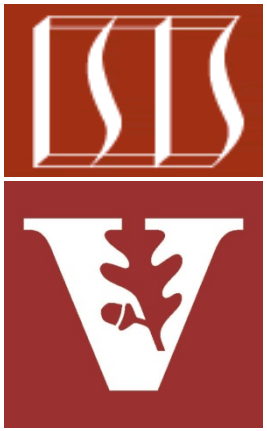
Overview of CS 282 & Android



Douglas C. Schmidt
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www.dre.vanderbilt.edu/~schmidt

Institute for Software
Integrated Systems
Vanderbilt University
Nashville, Tennessee, USA

CS 282 Principles of Operating Systems II

Systems Programming for Android

Topics Covered in this Part of the Module

- Course goals & logistics

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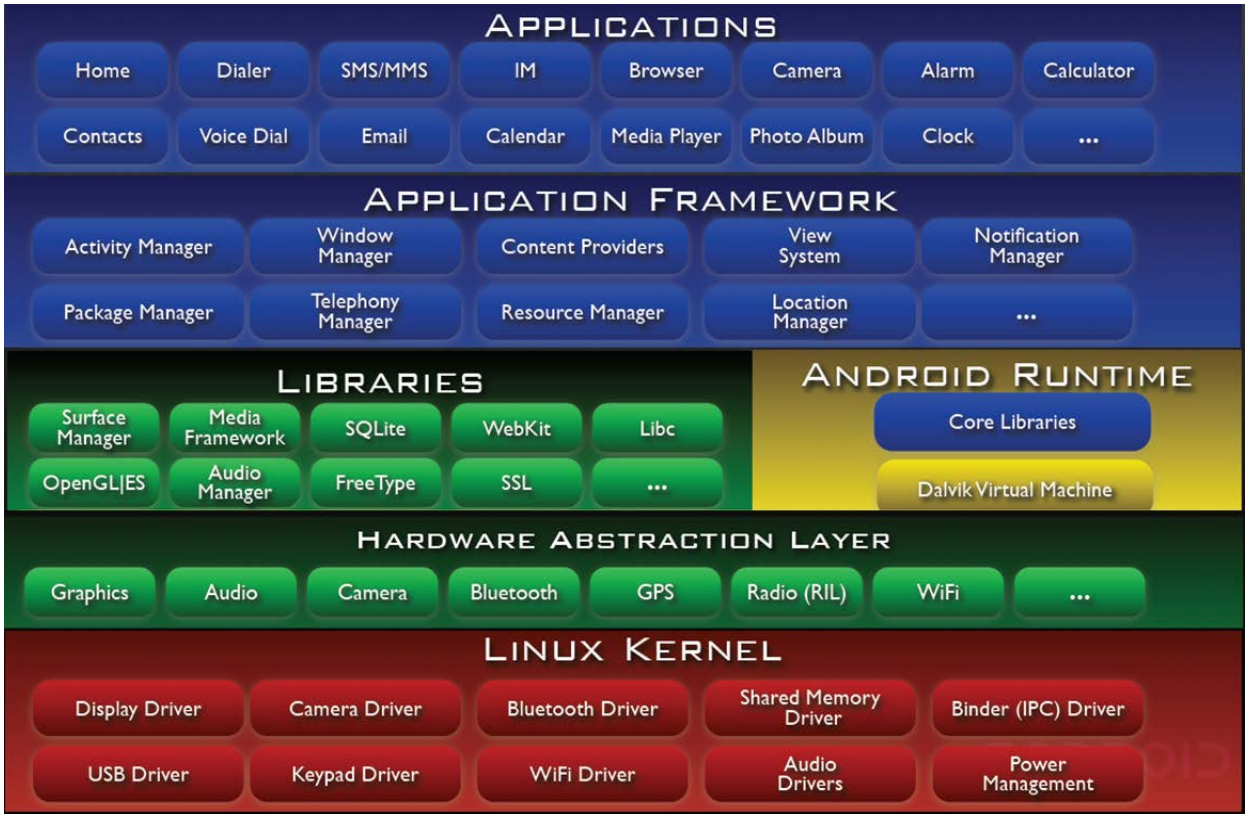
- Course goals & logistics
- Present an overview of the Android software architecture



