

Android Architecture

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Overview

- History of Android Architecture
- Five Layers
 - Linux Kernel
 - Android Runtime
 - Libraries
 - Application Framework
 - Applications
- Summary

History

- 2003 – Founded
 - No product for two years, funded by Andy Rubin
 - Planned the next generation of smartphones
 - **Open source** evolution of “Danger”
- 2005 – Purchased by Google
 - **Sooner or G1?**
- 2007 – Publically announced
- 2008 – Sold first phone



G1

Previous Versions



Lollipop
09/2014



Marshmallow
09/2014

Previous Versions

- Unnamed (1.0 + 1.1)
- **Cupcake (1.5)**
- **Donut (1.6)** – Quick Search Box
- **Éclair (2.1)** – High Density Displays, Traffic + Navigation
- **Froyo (2.2)** – Voice Control, Hotspot, Speed
- **Gingerbread (2.3)** – Simpler, Battery Life, More apps
- **Honeycomb (3.0)** – Flexible interface, tablets
- **Ice Cream Sandwich (4.0)** - Customization
- **Jelly Bean (4.1)** – Google Now, actionable notifications
- **KitKat (4.4)** – “Ok Google”, voice control variety
- **Lollipop (5.0)** – fluid tactile screens
- **Marshmallow (6.0)** – battery life, app permissions, UI



Cupcake



Ice Cream
Sandwich



Lollipop

APPLICATIONS

Home

Contacts

Phone

Browser

...

