phones



Android finally stands first



The word Android means **Human with a robot appearance**

Android Devices



Android

- An open source platform for mobile, embedded and wearable devices
- Google is the principle maintainer while several other companies contribute to the system.
- Device manufacturers can customize Android to suite their needs.
- Being open source, it can be liberally extended to incorporate new cutting edge technologies as they emerge.

Android

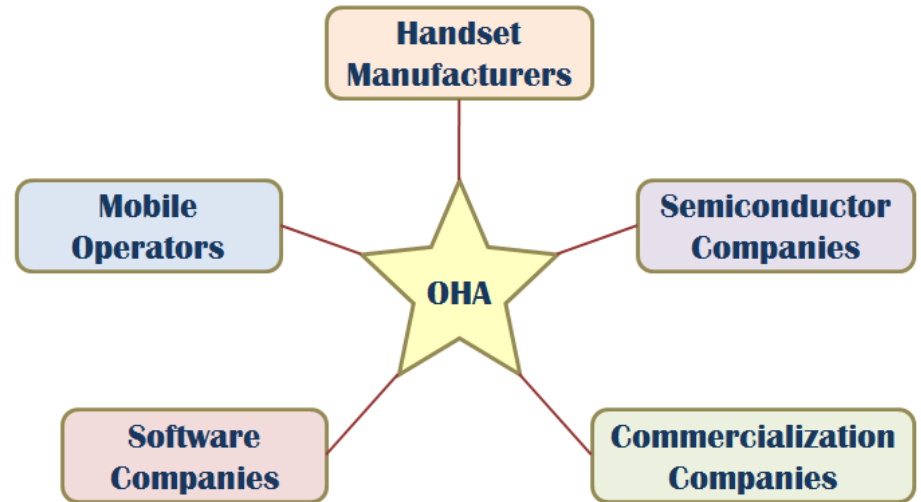
- provides connectivity
 - ❖ 3G Networks
 - ❖ 4G Networks
 - ❖ 802.11 Wi-Fi Networks
 - ❖ Bluetooth Connectivity
- a multi-process system, in which each application runs in its own process.
- supports advanced audio/video/still media formats such as MPEG-4, H.264, MP3 and AAC, AMR, JPEG, PNG, GIF.
- Except Android 1.0 and 1.1, all the other Android versions are named after sweet treats like Jelly Bean, Ice Cream Sandwich, Honeycomb etc.

Android –Facts

- ❑ Android is dominating the mobile market by powering **hundreds of millions** of mobile devices in more than **190 countries** around the world.
- ❑ Android is available in around **46 languages**, this also means apps can be produced in different languages to cover a wider audience.
- ❑ Android users are able to choose from **millions of** apps from Google Play and most of them are free.
- ❑ There is an Android running device in space. NASA equipped Floating space robots with Nexus S handsets running on Android Gingerbread.
- ❑ Google makes its biggest revenue from advertising.

Open Handset Alliance (OHA)

A business alliance consisting of 84 companies



Open Handset Alliance Members

Operators	Software Co.	Commercializat.	Semiconductor	Handset Manf
China Mobile	Ascender Corp.	Aplix	Audience	ACER
China Unicom	eBay	Noser Engineering	Broadcom Corp.	ASUS
KDDI Corp.	Esmertec	Astonishing Tribe	Intel Corp.	HTC
NTT DoCoMo	Google	Wind River Systems	Marvell Tech.	LG
Sprint Nextel	LivingImage	Omron Software	Group	Motorola
T-Mobile	NMS Comm.	...	Nvidia Corp.	Samsung
Telecom Italia	Nuance Comm.	Teleca	Qualcomm	ASUSTek
Telefónica	PacketVideo		SiRF Tech. Holdings	Garmin
Vodafone	SkyPop		Synaptics	Huawei Tech
Softbank	SONI VOX		Texas Instr.	LG
...	...		AKM Semicond.	Samsung
Ericsson	Borqs		ARM	...
			Atheros Comm	Sony Ericsson
			...	Toshiba
			EMP	

Open Handset Alliance (OHA)

- Quoting from **www.OpenHandsetAlliance.com**
- "... Open Handset Alliance a group of 84 technology and mobile companies have come together to accelerate innovation in mobile and offer consumers a richer, less expensive, and better mobile experience.
- Together we have developed Android, the first complete, open, and free mobile platform.
- We are committed to commercially deploy handsets and services using the Android Platform. "

Android –Brief History

- Android Inc. was founded way back in 2003 at Palo Alto, California.
- Android was developed by the Andy Rubin, Rich Miner, Nick Sears and Chris White.
- Android was named after Andy Rubin, co-creator of Android. It was the name given to him for his obsession and love for robots.
- Android was purchased by the Google in August, 2005 for 50 million \$.
- Android operating system was developed as a platform for digital cameras. But Google later changed its focus to smart phones as it saw its potential.

Android -Brief History

□ 2005

- Google acquires startup Android Inc. to start Android platform
- Work on Dalvik VM begins

□ 2007

- Open Handset Alliance announced
- Early look at SDK

□ 2008

- Google sponsored 1st Android Developer Challenge
- T-Mobile G1 (HTC Dream) announced
- SDK 1.0 released
- Android released open source (Apache License)
- Android Dev Phone 1 released

Android Versions



Android Beta

- ✓ First Version of Android.
- ✓ The focus of Android beta was testing usability.
- ✓ Android beta had many problems on speed and performance.