Course Goals

- Learn about
  - Mobile devices
  - Systems programming for mobile devices
  - The Android platform
- Develop interesting Android systems programming applications
  - Expect lots of programming
  - Each student will do multiple projects
  - There may also be a group project at the end

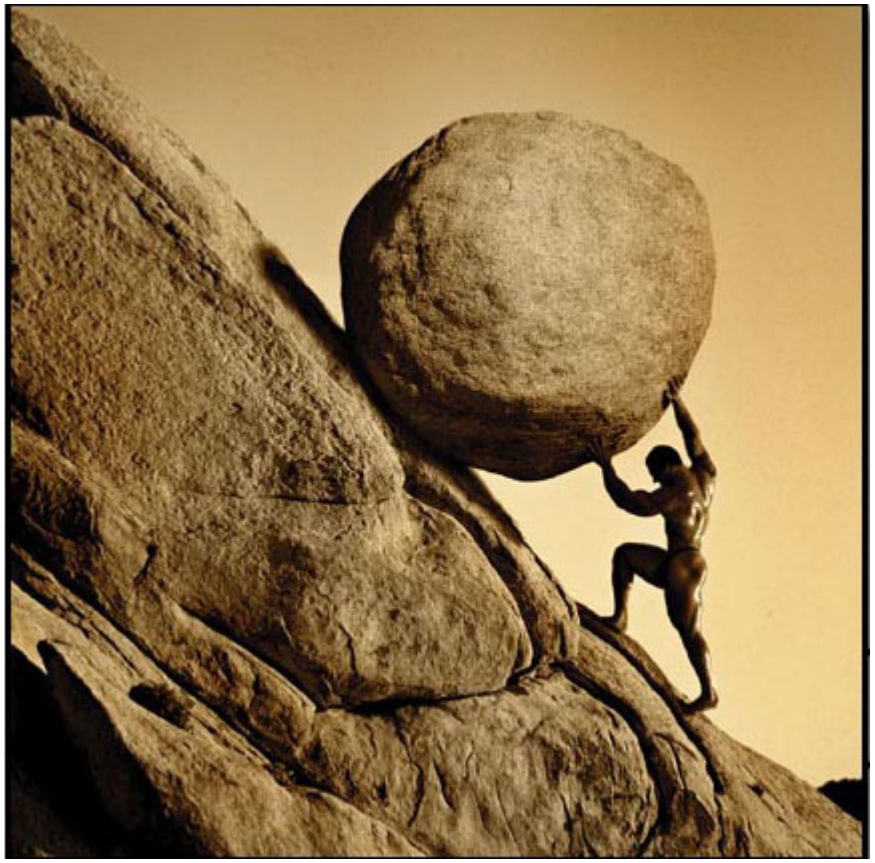
Administrivia

Logistics

- Douglas C. Schmidt
  - d.schmidt@vanderbilt.edu
  - Office: FGH #226
  - Office hours: M. 1-3pm & W. 1-3pm
    - Nearly always reachable by email
- TAs/graders
  - Nick King <nicholas.b.king@vanderbilt.edu>
  - Nolan Smith <nolan.m.smith@vanderbilt.edu>
  - Lane Kelly <lane.m.kelly@vanderbilt.edu>
- Course URL: www.dre.vanderbilt.edu/~schmidt/cs282

