# Recording in Progress

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# CMSC436: Programming Handheld Systems

# The Android Platform

# The Android Platform

A software stack for mobile devices:

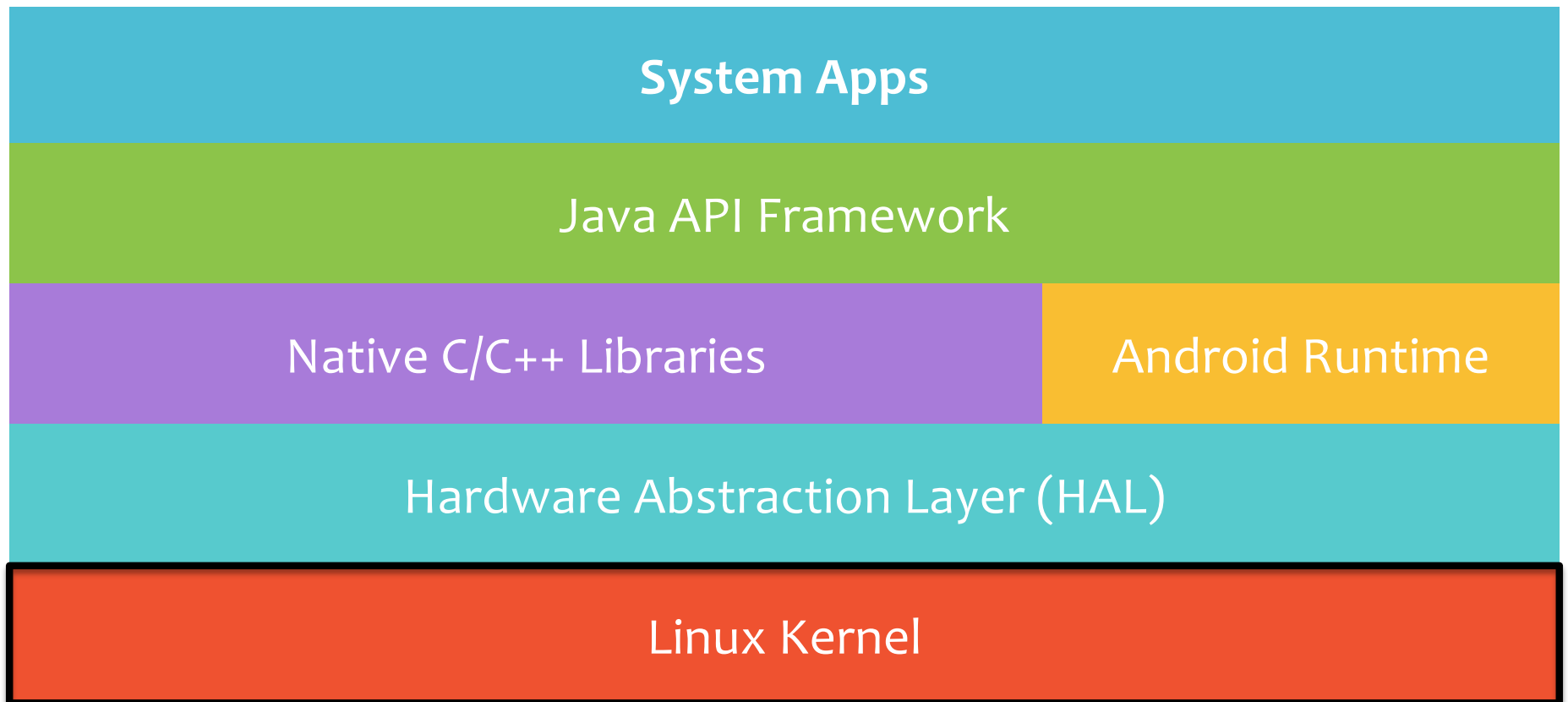OS kernel and interfaces, system libraries, frameworks & key apps

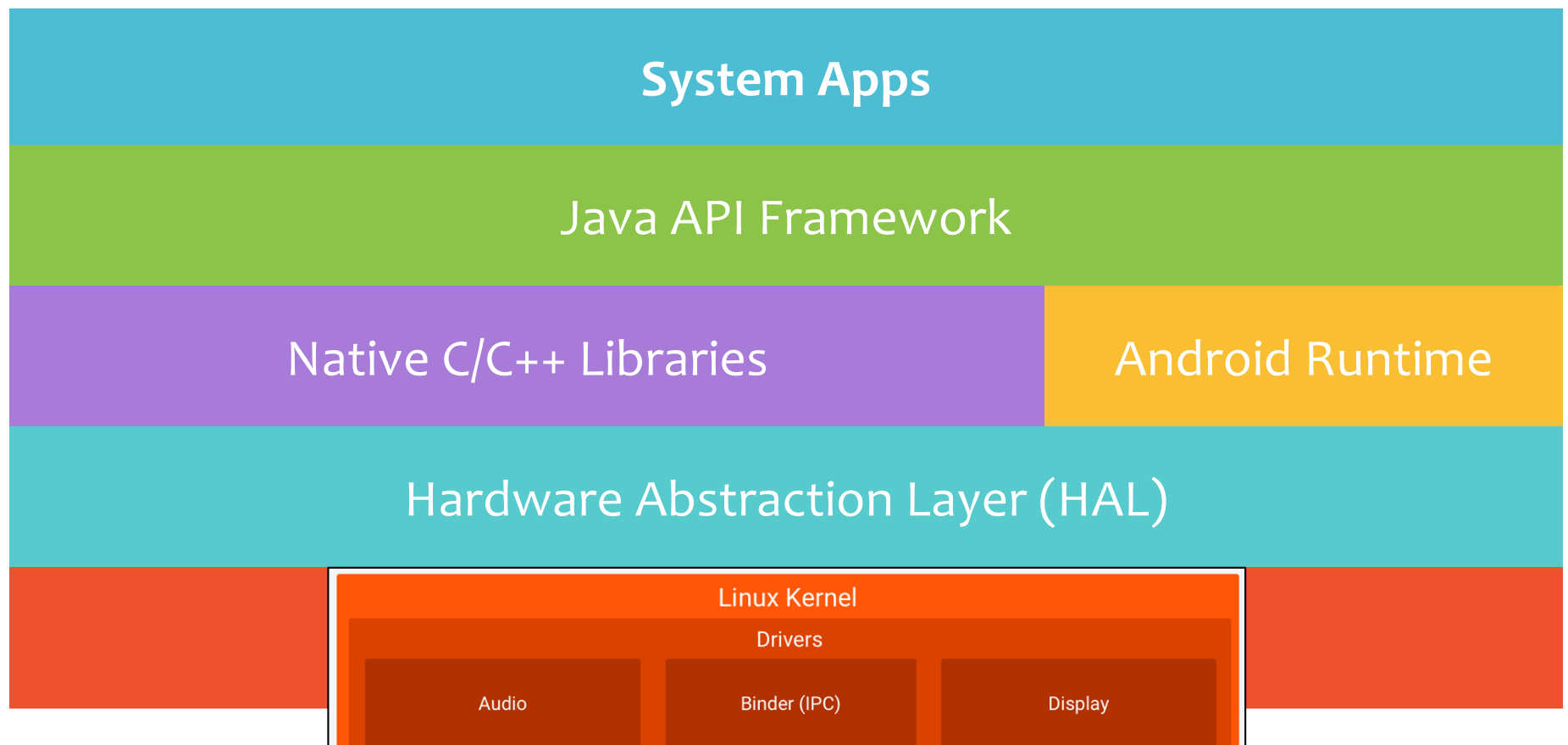Android SDK for creating apps

Libraries & development tools

Lots of documentation. Start browsing today!

