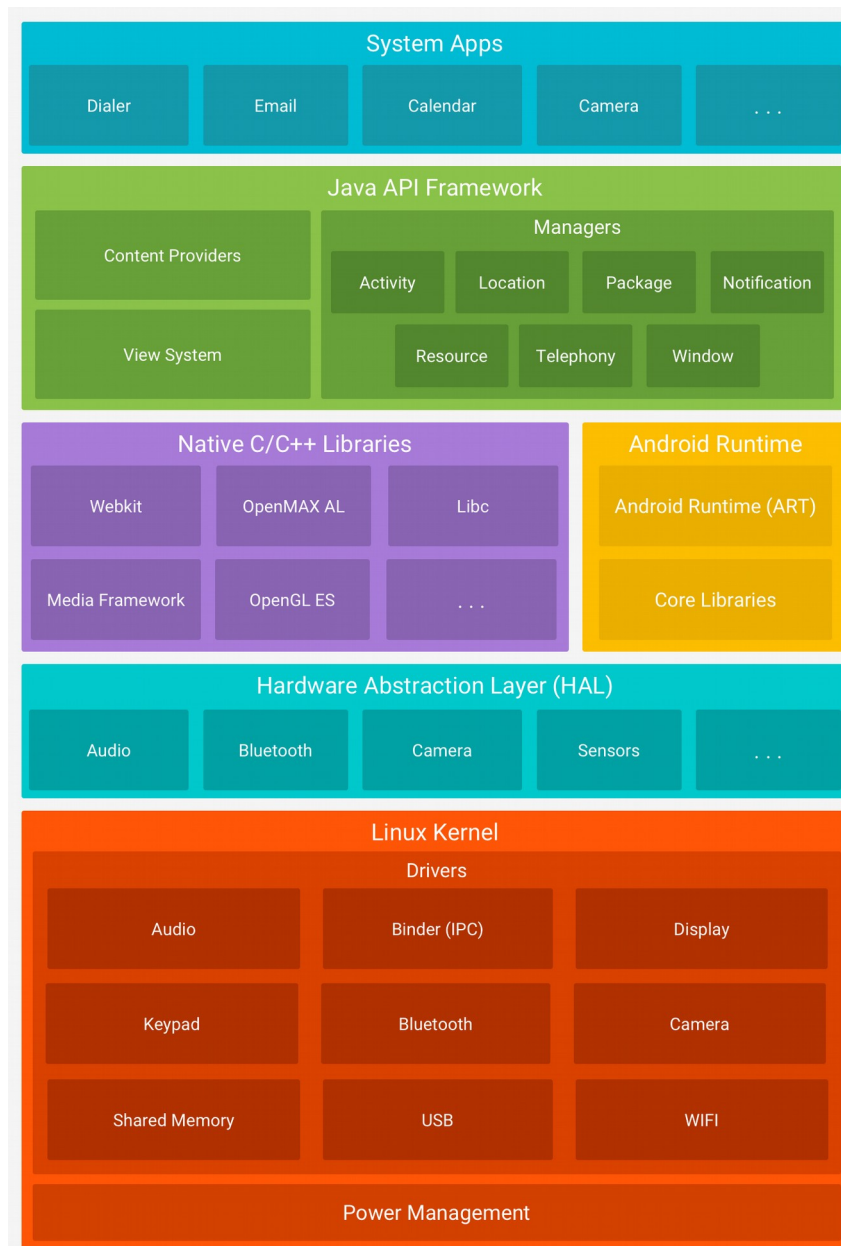# The Android Platform

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The Android Platform

❑ A software stack for mobile devices

  ▪ OS kernel, system libraries, application frameworks & key apps

❑ Android SDK for creating apps

  ▪ Libraries & Development tools

  ▪ Lots of documentation

❑ http://developer.android.com/guide/platform/

The Android Architecture

System Apps

| Dialer | Email | Calendar | Camera | . . . |

Java API Framework

Content Providers

Managers

| Activity | Location | Package | Notification |

View System

| Resource | Telephony | Window |

Native C/C++ Libraries

| Webkit | OpenMAX AL | Libc |
| Media Framework | OpenGL ES | . . . |

Android Runtime

Android Runtime (ART)