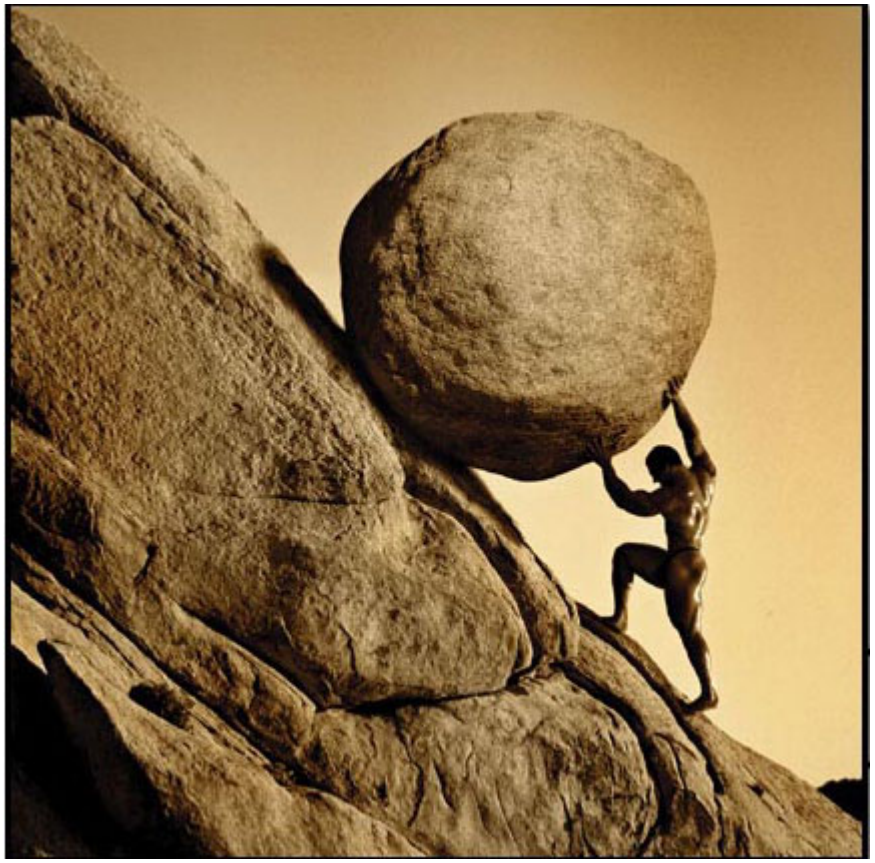
Course Work

- There will be 5-6 programming assignments written in Java
  - Can use Windows, Linux, Mac, etc.
- *Must* be done individually
- Programs will be graded as follows:
  - 40% execution correctness
  - 30% structure (e.g., modularization, information hiding, etc.)
  - 10% insightful programming (e.g., developing reusable class components, etc.)
  - 10% Consistent style (e.g., capitalization, indenting, etc.)
  - 10% appropriate commenting style



Course Work

- There will be a 5 point deduction (out of a possible 100 points) for each day that your program is late
  - Programs turned in later than two calendar days after the due date will receive a zero
- There will be weekly quizzes & a comprehensive final exam
- The relative weighting of each portion of the course is :
  - 40% Programming projects
  - 40% Quizzes
  - 10% Final Exam
  - 10% Class participation

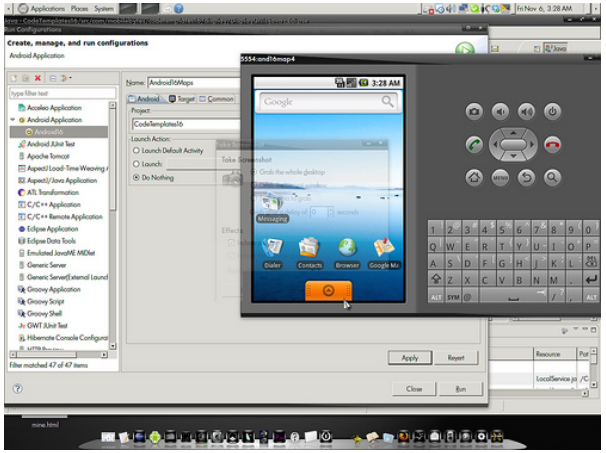


Ground Rules

- Assignments must be submitted on time
- Work *must* be your own (see www.owen.vanderbilt.edu/vanderbilt/about-us/honor-code.cfm)
- *No* laptops open in class unless explicitly allowed
- You will be called upon to answer questions
  - 10% class participation grade, so be involved & attend class
- You'll get out of this course what you put into it, so be prepared to work hard & learn a lot
- Be prepared for weekly quizzes & occasional guest lectures
- Make sure to avail yourself of available help, e.g., office hours, TAs, mailing list, etc.