Android Astro Boy 1.0

- ✓ First full version of android.
- ✓ Released on September 23, 2008.
- ✓ Wi-Fi and Bluetooth support.
- ✓ Quite slow in operations.
- ✓ Copy and paste feature in the web browser was not present.

Android Petit Four 1.1

- ✓ Released on Feb. 9, 2009.
- ✓ Ability to save attachments in messages.
- ✓ Support added for marquee in system layouts.

➤ **Android Cupcake 1.5**

- ✓ Released on **April 30, 2009**.
- ✓ Added auto-rotation option.
- ✓ Copy and Paste feature added in the web browser.
- ✓ Increased speed and performance but not upto required level.



➤ **Android Donut 1.6**

- ✓ Released on **September 15, 2009**.
- ✓ Voice search and Search box were added.
- ✓ Faster OS boot time and fast web browsing experience.
- ✓ Typing was quite slower.



➤ **Android Éclair 2.0/2.1**

- ✓ Released on **October 26, 2009**.
- ✓ Bluetooth 2.1 support.
- ✓ Improved typing speed on virtual keyboard, with smarter dictionary.
- ✓ no Adobe flash media support.



➤ **Android Froyo 2.2**

- ✓ Released on **May 20, 2010.**
- ✓ Support for Adobe Flash, tethering
- ✓ Improved Application launcher with better browser
- ✓ No internet calling.



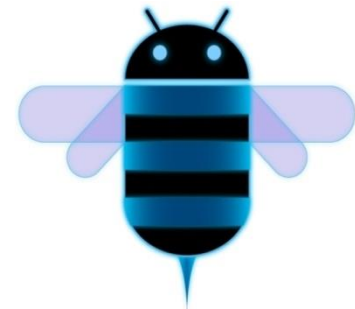
➤ **Android Gingerbread 2.3**

- ✓ Released on **December 6, 2010.**
- ✓ Updated User Interface with high efficiency and speed
- ✓ Internet calling
- ✓ One touch word selection and copy/paste.
- ✓ New keyboard for faster word input.
- ✓ More successful version of Android than previous versions.
- ✓ Voice or video chat using Google Talk
- ✓ not supporting multi-core processors.



➤ **Android Honeycomb 3.0**

- ✓ Released on **February 22, 2011.**
- ✓ Support for multi-core processors
- ✓ Ability to encrypt all user data.
- ✓ This version of android is only available for tablets.



➤ **Android IceCreamSandwich 4.0**

- ✓ Released on **November 14, 2011.**
- ✓ Virtual button in the UI.
- ✓ Support for NFC
- ✓ Better voice recognition (dictating/Voice typing)
- ✓ Facial recognition (Face Unlock)



➤ **Android JellyBean 4.1**

- ✓ Released on **June 27, 2012.**
- ✓ Triple buffered graphics pipeline
- ✓ Smoother user interface.
- ✓ Security and performance enhancements
- ✓ Camera app UI updated



➤ **Android KitKat 4.4**

- ✓ Released on **Oct. 31, 2013.**
- ✓ Screen recording
- ✓ New Translucent system UI
- ✓ Enhanced notification access
- ✓ System Performance improvements



➤ **Android Lollipop 5.0**

- ✓ Released on **Oct. 17, 2014.**
- ✓ New Material design
- ✓ Battery consumption improvement
- ✓ Multiple SIM cards support
- ✓ Quick settings shortcuts to join Wi-Fi networks or control Bluetooth devices
- ✓ Lock protection if lost or stolen
- ✓ High Definition voice call
- ✓ Stability and performance enhancements



➤ **Android Marshmallow 6.0**

- ✓ Released on **Oct. 5, 2015.**
- ✓ USB Type-C support
- ✓ Fingerprint Authentication support
- ✓ Better battery life with "deep sleep"
- ✓ Permissions dashboard
- ✓ Android Pay
- ✓ MIDI support



➤ **Android Nougat 7.0**

- ✓ Released on [Aug. 22, 2016.](#)
- ✓ Better multitasking
- ✓ Seamless system updates (with dual system partition)
- ✓ Better performance
- ✓ Night Light
- ✓ Storage manager improvements
- ✓ Performance improvements for Touch and Display management



➤ **Android Oreo 8.0**

- ✓ picture-in-picture (PIP) mode.
- ✓ ...

➤ **Android Pie 9.0**

- ✓ New Gesture Navigation
- ✓ Adaptive Battery and Brightness ...