Core Libraries

Hardware Abstraction Layer (HAL)

| Audio | Bluetooth | Camera | Sensors | . . . |

Linux Kernel

Drivers

Audio	Binder (IPC)	Display
Keypad	Bluetooth	Camera
Shared Memory	USB	WIFI

Power Management

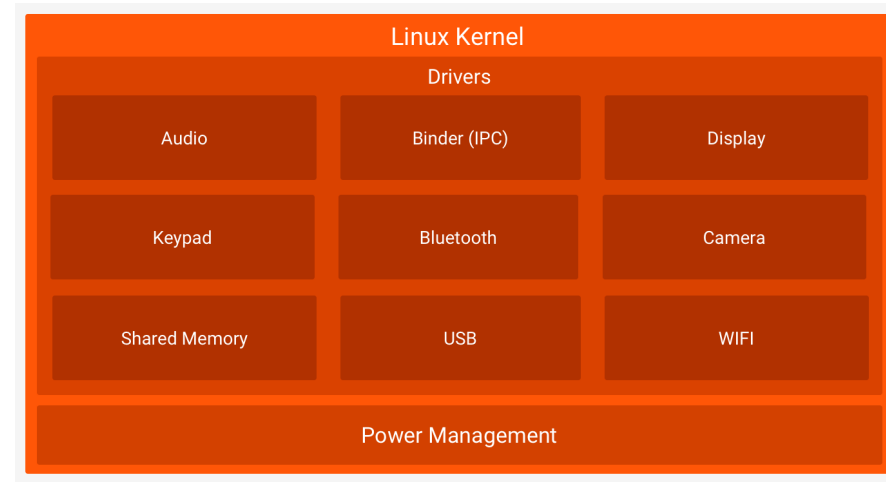https://developer.android.com/guide/platform/

Linux Kernel

❏ Some standard services
- Security
- Memory & process management
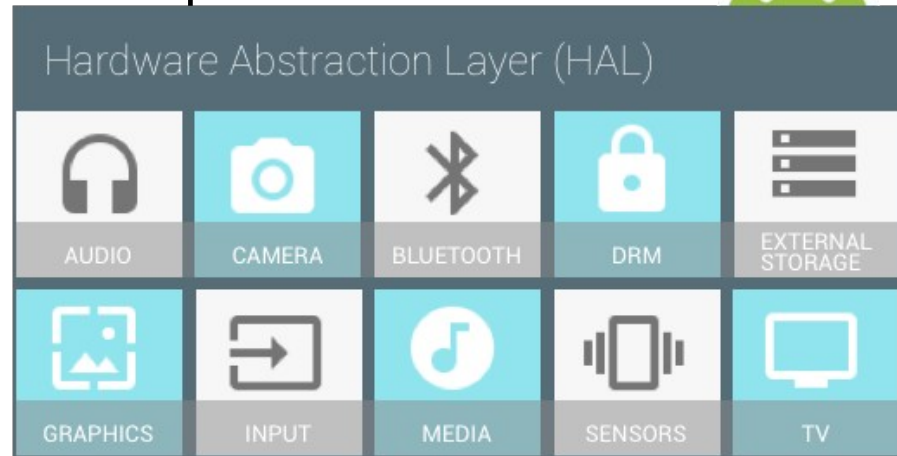- File & network I/O
- Device drivers

❏ Android-specific
- Power management
- Android shared memory
- Low Memory killer
- Interprocess communication (IPC)

