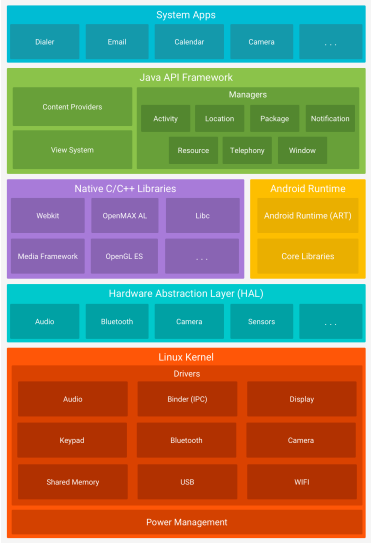
Contents

1 Architecture

- A software stack for mobile devices
- Operating system kernel
- Standard middleware
  - Android library support
- Key applications / user interfaces
  - Vendor specific modifications
- LK: threading, low level memory management, driver
- HAL: libs for hardware module
- AR: virtual machine
- NCL: fundamental core functionalities
- API: programming interface
- APP: system apps can be customised.



1.1 Kernel

1.1.1 Modifications

Modifications made by android to linux OS

- wakelocks
  - Keep the phone awake
- binder
  - Interprocess communication mechanism, and remote method invocation system.
  - One Android process can call a routine in another Android process
- ashmem
  - Android Shared Memory
  - A component of the Android operating system that facilitates memory sharing and conservation
- LMK kills processes when memory is low
- alarm manager
  - Wakes up the phone when necessary

1.2 Hardware support

- Bluetooth - BlueZ
- GPS Manufacturer provided libgps
- Wifi `wpa-supplicant`
- Display Standard framebuffer driver
- Keyboard Standard input event
- Lights Manufacturer provided liblights.so
- Audio Manufacturer provided libaudio.so
- Camera Manufacturer provided libcamera.so
- Power Management wakelocks kernel patch
- Sensors Manufacturer provided libsensors.so
- Radio Manufacturer provided libril.so

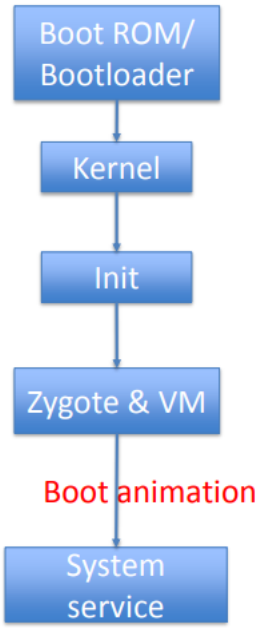
1.3 Security

Applications are sandboxed

- A security mechanism for separating running applications and data
- This allows applications run in a different context, so if one app crashed, others can stay uneffected
- On Android, each app runs as its own **user**, which guarantees that different users are unable to interfere with each other, access each others files and so on. Root can access the entire system
- Own process, own VM, own UID/AID for different app

2 System boot process

- **Boot ROM/ Bootloader:** Load bootloader into RAM, detect external RAM, setup network, memory, etc.
- **Kernel:** Setup cache, protected memory, scheduling and loads drivers.
- **Init:** Mounts directories like /sys , /dev or /proc Runs init.rc script
- **Zygote & VM:** Enables code sharing across the android VM for quick start of separate VM for different apps preloadClasses(), preloadResources()
- **System service:** Power manager, activity manager, telephony registry, package manger, context manager, system contact providers, etc.



3 Zygote

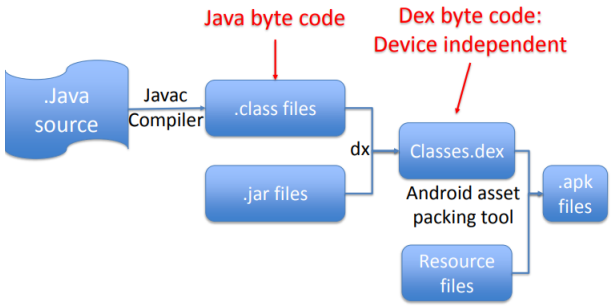
- Initialised process that has all core libraries linked in
- Load all java.*, android.* classes at boot time
- Initially create a single android VM process Referencing classes loaded above
- When user runs an application:
  - Creates a copy of itself in a separate address space
  - **Does not** copy memory, instead refers to original memory until modified
  - Because each container recieves a map, these resources are shared between applications, eliminating the need for each new fork of the VM to keep its own copy of classes and resource.

4 Memory

In many places, Android shares the same dynamic RAM across processes using explicitly allocated shared memory regions. Android uses paging and mmap instead of providing swap space, which means any memory your application touches cannot be paged out unless you release all references.