See: http://developer.android.com/training

# The Android Architecture

| System Apps | |
|---|---|
| Java API Framework | |
| Native C/C++ Libraries | Android Runtime |
| Hardware Abstraction Layer (HAL) | |
| Linux Kernel | |

# The Android Architecture

**System Apps**

Java API Framework

Native C/C++ Libraries

Android Runtime

Hardware Abstraction Layer (HAL)

Linux Kernel

Drivers

Audio

Binder (IPC)

Display

# Linux Kernel – Standard Services

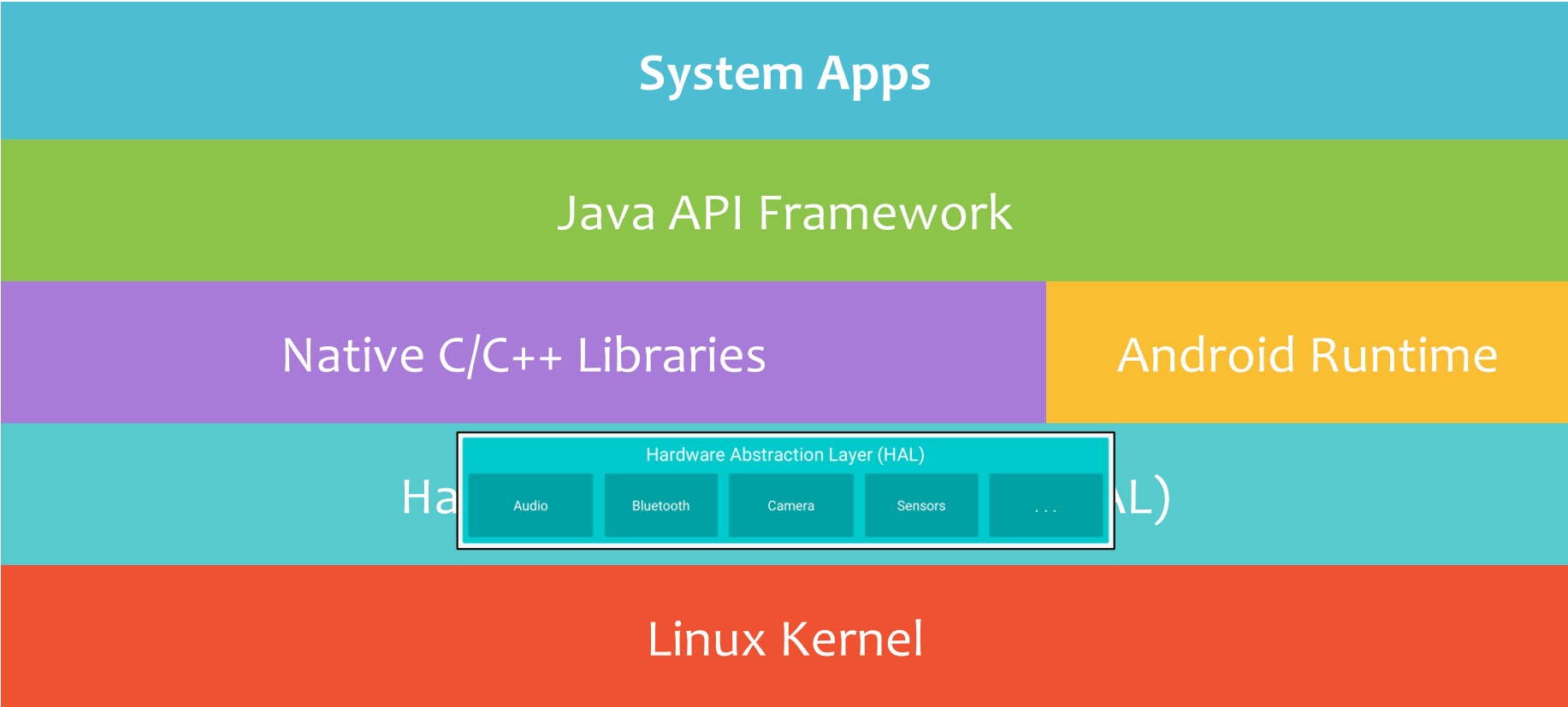Security

Memory & process management

File & network I/O

Device drivers

# Linux Kernel - Android-Specific

Power management

Low memory killer

Interprocess communication (IPC)

# The Android Architecture

**System Apps**

Java API Framework

Native C/C++ Libraries

Android Runtime

Ha                    AL)

Hardware Abstraction Layer (HAL)

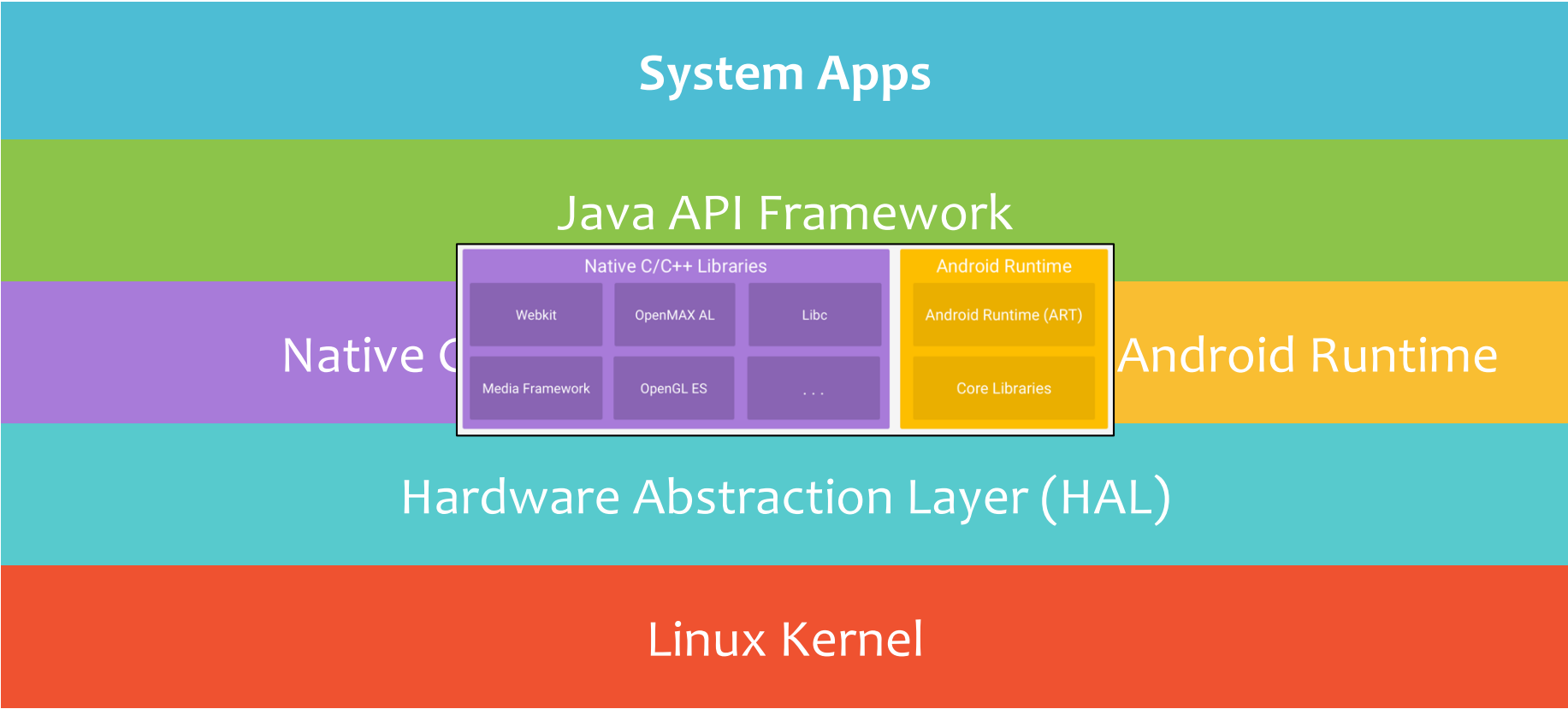| Audio | Bluetooth | Camera | Sensors | . . . |