➤ **Android 10.0**

- ✓ Background access to camera, microphone and sensors disabled for more privacy protection
- ✓ New system-wide dark theme/mode ...
- ✓ Addition of Kotlin language

➤ **Android 11 is the eleventh major version of the Android operating system called “R” on Sep., 2020**

Android Distribution

Version	Codename	API	Distribution
2.3.3 - 2.3.7	Gingerbread	10	0.3%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	0.3%
4.1.x	Jelly Bean	16	1.2%
4.2.x		17	1.5%
4.3		18	0.5%
4.4	KitKat	19	6.9%
5.0	Lollipop	21	3.0%
5.1		22	11.5%
6.0	Marshmallow	23	16.9%
7.0	Nougat	24	11.4%
7.1		25	7.8%
8.0	Oreo	26	12.9%
8.1		27	15.4%
9	Pie	28	10.4%

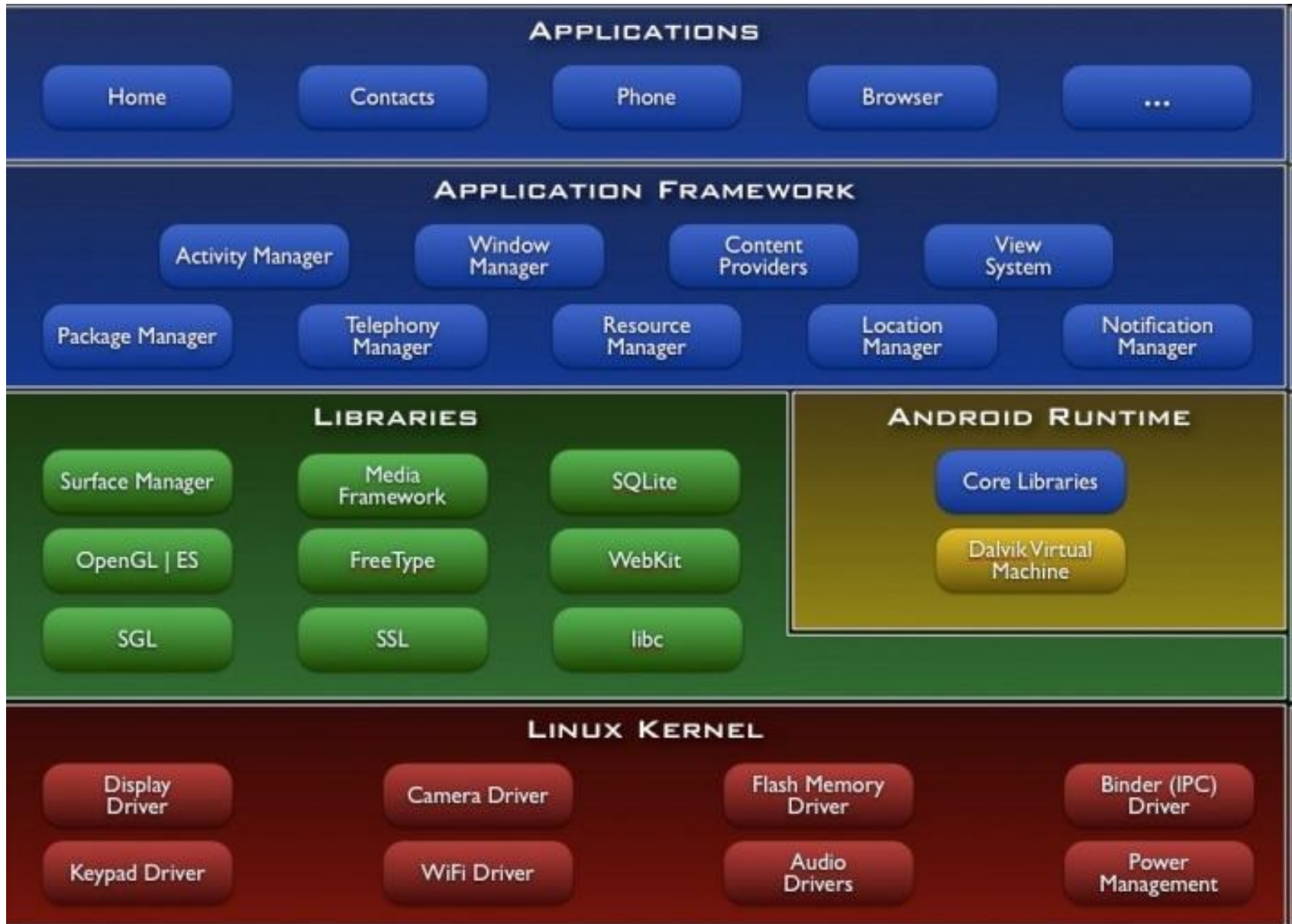
Source: <http://developer.android.com/resources/dashboard/platform-versions.html>

Technically speaking

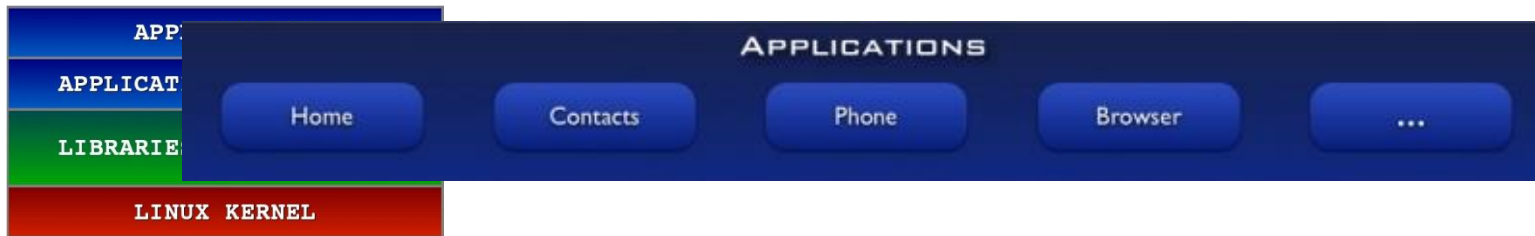


Android is a software stack for mobile devices that includes an operating system, middleware and key applications.