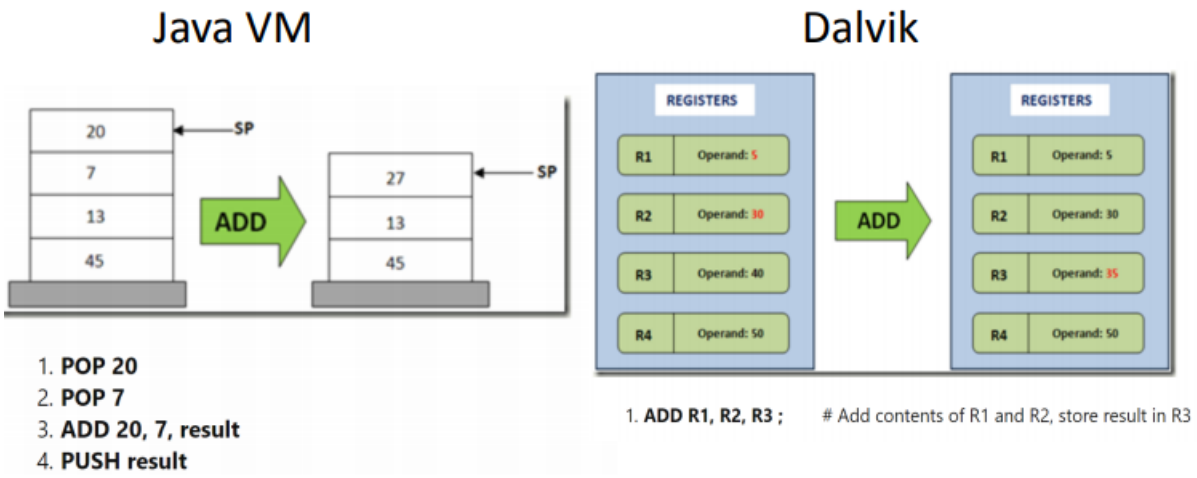
5 Android compilation

- Applications are written in Java
  - Run on Googles own VM Dalvik/ Android Run Time
  - Uses its own bytecode (DEX) format
- Code compiled using standard Java tools then convert to DEX format
  - Multiple class files can be put in to a single .dex file.
- Code, data and resource files packed into a .apk file



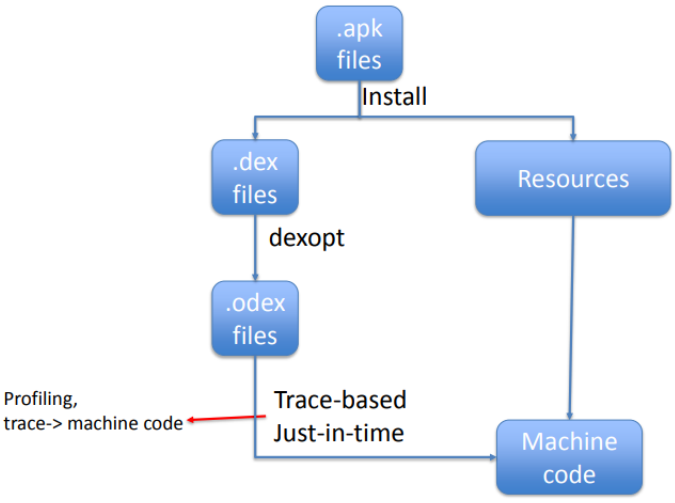
5.1 Dalvik

- Dalvik architecture is *register based* rather than *stack based*, which make's it optimised to use less space
- Execute its own Dalvik byte code rather than Java bytecode
- Dalvik interprets .dex files
  - Post-processes .class files
  - Size reduction
  - JIT compilation to native ARM instructions
- Target slow cpu, no swap, low RAM, battery powered device.
- This approach allows us to execute less instructions, but the instructions are larger

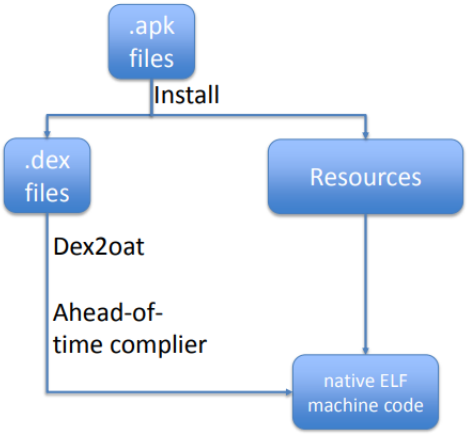


6 Runtime

6.1 Darvik runtime



6.2 ART runtime



7 ART

- **Pros**
  - Apps run faster as DEX bytecode translation done during installation
  - Reduces start-up time of applications as native code is directly executed
  - Improves battery performance as power utilised to interpreted byte codes line by line is saved
- **Cons**
  - App Installation takes more time because of DEX bytecodes conversion into machine code
  - More internal storage is required to store the fully converted machine code at installation

7.1 Android 7.0

Android 7.0 adds a JIT compiler with code profiling to ART that constantly improves the performance of Android apps as they run

7.2 Programming Models

7.3 Comparison

Traditional OS applications:

- A single entry point
- Main OS loads the program into a process and executes it

Java applications:

- A Java VM is instantiated
- Loads all classes used by the application
- Executes main

Component based model

- Multiple application entry points
- The point through which the system can enter the application

7.4 Android components

Activities

- Dictate the UI and handle the user interaction to the smart phone screen.

Services

- Mechanism for doing something long-running in the background
- Handle background processing associated with an application.

Broadcast Receivers

- Respond to broadcast messages from the OS / other apps

Content Providers

- Make data available to / make use of data from other apps

placeholder