Hardware Abstraction Layer
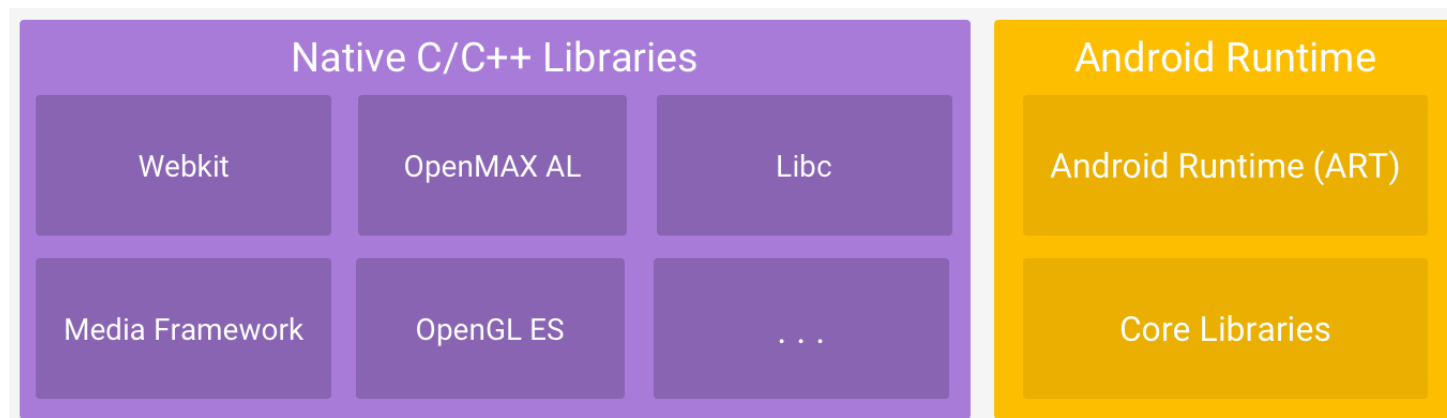
❑ Standard Interface for HW vendors

- ▪ A Module (dynamic library .so file)
    - • Metainformation (version, author, name, API_version)
        - – Standard C struct: hw_module_t
    - • Additional features specific to the HW
    - • **Loaded (dynamically) by the kernel when needed**
- ▪ A device (hw_device_t)
    - • 1 module (audio) may refer to several devices (Usb, bluetooth)
    - • Meta-information + device-specific code

Hardware Abstraction Layer (HAL)

AUDIO   CAMERA   BLUETOOTH   DRM   EXTERNAL STORAGE

GRAPHICS   INPUT   MEDIA   SENSORS   TV

Native C/C++ Libraries

❑ Used by Runtime (and native apps)

- ▪ SystemC Library: Bionic LibC
- ▪ Surface Manager: Display Management, activity manager
- ▪ Media Framework: Audio/Video
- ▪ Webkit: Browser engine
- ▪ OpenGL: Graphics engine
- ▪ SQLite: Relational database engine

Native C/C++ Libraries			Android Runtime
Webkit	OpenMAX AL	Libc	Android Runtime (ART)
Media Framework	OpenGL ES	. . .	Core Libraries

Android RunTime

- ❑ Two Main Components
  - ▪ Core Java Libraries
  - ▪ Dalvik Virtual Machine
    - • Just-In-Time Compilation
    - • Now replaced by Android Runtime (ART)
      - − Native compilation on installation
- ❑ Core Java Libraries
  - ▪ Basic Java Classes: java.*, javax.*
  - ▪ App Lifecycle: android.*
  - ▪ Internet/Web services: org. *
  - ▪ Unit Testing: Junit.*

Android Runtime

Android Runtime (ART)

Core Libraries
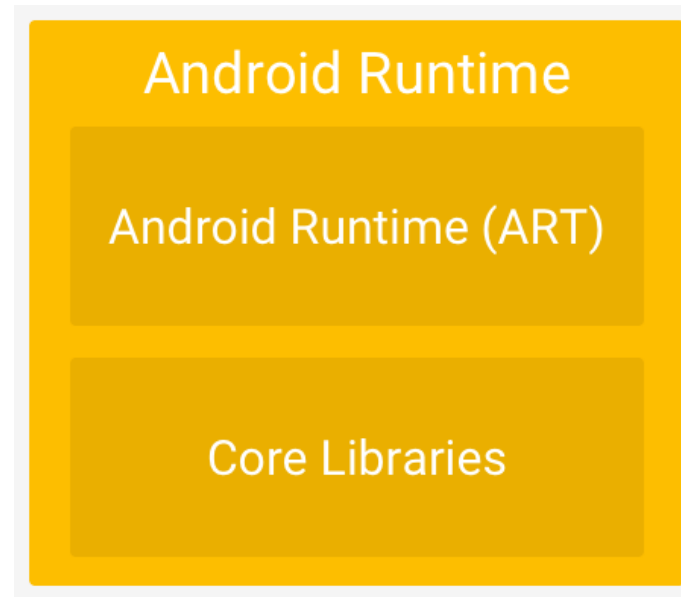
Dalvik and Android RunTime