Linux Kernel

# Hardware Abstraction Layer (HAL)

Provides standard interfaces between Java API framework and device hardware

Defines and interface for various hardware classes, such as Camera, Audio, Graphics, etc.

Android loads library modules for hardware components on demand

# The Android Architecture

**System Apps**

Java API Framework

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

Native C                                                Android Runtime

Hardware Abstraction Layer (HAL)

Linux Kernel

# Libraries

Bionic libc

Surface Manager

Media Framework

FreeType

Webkit

OpenGL

SQLite

SSL

# The Android Architecture

**System Apps**

Native C/C++ Libraries

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

Android Runtime

Android Runtime (ART)

Core Libraries

...ntime

Hardware Abstraction Layer (HAL)

Linux Kernel
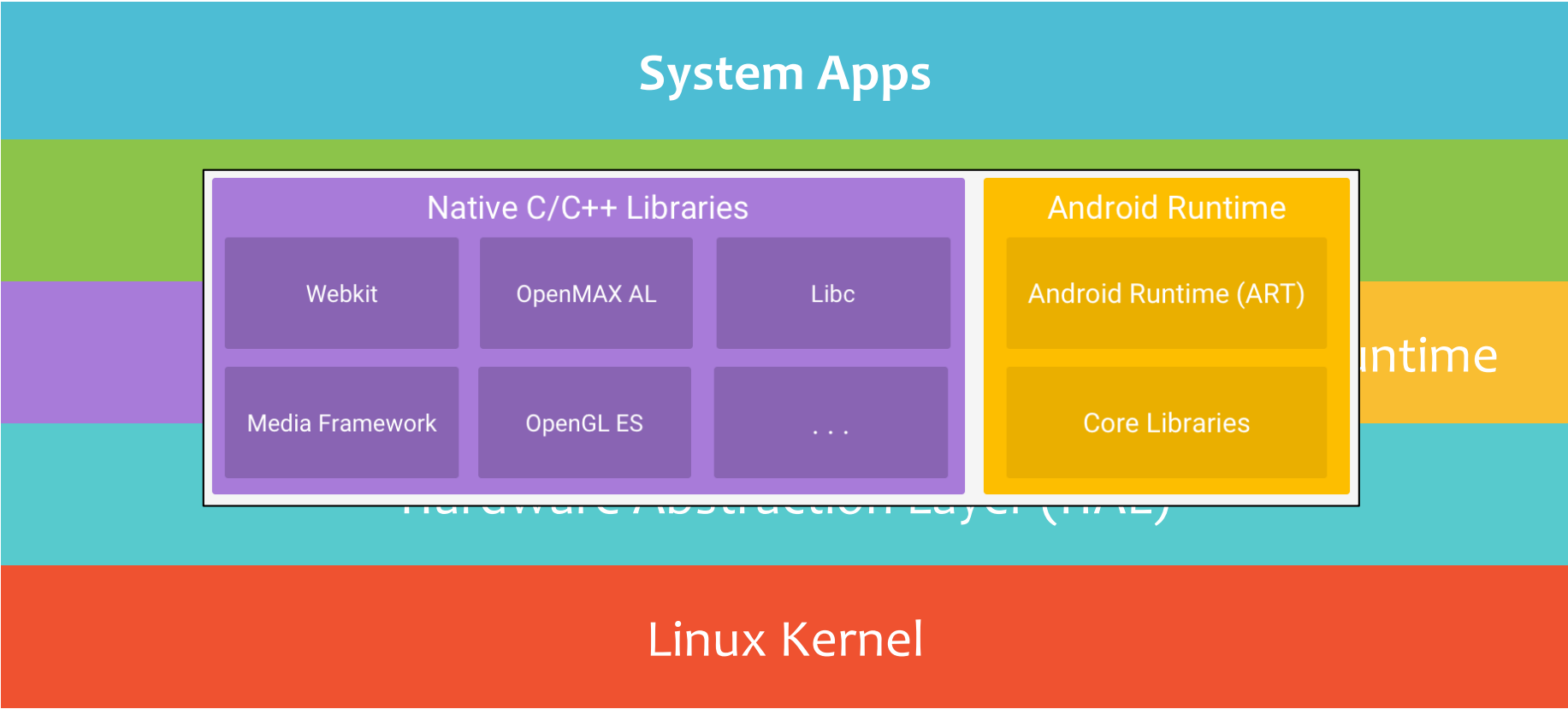
# Android Runtime

Two main components

    Core Java libraries with some Java 8 feature support

    Android Runtime (ART)

# Core Java Libraries

Basic java classes  -- java.*, javax.*

App lifecycle, basic services -- android.*, androidx

Internet/Web services -- org. *

Unit testing -- junit.*

# Java 8 support

Android does not support all Java 8 language features

Some supported features (in API level 24 or higher)

Lambda expressions

Method references

java.util.function and java.util.stream

See:

https://developer.android.com/studio/write/java8-support

# Android Runtime (ART)

Since Android 5.0, apps are executed in a managed runtime environment

On older platforms, apps run in the Dalvik Virtual Machine

# ART Design Goals

Designed for resource-constrained environments

Slower CPU

Less RAM

Limited battery life

# Major ART Features

Ahead-of-time (AOT) and just-in-time (JIT) compilation

Optimized garbage collection (GC)

API level 28+ conversion of an app package's Dalvik Executable format (DEX) files to more compact machine code

Better debugging support, including a dedicated sampling profiler, detailed diagnostic exceptions and crash reporting, and the ability to set watchpoints to monitor specific fields