APPLICATION FRAMEWORK

Activity
Manager

Window
Manager

Content
Providers

View
System

Notification
Manager

Package
Manager

Telephony
Manager

Resource
Manager

Location
Manager

XMPP
Service

LIBRARIES

Surface
Manager

Media
Framework

SQLite

OpenGL|ES

FreeType

WebKit

SGL

SSL

libc

ANDROID RUNTIME

Core
Libraries

Dalvik Virtual
Machine

LINUX KERNEL

Display
Driver

Camera
Driver

Bluetooth
Driver

Flash Memory
Driver

Binder (IPC)
Driver

USB
Driver

Keypad
Driver

WiFi
Driver

Audio
Drivers

Power
Management

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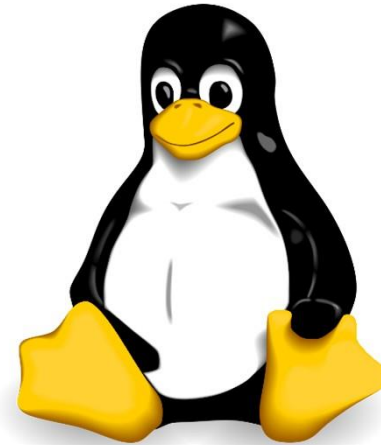
WiFi
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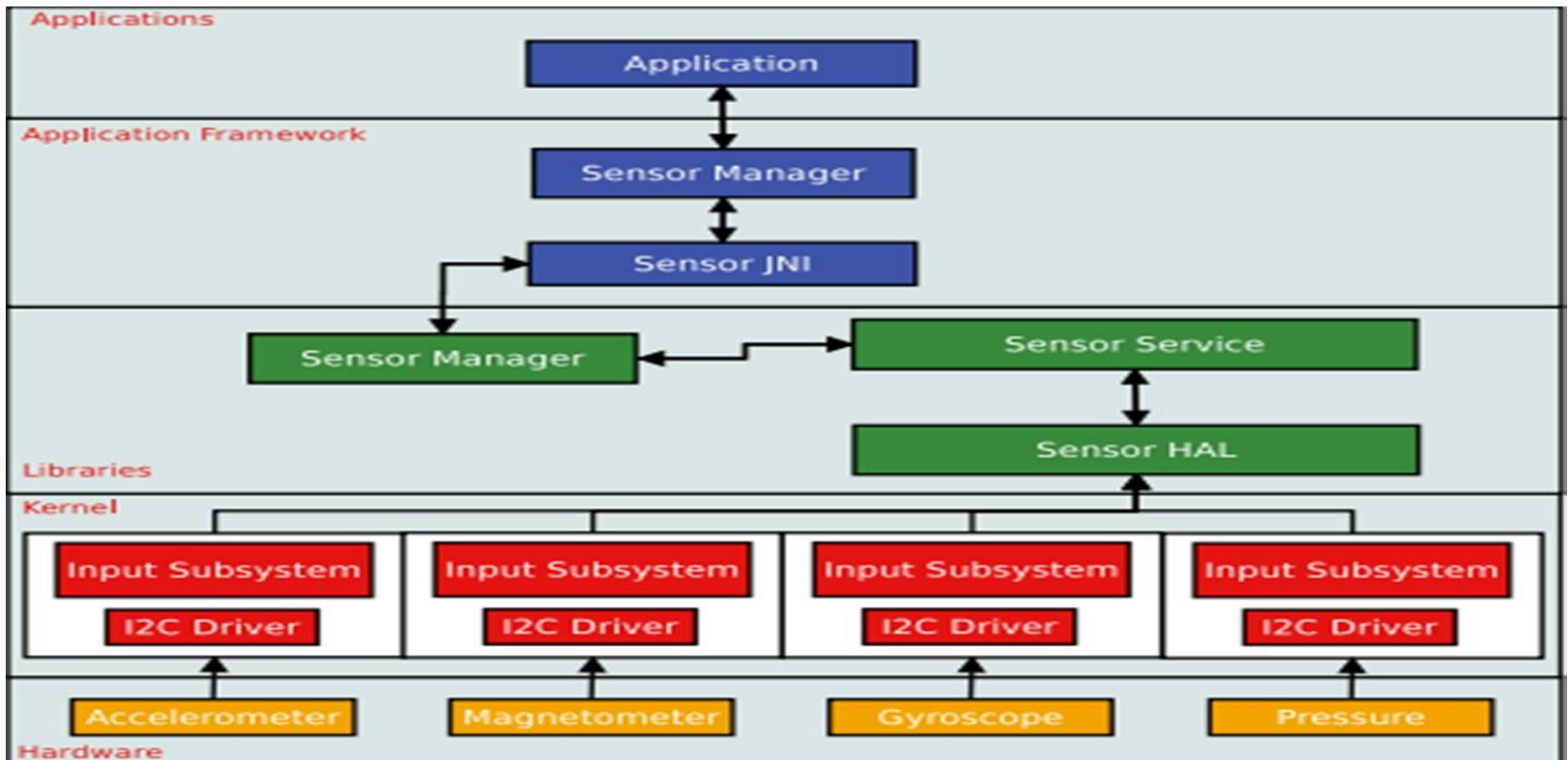
Linux Kernel

- 3.6 with ~115 patches
- Generic System Services
 - Permissions
 - Memory and Process management
 - File & Network I/O
 - Device Drivers
- Preemptive Multitasking
- Lean, efficient, and secure
- Open Source



Hardware Abstraction Layer (HAL)

- Software hooks between stack and hardware
- Hardware Specific
 - Allows Applications to be hardware ignorant



APPLICATIONS

Home Contacts Phone Browser ...

APPLICATION FRAMEWORK

Activity Manager Window Manager Content Providers View System Notification Manager

Package Manager Telephony Manager Resource Manager Location Manager XMPP Service

LIBRARIES

Surface Manager Media Framework SQLite

OpenGL ES FreeType WebKit

SGL SSL libc

ANDROID RUNTIME

Core Libraries

Dalvik Virtual Machine

LINUX KERNEL

Display Driver Camera Driver Bluetooth Driver Flash Memory Driver Binder (IPC) Driver