Architecture



Android S/W Stack - Application



- Android provides a set of core applications:
 - ✓ Email Client
 - ✓ SMS Program
 - ✓ Calendar
 - ✓ Maps
 - ✓ Browser
 - ✓ Contacts
 - ✓ And many more

- All applications are generally written using the Java language.

Android S/W Stack – App Framework



- Enabling and simplifying the reuse of components
 - ✓ Applications can publish their capabilities and any other application may then make use of those capabilities
 - ✓ Developers have full access to the same framework APIs used by the core applications.
 - ✓ Users are allowed to replace components.

Android S/W Stack – App Framework



- Contains all classes, cores and services that are used to build Android apps
- Categorization
 - Hardware services
 - Core platform services

Hardware Services

- Telephony Service
- Location Service
- Bluetooth Service
- Wi-Fi Service
- USB Service
- Sensor Service



Core Platform Services

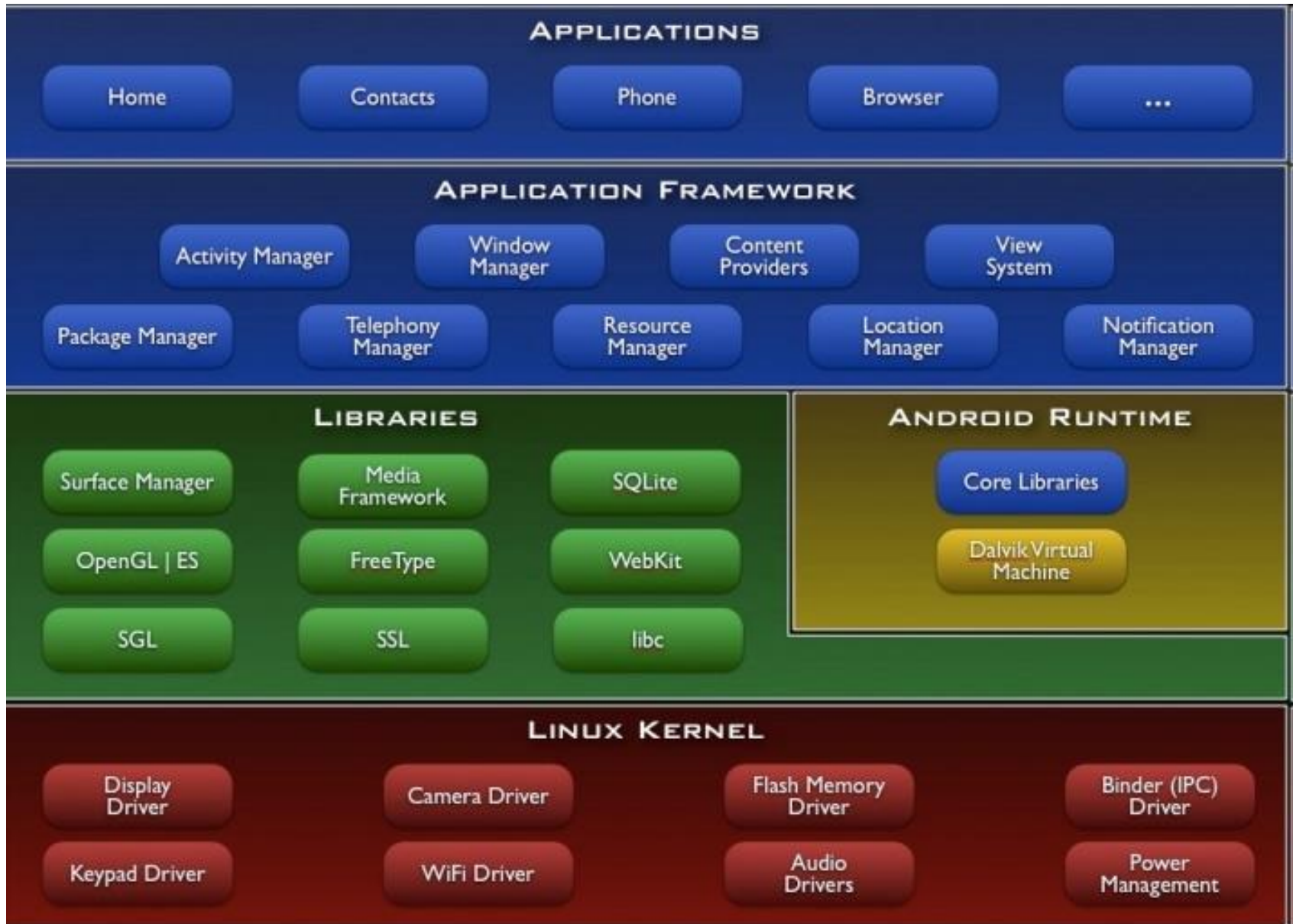
- Services that are essential to the Android platform, e.g.
 - Manage application lifecycle, manage package, load resources
- Working behind the scenes
 - Applications don't access/interrupt them directly
- Core platform services
 - Activity Manager
 - Package Manager
 - Window Manager
 - Resource Manager
 - Content Providers
 - View System



Core Platform Services (cont.)