❑ Dalvik Virtual Machine

- ▪ Code partly in Java, partly in xml resources
- ▪ All transformed into Java Bytecode (.class)
- ▪ DX
  - • Converts .class into .dex
  - • Resource-constrained environments
    - − Slower CPU, less RAM, limited battery
    - − Obfuscated bytecode
- ▪ Dalvik VM can execute .dex files

❑ Android RunTime (upward compatibility)

- ▪ At Installation Time (Ahead-Of-Time – AOT): dex2oat
- ▪ .dex are compiled into native code depending on the target processor
- ▪ Since Android 5.0, each app runs its own instance of ART
  - • Optimized for low-memory footprint

F. Mallet

Java API Framework
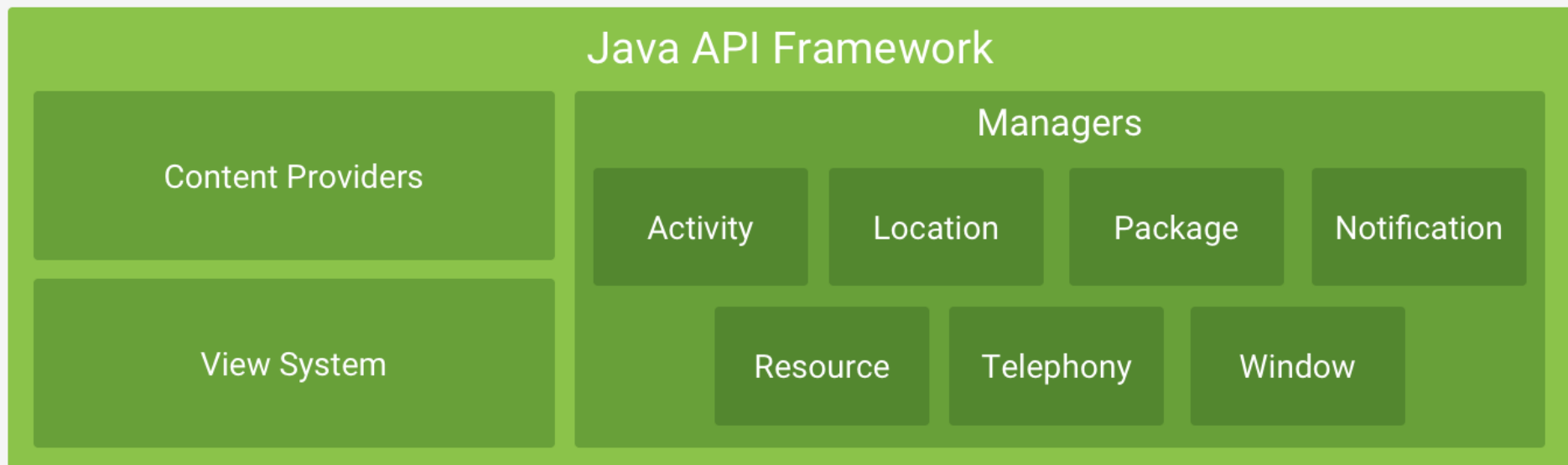
Java API Framework

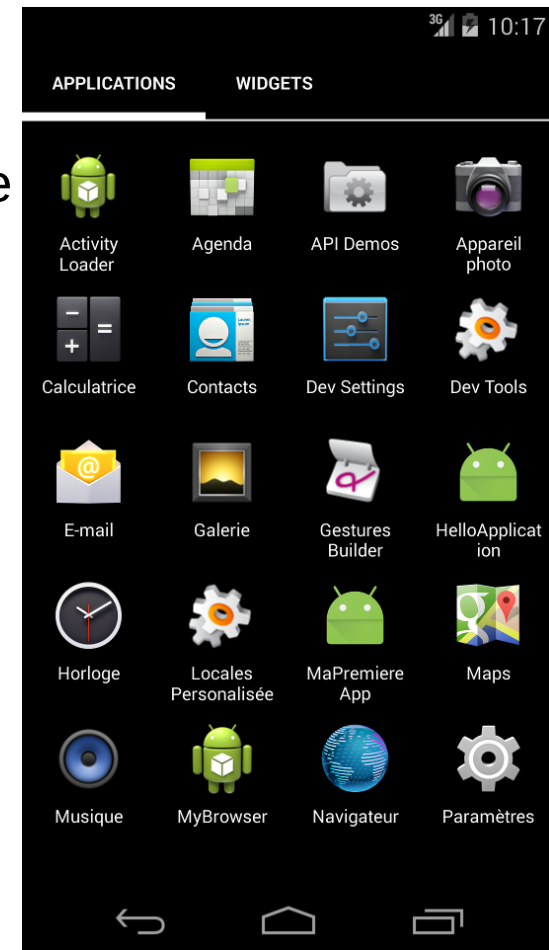❑ Set of Applications to build the Framework

❑ **Activity Manager**

  ▪ Interacts with the overall activities running in the system.

  ▪ Activity Description

  ▪ Memory Information

  ▪ Start Activities and monitor them (e.g. Activity Not Responding)

  ▪ Broadcast Intents

http://developer.android.com/reference/android/app/ActivityManager.html

Application Framework

❑ Set of Applications to build the Framework

❑ Activity Manager