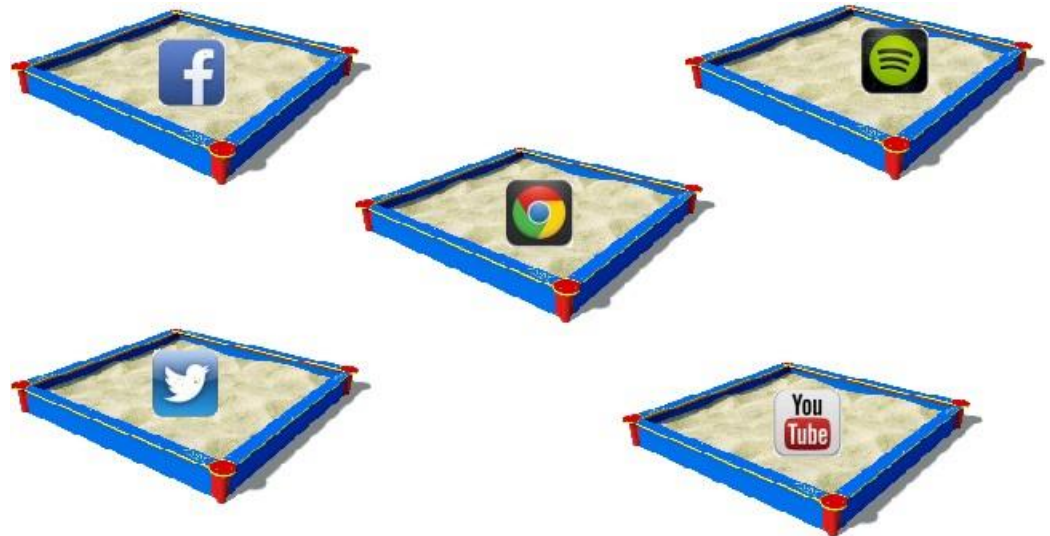
USB Driver Keypad Driver WiFi Driver Audio Drivers Power Management

Android Runtime

- Dalvik Virtual Machine
- Core Java libraries
 - **Specific to Android development**
 - Apple: Swift (Objective C)
 - Windows: Visual C++ (C++), Changes with OS
 - **Wrappers around C/C++ libraries**
- ART (Android Runtime VM)
 - **Replaced Dalvik in Lollipop (Android 5.0)**
 - **Advantages over Dalvik**
 - AOT (Ahead of Time) Compilation
 - Improved Garbage Collection

Dalvik Virtual Machine

- Executes Android Applications
 - Each Application runs within its own VM
 - Each app is “sandboxed”
- Memory Management
- Multi-threading



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Libraries

- C/C++
- Play and record audio and video
- Internet Security
- User interface building
- Graphics
- Database access





Library Examples

- WebKit
 - Web Browser Engine
- OpenGL
 - High Performance Graphics
 - Render 2D or 3D Graphic Content
- libc
 - Generic C library
- SQLite
 - Storage and sharing of application data

Library Examples Cont.

- Surface Manager
 - Off-screen buffering
 - Apps can't directly draw into screen
 - Drawings go to off-screen buffer
 - Combined with other drawings
 - Reason behind window transparency
- Media Framework
 - Provides media codecs allowing recording and playback of different types of media

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Application Framework

- Higher Level Services to Applications
- Environment in which applications are run and managed
- Package Manager
 - Keeps track of installed Applications
 - Apps can communicate with other Apps on device
- Window Manager
 - Manages main window that comprises Application



Application Framework Cont.

- View System
 - Provide Common User Interface Elements
 - Icons
 - Buttons
 - Text Entry
 - Etc.
- Content Providers
 - Databases that allow application to store and share structured info



Application Framework Cont.

- Location Manager
 - Allows application to receive location and movement info generated by GPS
- Activity Manager
 - Manages activity life cycle of applications
- Telephony Manager
 - Manages all voice calls

Application Framework Cont.

- Resource Manager
 - Manage various types of resources used in applications
 - Allows access to non-code embedded resources
 - Strings
 - Color settings
 - UI Layout
- Notifications Manager
 - Allows applications to display alerts

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Dalvik Virtual Machine

LINUX KERNEL

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Camera Driver

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Flash Memory Driver

Binder (IPC) Driver

USB Driver

Keyboard Driver

WiFi Driver

Audio Drivers

Power Management

Applications

- Hosts Android Applications
- Written in Java
 - Access to all Android APIs
- Executed in the VM (Dalvik or ART)
- Examples
 - SMS client app
 - Dialer
 - Web Browser
 - Contact manager



Conclusion

- **Designed** for mobile and flexibility
 - **Both in software and hardware**
- 5 Layers
- Application Development
 - **Simple**
 - Java
 - **Access to all aspects of the Kernel**
 - Open Source
 - APIs