Feature	Role
View System	Used to build an application, including lists, grids, text boxes, buttons, and embedded web browser
Content Provider	Enabling applications to access data from other applications or to share their own data
Resource Manager	Providing access to non-code resources (localized strings, graphics, and layout files)
Notification Manager	Enabling all applications to display customer alerts in the status bar
Activity Manager	Managing the lifecycle of applications

Architecture

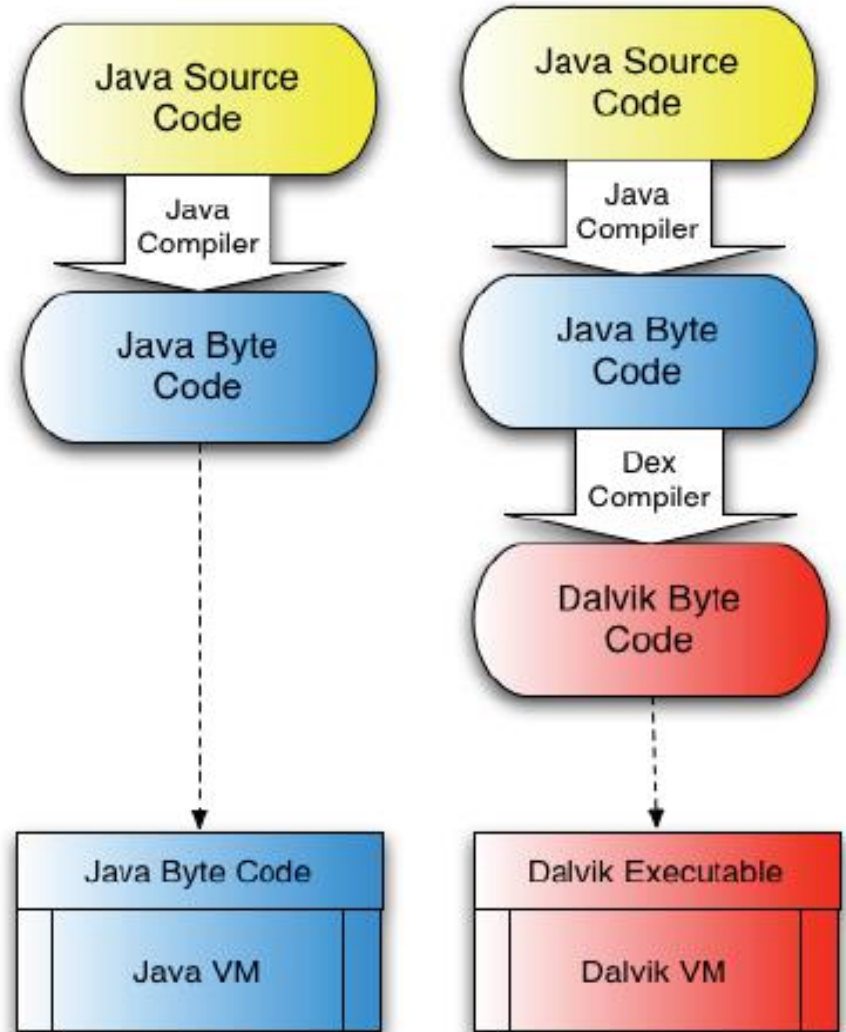


Android S/W Stack - Libraries



- ❑ Bionic, a super fast and small GPL-based standard C system library (libc) optimized for embedded Linux-based devices
- ❑ Surface Manager for composing window manager with off-screen buffering for 2D and 3D graphics hardware support or software simulation
- ❑ Media codecs offer support for major audio/video codecs
- ❑ SQLite database
- ❑ WebKit library for fast HTML rendering
- ❑ Exposed to developers through the Android application framework

Android S/W Stack - Android Runtime



Android S/W Stack – Runtime (cont.)

- ❑ Dalvik VM is Google's implementation of Java
- ❑ Execute the Dalvik Executable (.dex) format
- ❑ Optimized for minimal memory footprint
- ❑ Provides Android apps portability and run time consistency

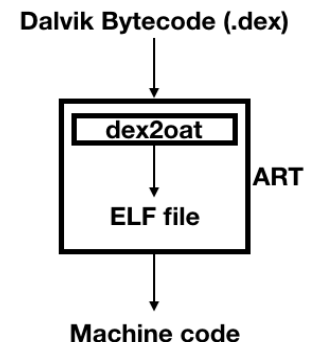
- ❑ Relying on the Linux Kernel for:
 - Threading
 - Low-level memory management

- ❑ Key Dalvik differences:
 - Register-based versus stack-based VM
 - More efficient and compact implementation
 - Different set of Java libraries than SDK

Android ART

- ❑ Android Runtime has replaced DVM since Android Lollipop. ART uses Ahead of Time Approach (AOT) instead of JIT.
- ❑ Using AOT, the dex files are compiled before they are needed. Usually, they are done at installation time only and then stored in phone storage.
- ❑ **dex2oat** is a utility used when installing for updating applications
- ❑ **ELF** (Executable and Link formatable format)