# Typical Workflow

App written in Java, Kotlin or C++

Compiled to Java bytecode files

Tool chain converts java bytecode files to a single dex-formatted bytecode file

Virtual machine executes bytecode file

# ART

- Compiles dex bytecode to native binary for improved runtime performance

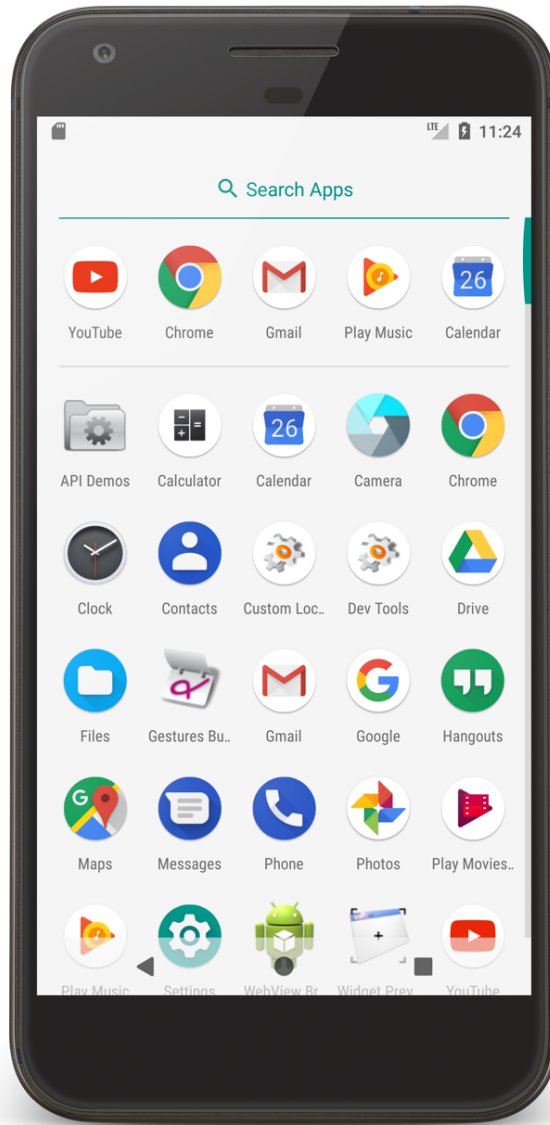- Applies system-dependent optimizations at installation time, runtime, and in background

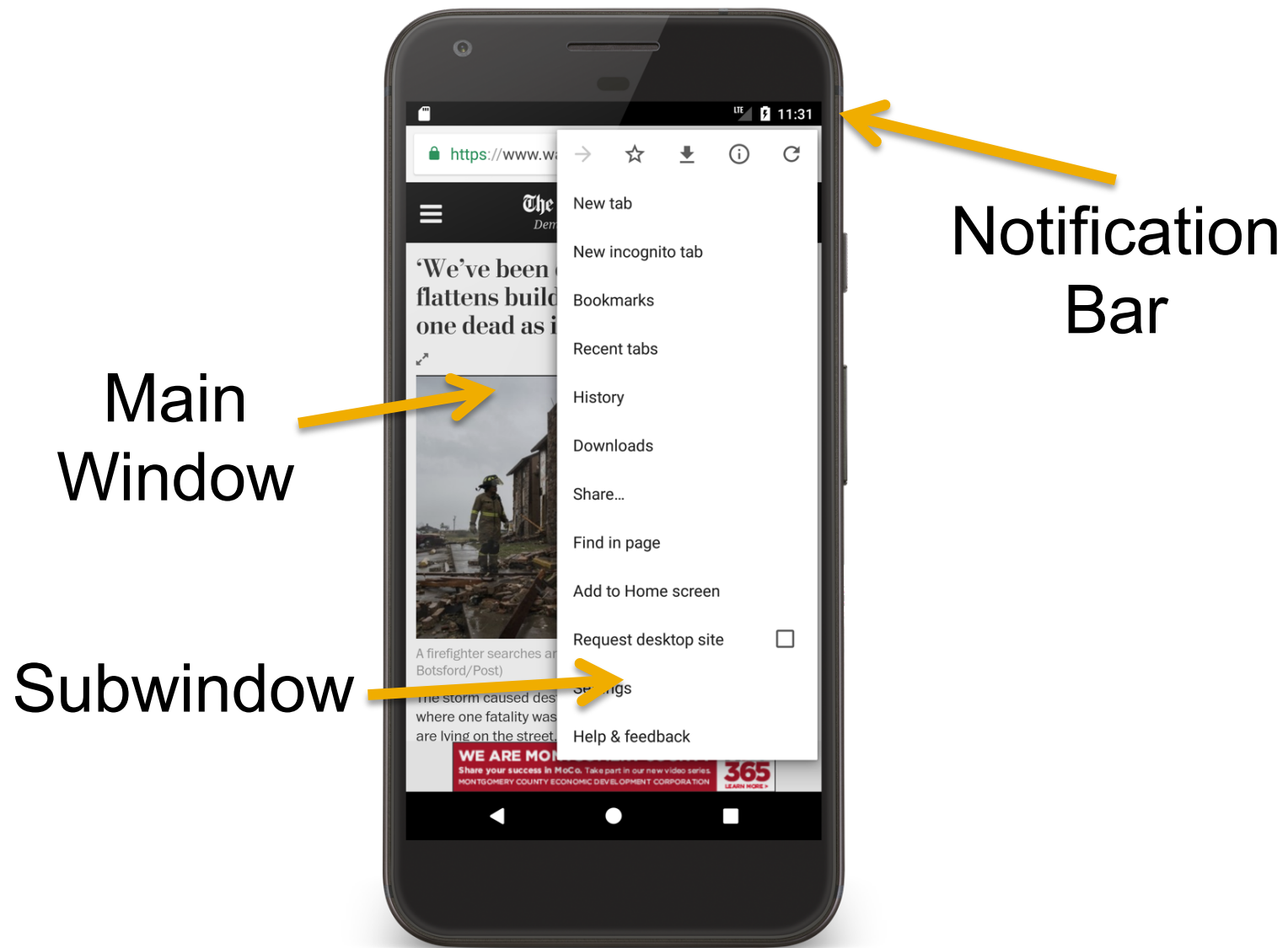- Results in faster execution at cost of larger executable

# The Android Architecture

**System Apps**

Java API Framework

Content Providers

Managers

Activity | Location | Package | Notification

View System

Resource | Telephony | Window

Native C/C++ Libraries

Android Runtime

Hardware Abstraction Layer (HAL)