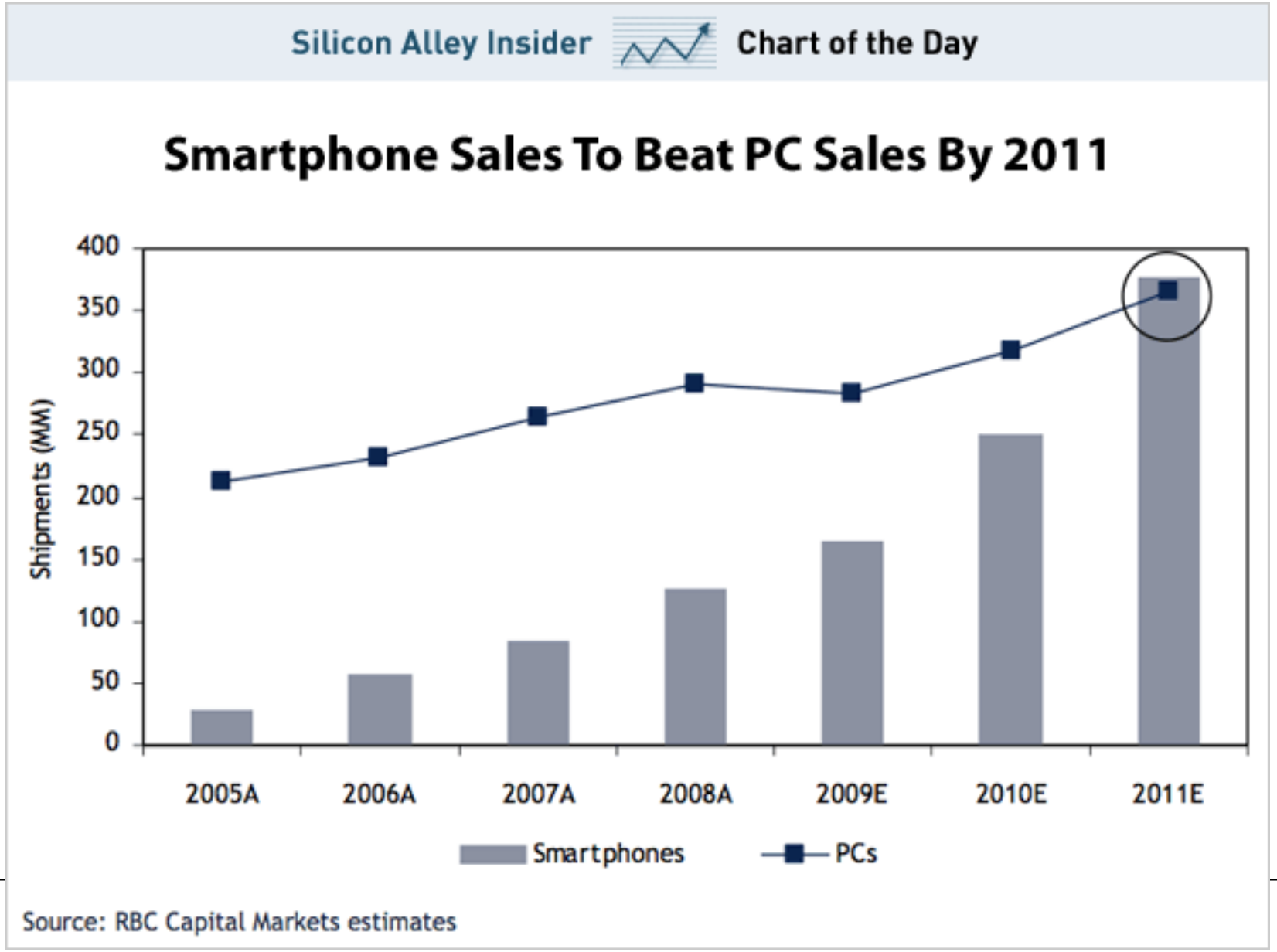
Class Organization

- Mix of lecture & programming exercises
  - ½ presentation
  - ½ laboratory exercises & semester project
- Organization will remain flexible
  - Will change as needed



Why Mobile Devices & Android?

Mobile Devices are the Next Computing Platform



Why Android?