❑ **Package Manager**

 ▪ Install, remove, list apps installed on the device

http://developer.android.com/reference/android/con
tent/pm/PackageManager.html

Application Framework

❑ Set of Applications to build the Framework

❑ Activity Manager

❑ Package Manager

❑ **Window Manager**

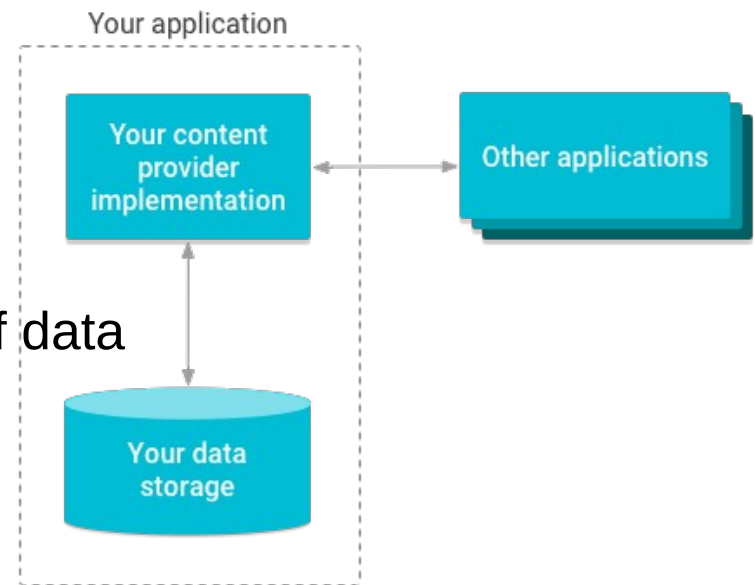 ▪ One for each display

  ▪ Attaches new views on a display

http://developer.android.com/reference/andro
id/view/WindowManager.html

Application Framework

❑ Set of Applications to build the Framework

❑ Activity Manager

❑ Package Manager

❑ Window Manager

❑ **Telephony Manager**

- ▪ Provides information about telephony services
  - • Available services and states (ringing, off-hook), subscriber information
- ▪ Can register listener to receive notifications on state changes
  - • Data connection (active, no traffic, connected, suspended…)
- ▪ [PERMISSION PROTECTED]

http://developer.android.com/reference/android/tele
phony/TelephonyManager.html

Application Framework

❑ Set of Applications to build the Framework
❑ Activity Manager
❑ Package Manager
❑ Window Manager
❑ Telephony Manager
❑ **Content Providers**