Linux Kernel
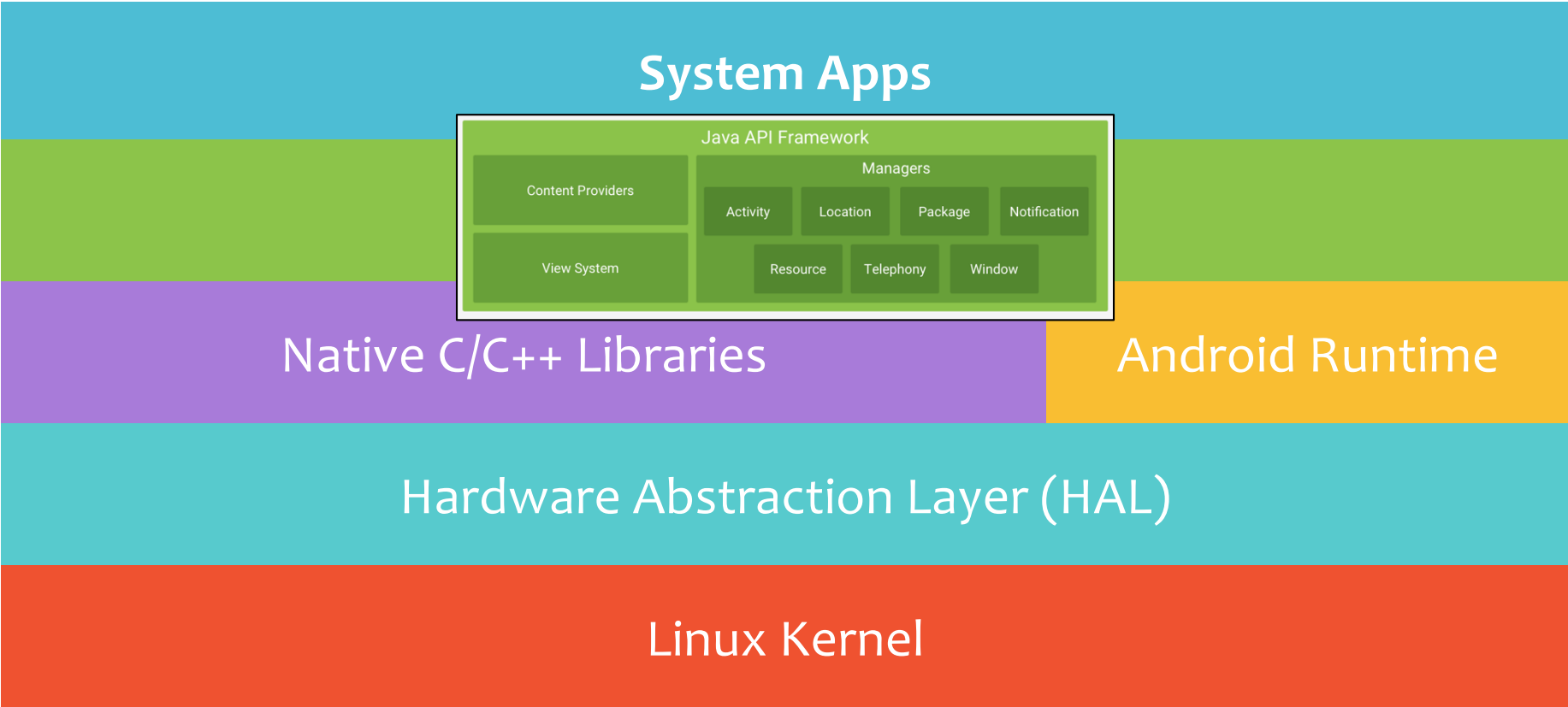
# Package Manager

Keeps track of app packages on device

# Window Manager

Manages the windows comprising an app

Notification Bar

Main Window

Subwindow

New tab

New incognito tab

Bookmarks

Recent tabs

History

Downloads

Share…

Find in page

Add to Home screen

Request desktop site

Settings

Help & feedback

# View System

Provides common user interface elements

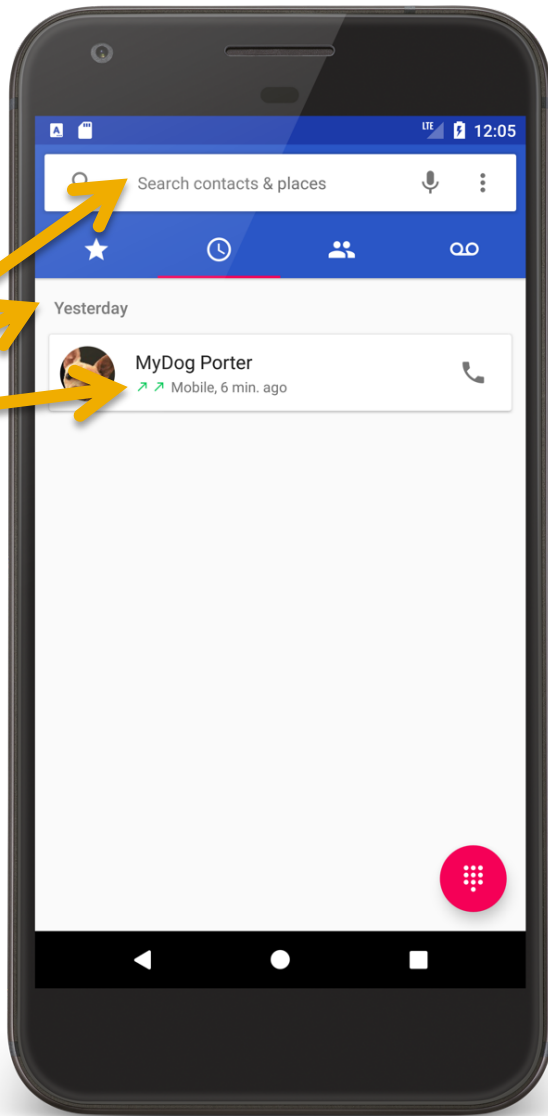e.g., icons, text entry boxes, buttons and more