- Android has > 50% of the smartphone market (#1)
- iPhone has < 30% of the smartphone market (#2)
- Blackberry, Windows Mobile, & etc. are rapidly losing market share since their platforms not nearly as interesting to develop for as Android/iPhone

Top Smartphone Platforms 3 Month Avg. Ending Feb. 2012 vs. 3 Month Avg. Ending Nov. 2011 Total U.S. Smartphone Subscribers Ages 13+ Source: comScore MobiLens			
	Share (%) of Smartphone Subscribers		
	Nov-11	Feb-12	Point Change
Total Smartphone Subscribers	*100.0%*	*100.0%*	*N/A*
Google	46.9%	50.1%	3.2
Apple	28.7%	30.2%	1.5
RIM	16.6%	13.4%	-3.2
Microsoft	5.2%	3.9%	-1.3
Symbian	1.5%	1.5%	0.0

Why Android?

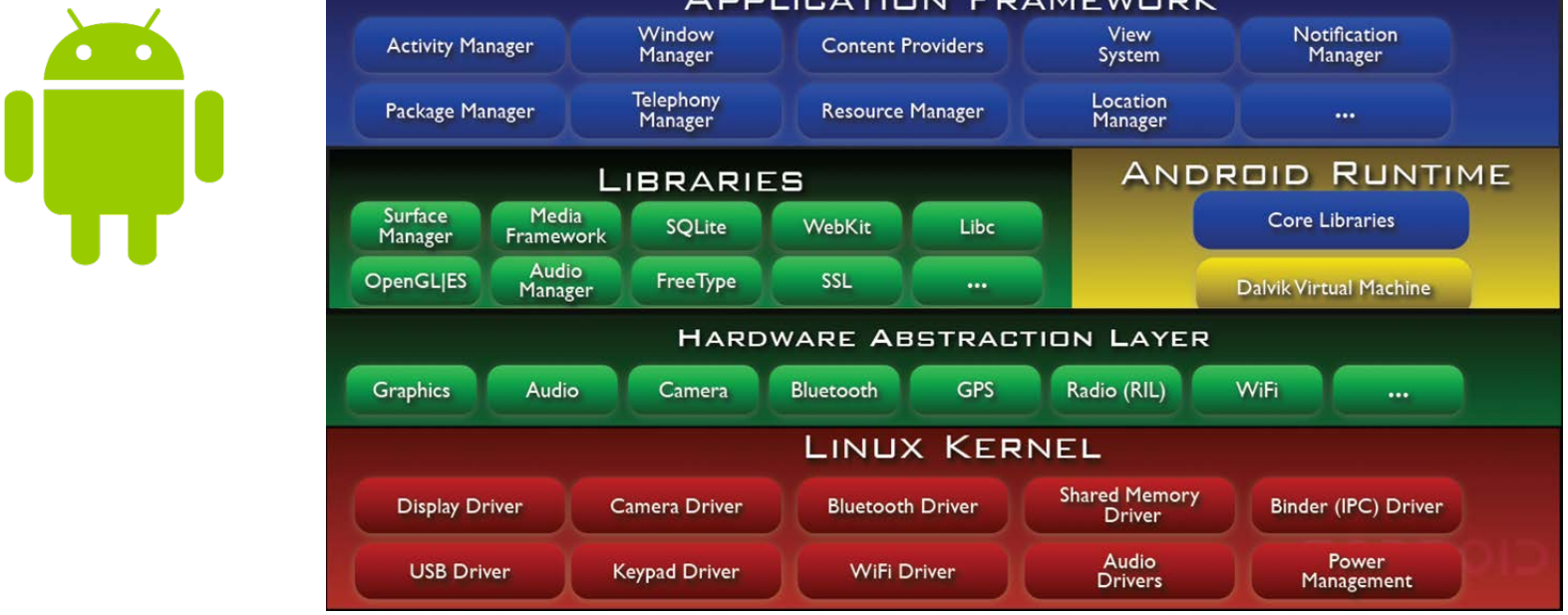
Android is:

- the fastest growing smartphone platform
  - open-source & works on multiple platforms
  - no need to own a Mac
  - no need to join a developer program
- Easy to learn for Java (& C++) programmers
  - Much easier to transition to than Objective-C