- ❑ <https://www.geeksforgeeks.org/difference-between-dalvik-and-android/>



Android S/W Stack – Linux Kernel

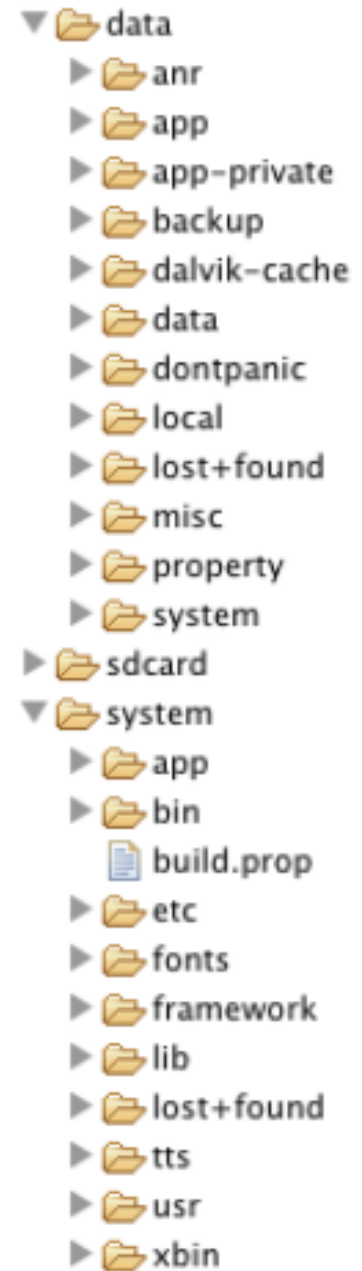


- Relying on Linux Kernel 2.6 for core system services
 - ✓ Memory and Process Management
 - ✓ Power management
 - ✓ Network Stack
 - ✓ Driver Model
 - ✓ Security
- Providing an abstraction layer between the H/W and the rest of the S/W stack



File System

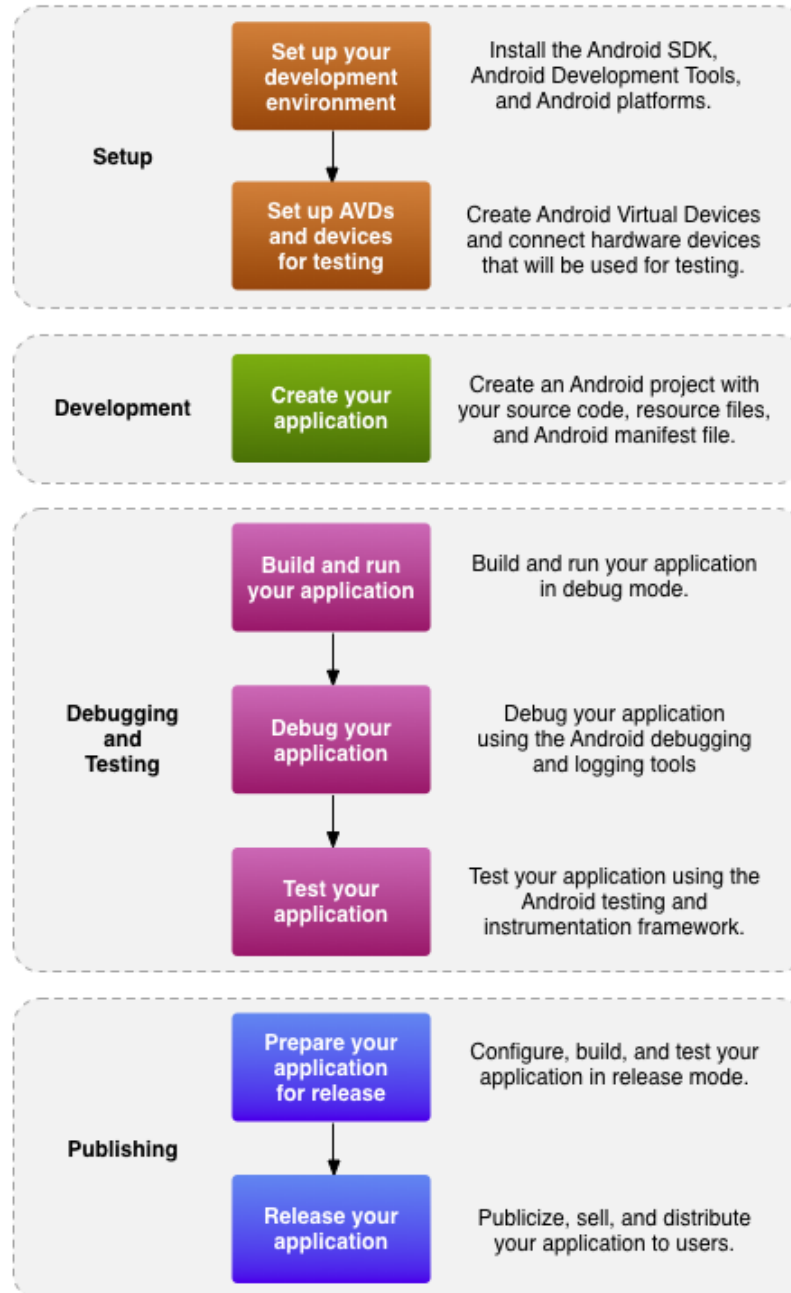
- The file system has three main mount points.
 - One for system,
 - one for the apps,
 - and one for others
- Each app has its own sandbox easily accessible to it. No one else can access its data. The sandbox is in `/data/data/package_name/`
- SDCard is always there. It's a good place for large files, such as movies and music. Everyone can access it.