Tabs

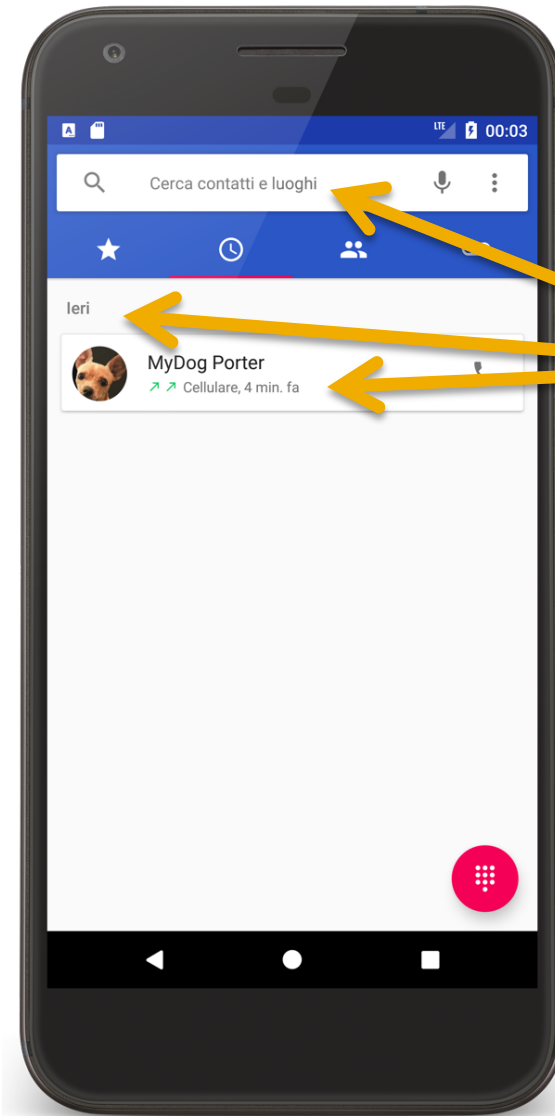TextView → (555) 555-5555
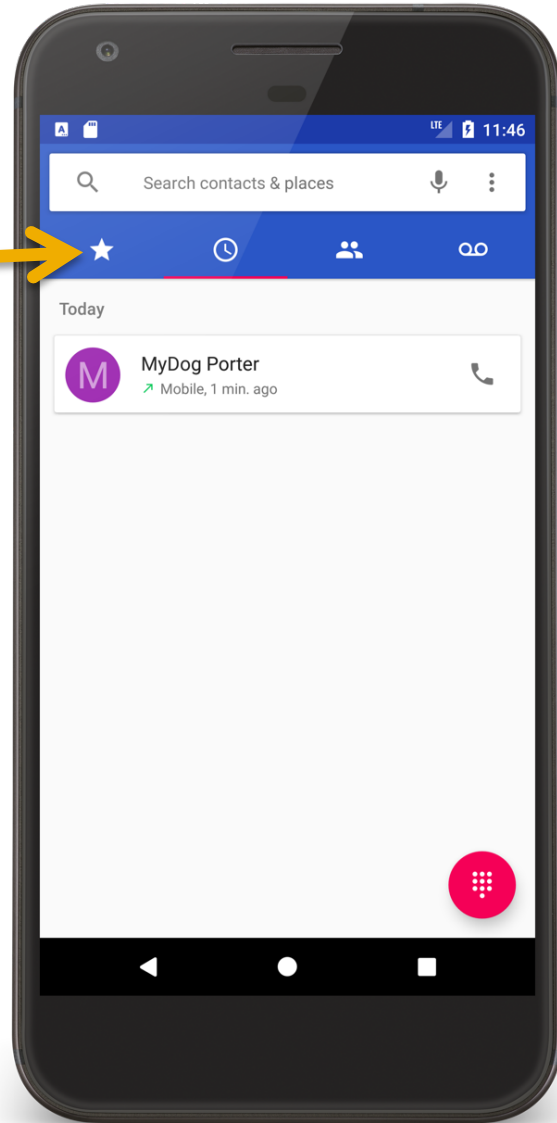
Buttons
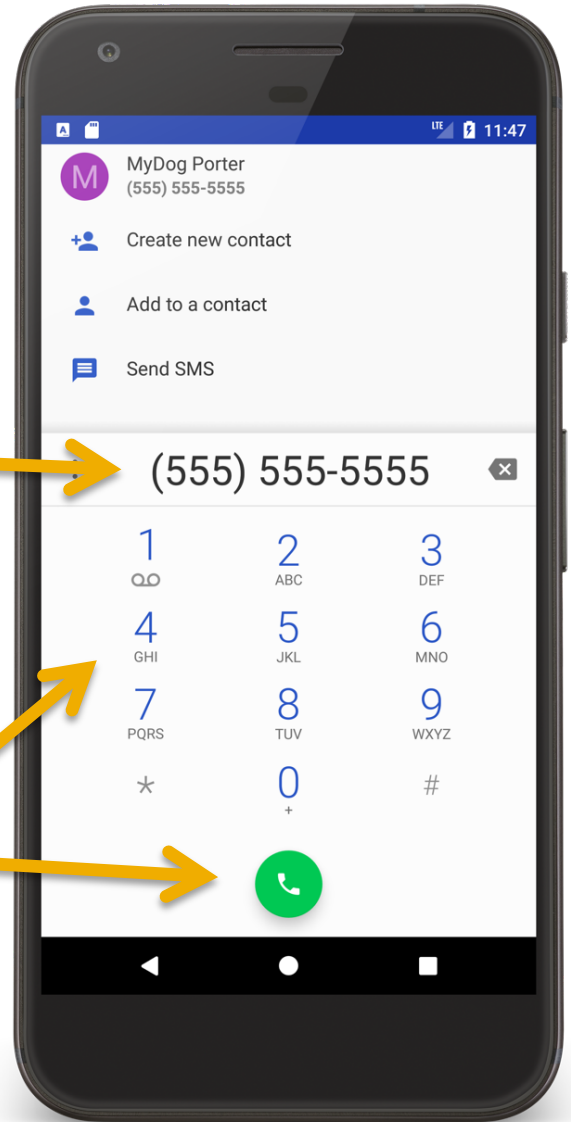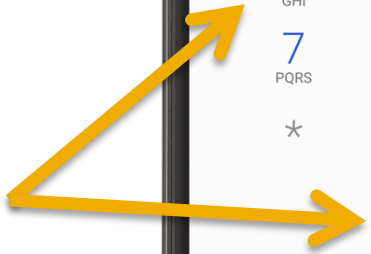
# Resource Manager