Getting Started with Android

Developing Android Apps

- Android is a software stack for mobile devices that provides an operating system, middleware, & key services/applications
  - The Android SDK contains libraries & development tools for creating applications



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  - editors for manipulating Android XML descriptors needed for your app
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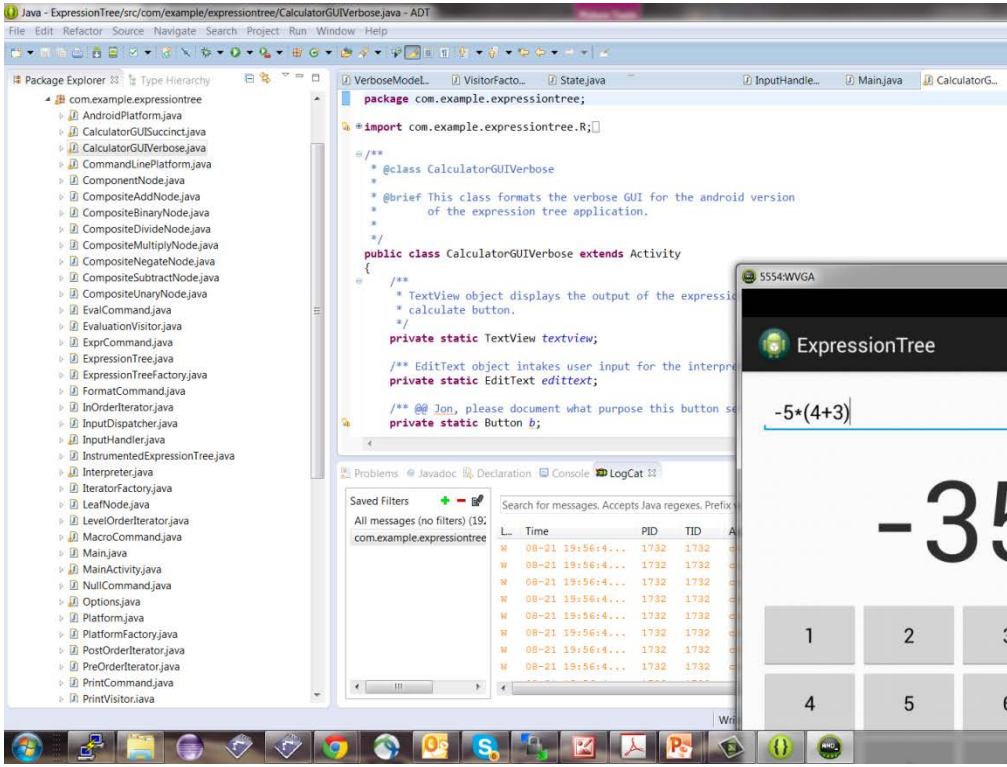
  - a debugger for finding errors in the emulator or on a device