▪ Manager access to a structured set of data
▪ Mechanisms for data security

Your application

Your content provider implementation

Other applications

Your data storage

http://developer.android.com/guide/topics/providers/content-providers.html

Application Framework

❑ Set of Applications to build the Framework

❑ Activity Manager

❑ Package Manager

❑ Window Manager

❑ Telephony Manager

❑ Content Providers

❑ **Resource Manager**

  ▪ Provides access to non-code resources (icons, layout, strings…)

Application Framework

❑ Set of Applications to build the Framework

❑ Activity Manager

❑ Package Manager

❑ Window Manager

❑ Telephony Manager

❑ Content Providers

❑ Resource Manager

❑ **View System**

  ▪ Handles GUI-related tasks

  ▪ Set of widgets for building GUI

http://developer.android.com/reference/android/view/View.html

Application Framework

- ❑ Set of Applications to build the Framework
- ❑ Activity Manager
- ❑ Package Manager
- ❑ Window Manager
- ❑ Telephony Manager
- ❑ Content Providers
- ❑ Resource Manager
- ❑ View System
- ❑ **Location Manager**
  - ▪ Access to system location services
  - ▪ Periodic update to geographical location
  - ▪ Fire a specific intent when entering a pre-defined location

http://developer.android.com/reference/android/location/LocationManager.html

Application Framework

❏ Set of Applications to build the Framework
❏ Activity Manager
❏ Package Manager
❏ Window Manager
❏ Telephony Manager
❏ Content Providers
❏ Resource Manager
❏ View System
❏ Location Manager
❏ **Notification Manager** (see Notification.Builder)
  ▪ Notify the user of events occurrences (icon in status bar, flashing LEDS on the device, flashing backlight, play sound, vibrating,…)

http://developer.android.com/reference/android/app/NotificationManager.html

Applications

❑ Standard Applications
  ▪ Home, Contacts, Phone, Browser
  ▪ Can be replaced by your own (answer standard intents)

❑ Standard Activity actions
  ▪ ACTION_DIAL: Dial numbers
  ▪ ACTION_VIEW:
    • Tel: 123
    • content://contacts/people/1 (CONTACTS)
    • AUDIO, VIDEO, TEXT, GEO_LOCATION, EBOOK, WEB_PAGES
  ▪ ACTION_EDIT: modify
  ▪ ACTION_SEND, ACTION_CHOOSER, ACTION_SYNC

❑ Standard BroadCast Actions
  ▪ ACTION_TIME_TICK, ACTION_SHUTDOWN

System Apps

| Dialer | Email | Calendar | Camera | . . . |
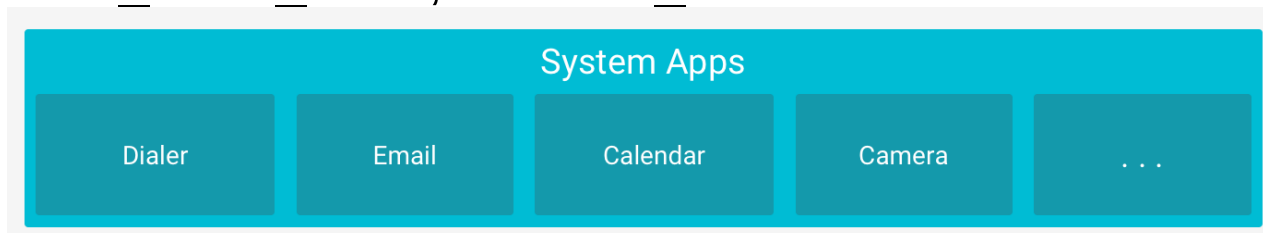
References

❑ Android Developers

 ▪ http://developer.android.com/training/index.html

❑ Other lectures at UNS

 ▪ P. Renevier

 ▪ E. Amosse

❑ Books

 ▪ Beginning Android, M. L. Murphy, APress

 ▪ Android Programming: The Big Nerd Ranch Guide, B. Phillips, B. Hardy, http://www.bignerdranch.com