Manages non-compiled resources
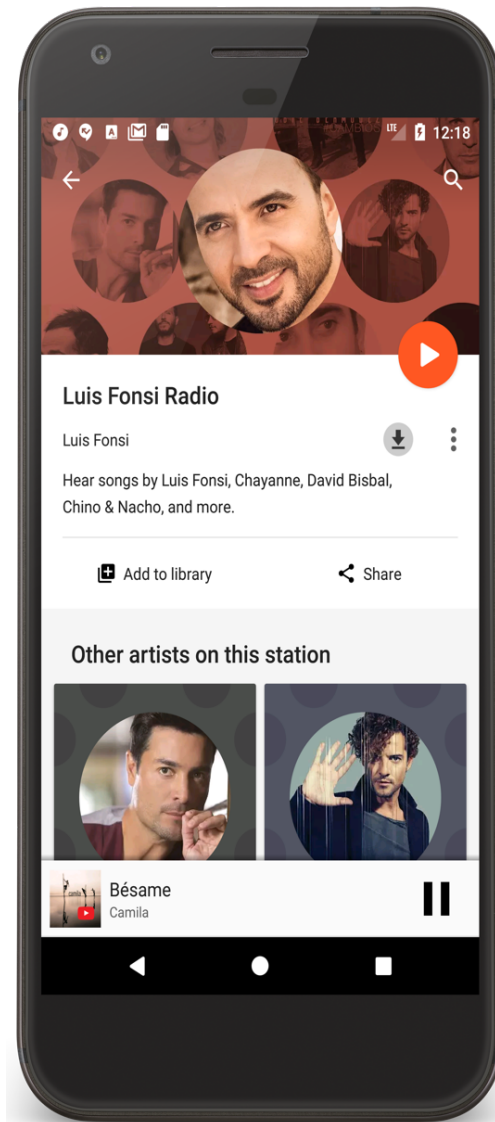
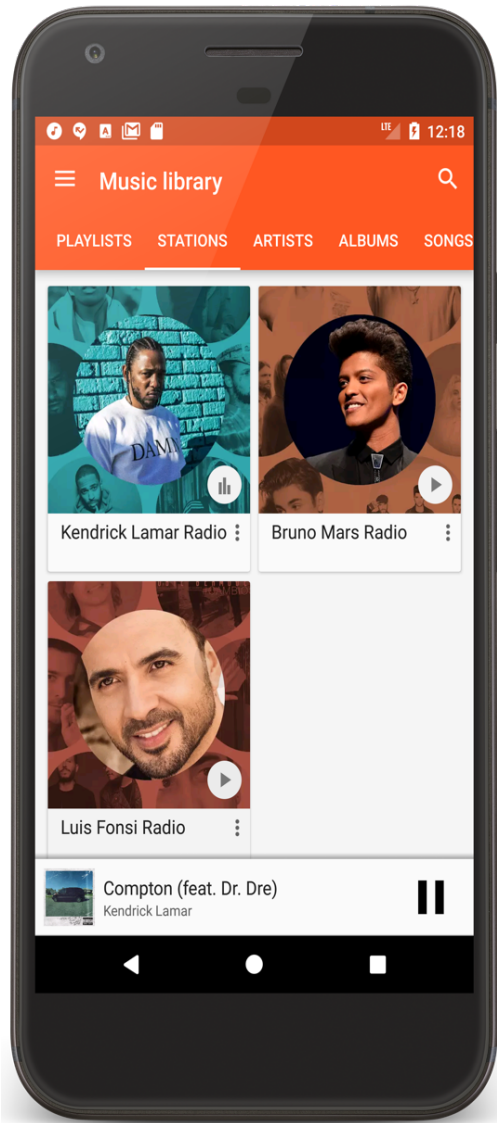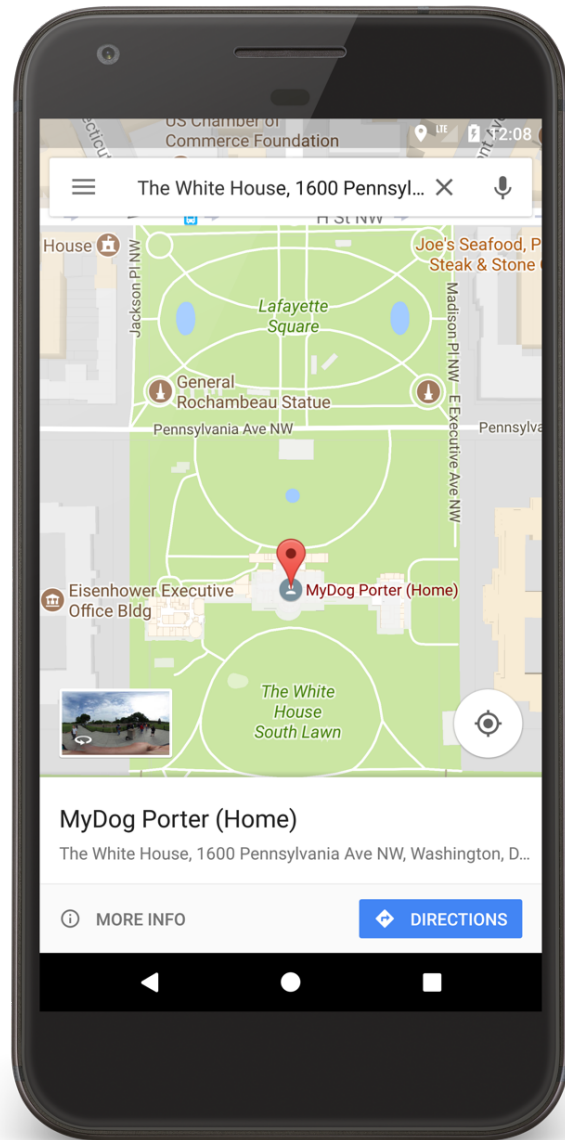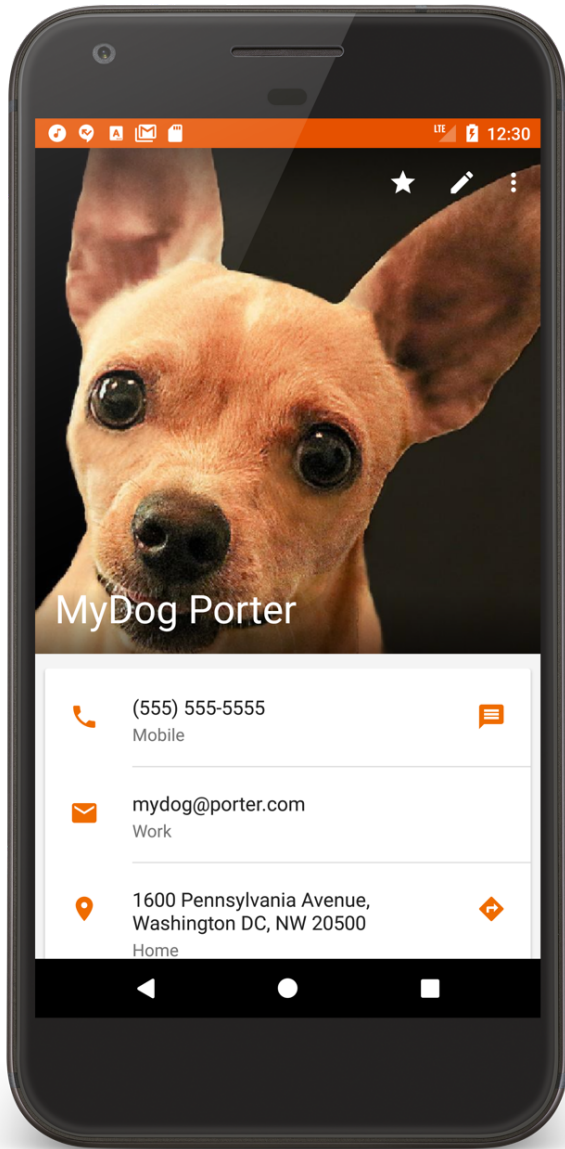e.g., strings, graphics, & layout files

English Strings

Italian Strings

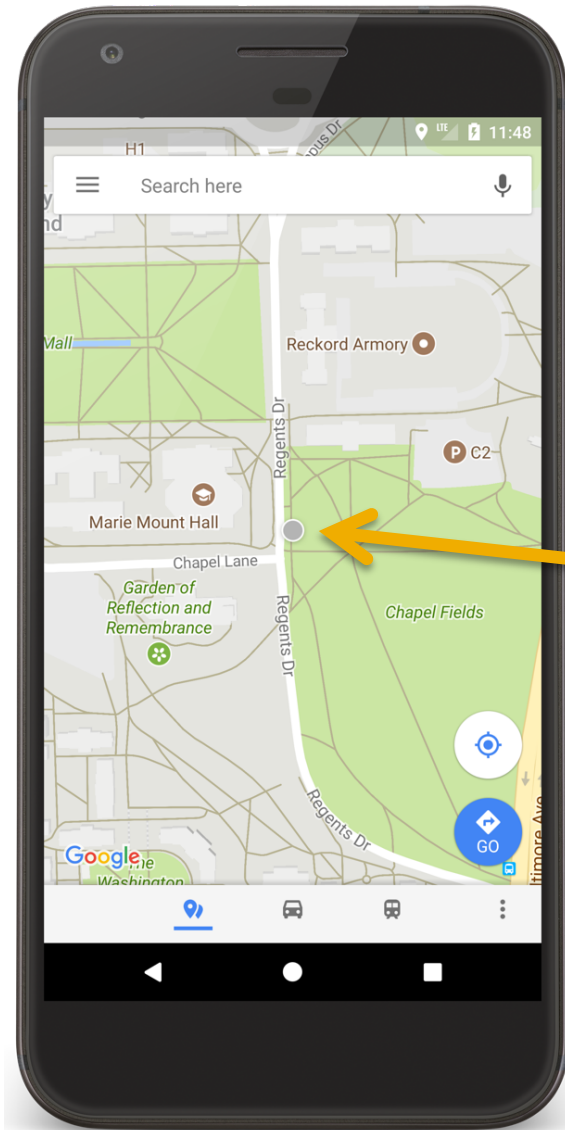# Activity Manager

Manages app lifecycle and navigation stack

# ContentProvider

Inter-application data sharing

**Left phone (contact screen):**

★  ✎  ⋮

MyDog Porter

📞 (555) 555-5555
Mobile                    💬

✉ mydog@porter.com
Work

📍 1600 Pennsylvania Avenue,
Washington DC, NW 20500      ➡
Home

**Right phone (map screen):**

The White House, 1600 Pennsyl...  ✕  🎤

US Chamber of
Commerce Foundation

House
Lafayette
Square

General
Rochambeau Statue
Pennsylvania Ave NW

Joe's Seafood,
Steak & Stone

MyDog Porter (Home)

Eisenhower Executive
Office Bldg

The White
House
South Lawn

MyDog Porter (Home)

The White House, 1600 Pennsylvania Ave NW, Washington, D...