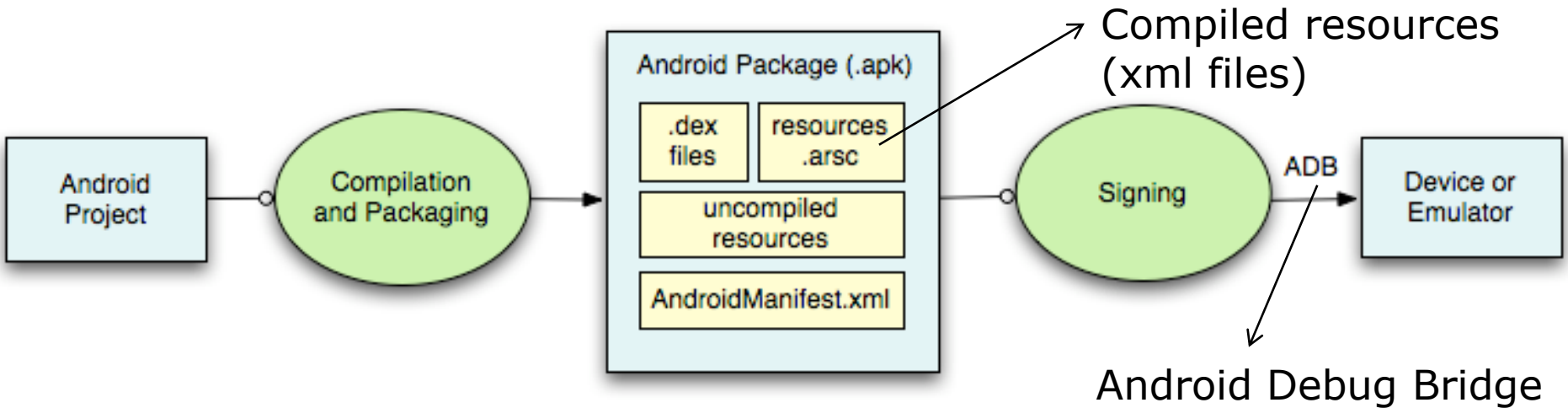
Database Support

- ❑ The Android API contains support for creating and using SQLite databases. Each database is private to the application that creates it.
- ❑ SQLite, a database tool enables you to browse table contents, run SQL commands, and perform other useful functions on SQLite databases.
- ❑ All databases, SQLite and others, are stored on the device in `/data/data/package_name/databases`.

Development Process for an Android app



Building and Running

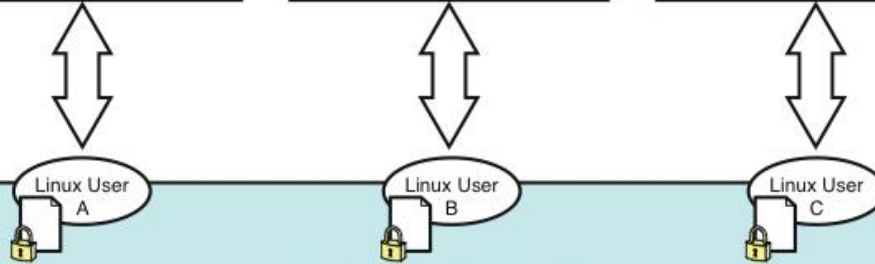
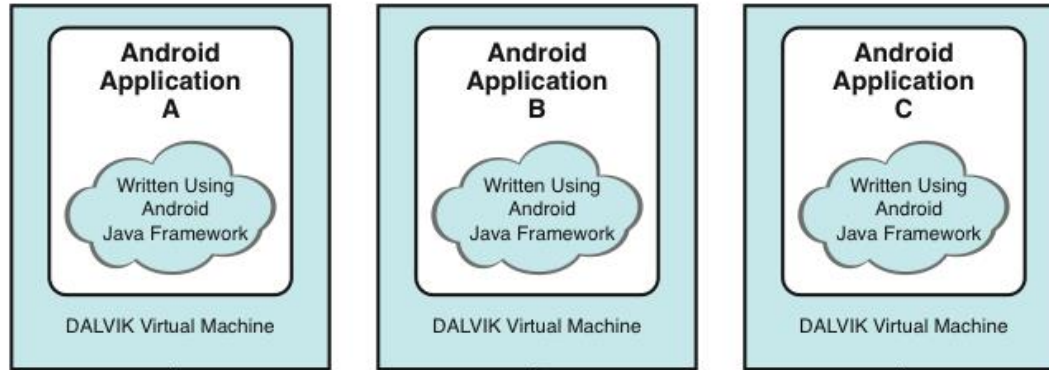


- ❑ ADB is a client server program that lets you communicate with an emulator instance or connected Android device for installing and debugging apps
- ❑ ADB is included in the Android SDK Platform
- ❑ An IDE like Android Studio handles this entire process for you.