ⓘ MORE INFO            ◆ DIRECTIONS
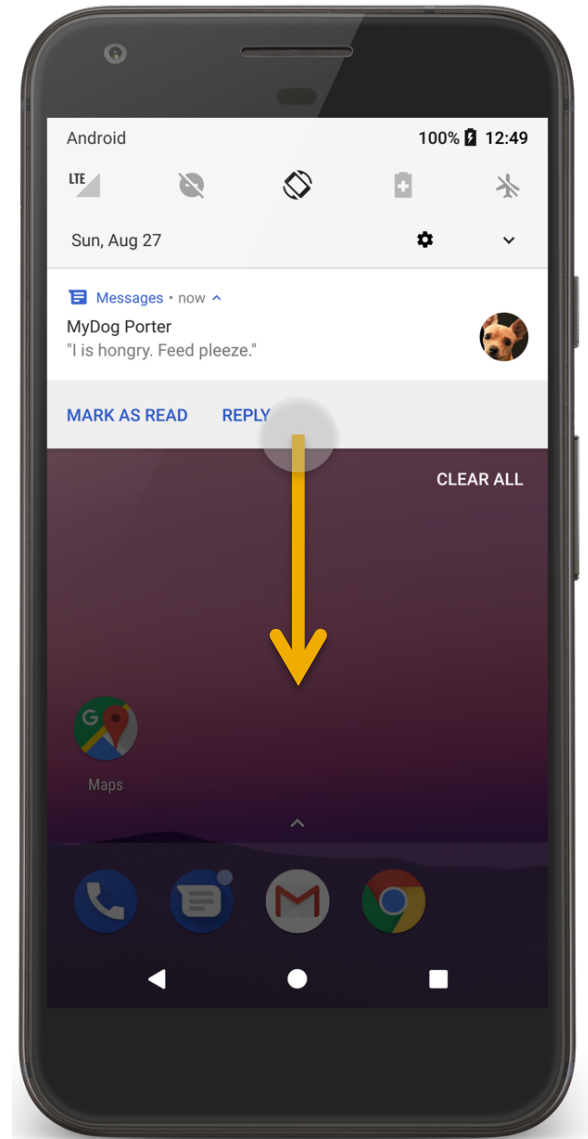
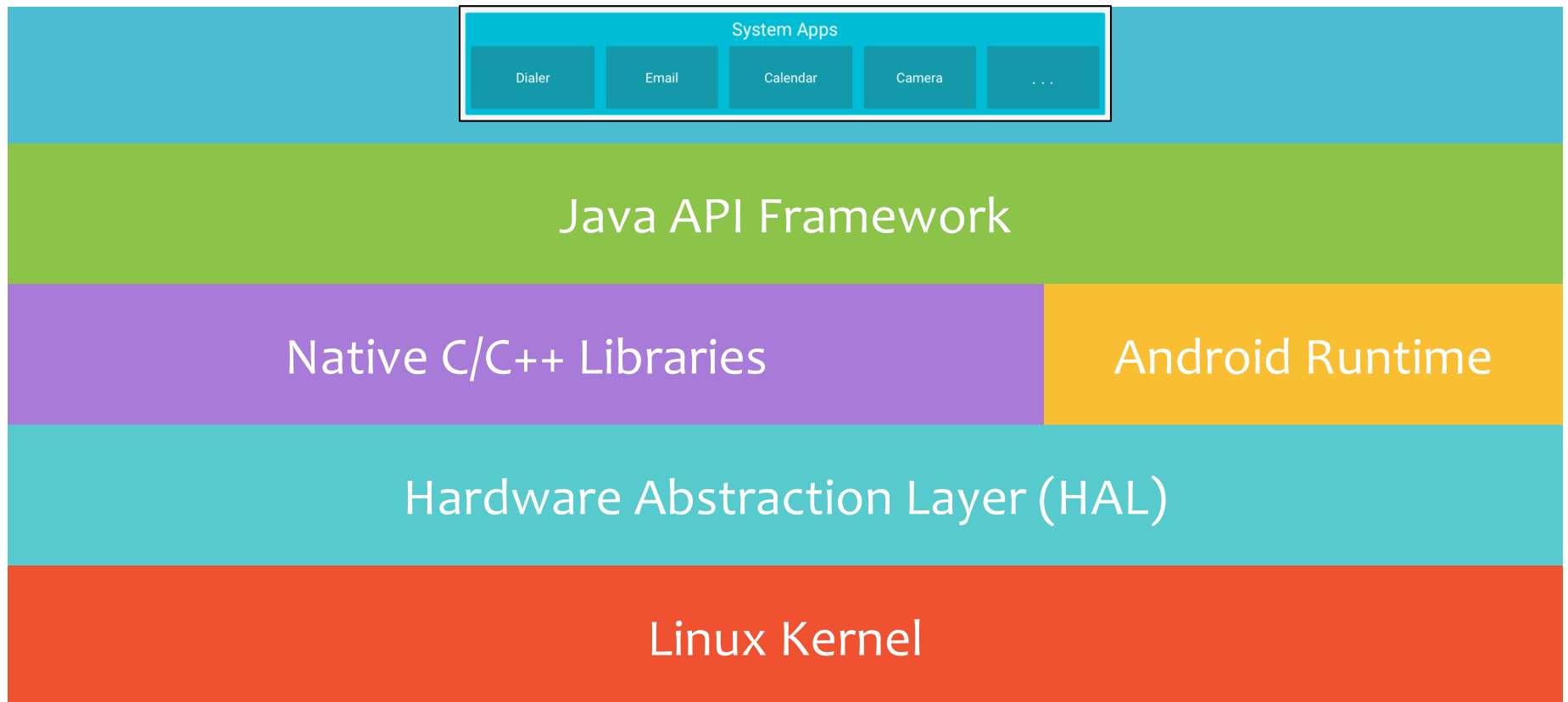# Location Manager

Provides location & movement information

User's Location

# Notification Manager

Place notification icons in the status bar area
when important events occur

# The Android Architecture

**System Apps**

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

**Java API Framework**

**Native C/C++ Libraries**

**Android Runtime**

**Hardware Abstraction Layer (HAL)**

**Linux Kernel**

# Applications

Standard apps include:

Home – main screen

Contacts – contacts database

Phone – dial phone numbers

Browser – view web pages

Email reader –compose & read email messages

# Applications

Nothing special about these apps

You can substitute your own or 3rd party app for any of them

# Next

Android Development Environment