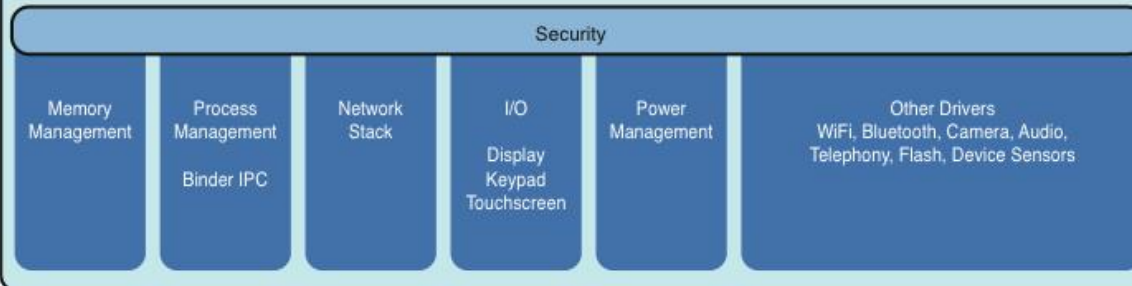
Applications Are Boxed

- 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

The Android Platform



Linux 2.6 Operating System (Hardware Abstraction Layer)



Physical Hardware

Application packages

- .apk files - compressed files
 - class byte code
 - resources(icons, sounds, etc).
 - Binary native files
- All .apks are signed
 - Default development key is created by SDK.
 - When updating an application, signature are checked.
- Installing an app from application distribution markets
 - Google Play
 - Amazon AppStore
- From your local computer using adb

Google Play

<https://play.google.com/store>

- Has various categories, allows ratings
- Have both free/paid apps
- Featured apps- To help users discover great apps, there are many lists where apps are featured such as
 - Popular
 - New
 - Selected by Google Play team

Publishing to Google Play

- Registering for a Google Play publisher account
 - Enter basic information about your **developer identity**.
 - Read and accept the **Developer Distribution Agreement**
 - Pay a **\$25 USD registration fee** using Google payments.
 - When your registration is verified, you'll be notified at the email address you entered during registration
- Setting up a Google payments merchant account, if you will sell apps or in-app products.
- Exploring the Google Play Developer Console and publishing tools.
- Refer
<https://developer.android.com/distribute/googleplay/start.html>

Security and Permissions

Security Architecture:

- ❑ A central design point of the Android security architecture is that no application, by default, has permission to perform any operations that would adversely impact other applications, the operating system, or the user.
- ❑ An application's process is a secure sandbox. It can't disrupt other applications.
- ❑ The permissions required by an application are declared statically in that application, so they can be known up-front at install time and will not change after that.

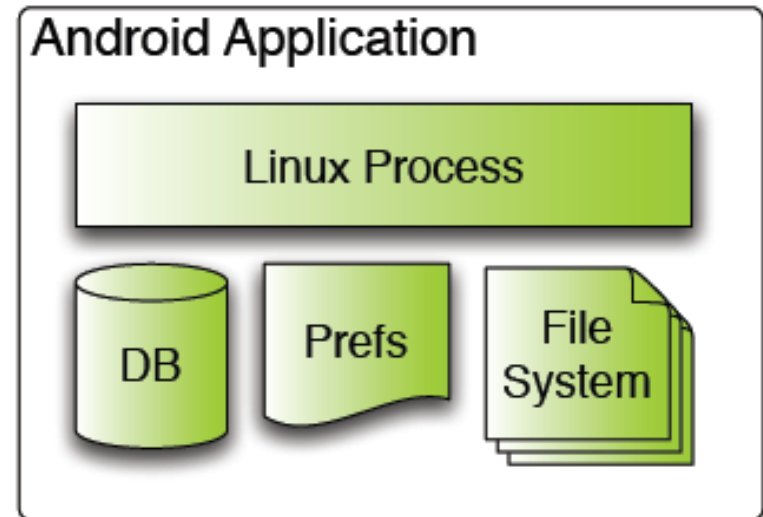
Security and Permissions

- a. Process level security
- b. User & File level security
- c. Using Permissions

Security and Permissions

a. Process level security:

- Each Android application runs inside its own Linux process.
- Additionally, each application has its own sandbox file system with its own set of preferences and its own database.
- Other applications cannot access any of its data, unless it is explicitly shared.



Security and Permissions

b. User and File level security :

- ❑ Each Android package (.apk) file installed on the device is given its own unique Linux user ID, creating a sandbox for it and preventing it from touching other applications (or other applications from touching it).
- ❑ This user ID is assigned to it when the application is installed on the device, and remains constant for the duration of its life on that device.
- ❑ Security enforcement happens at the process level, the code of any two packages can not normally run in the same process, since they need to run as different Linux users.
- ❑ Any data stored by an application will be assigned to that application's user ID, and not normally accessible to other packages.
- ❑ The file created by your application is owned by your application, but its global read and/or write permissions have been set appropriately so any other application can see it.

Security and Permissions

c. Using Permissions:

- A basic Android application has no permissions associated with it.
- To make use of protected features of the device, you must include in your **AndroidManifest.xml** one or more <uses-permission> tags declaring the permissions that your application needs.
- For example, an application that needs to monitor incoming SMS messages would specify:
- ```
<manifest
xmlns:android="http://schemas.android.com/apk/res/android"
 package="com.android.app.myapp" >

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

</manifest>
```