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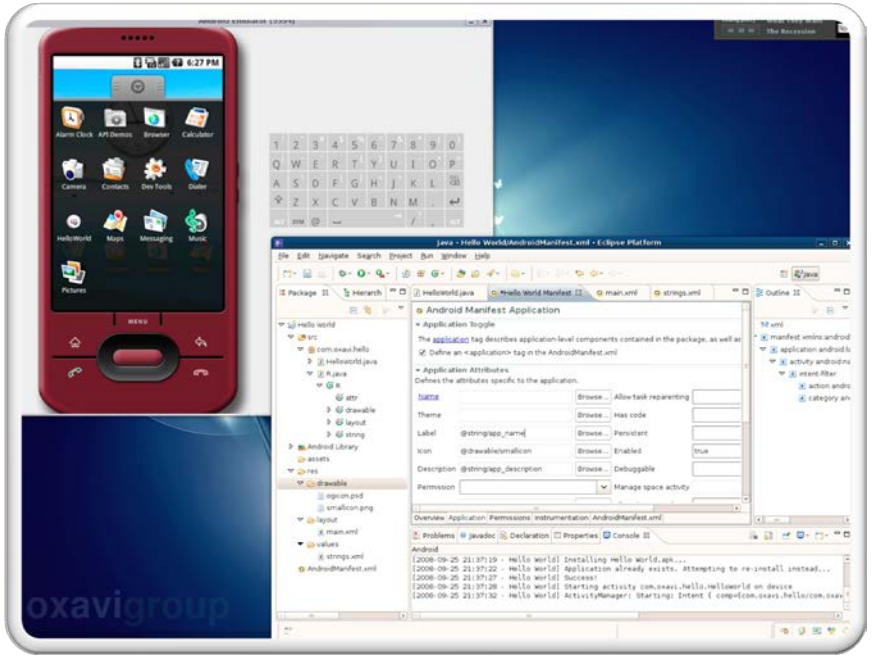
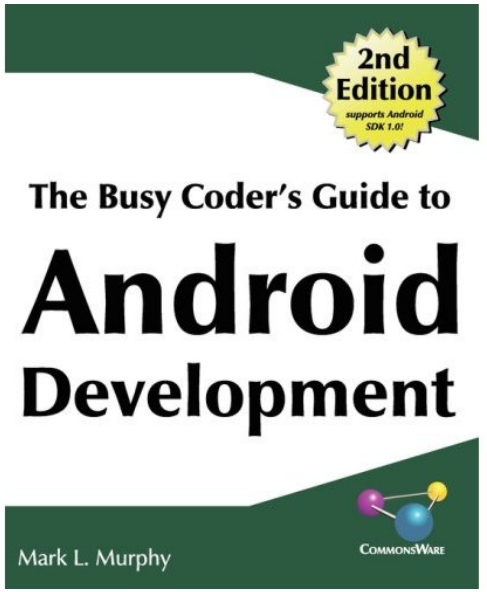


Setting Up an Android Development Environment

- Follow the instructions for Lab1 at http://www.dre.vanderbilt.edu/~schmidt/cs282/Lab1.pdf

Figuring Out Android

- Android is well documented
- The Android javadoc references will be critical reference material for your projects:
  - http://developer.android.com/reference/packages.html
- The Android developer guide is another important resource:
  - http://developer.android.com/guide/components
- We recommend “The Busy Coder’s Guide to Android Development” e-book
  - http://commonsware.com/warescription



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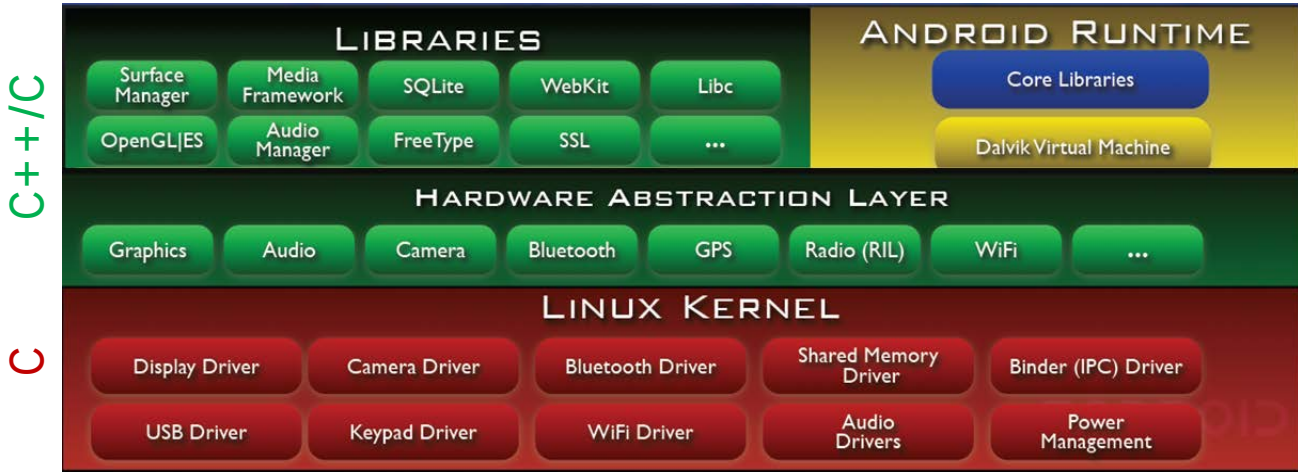

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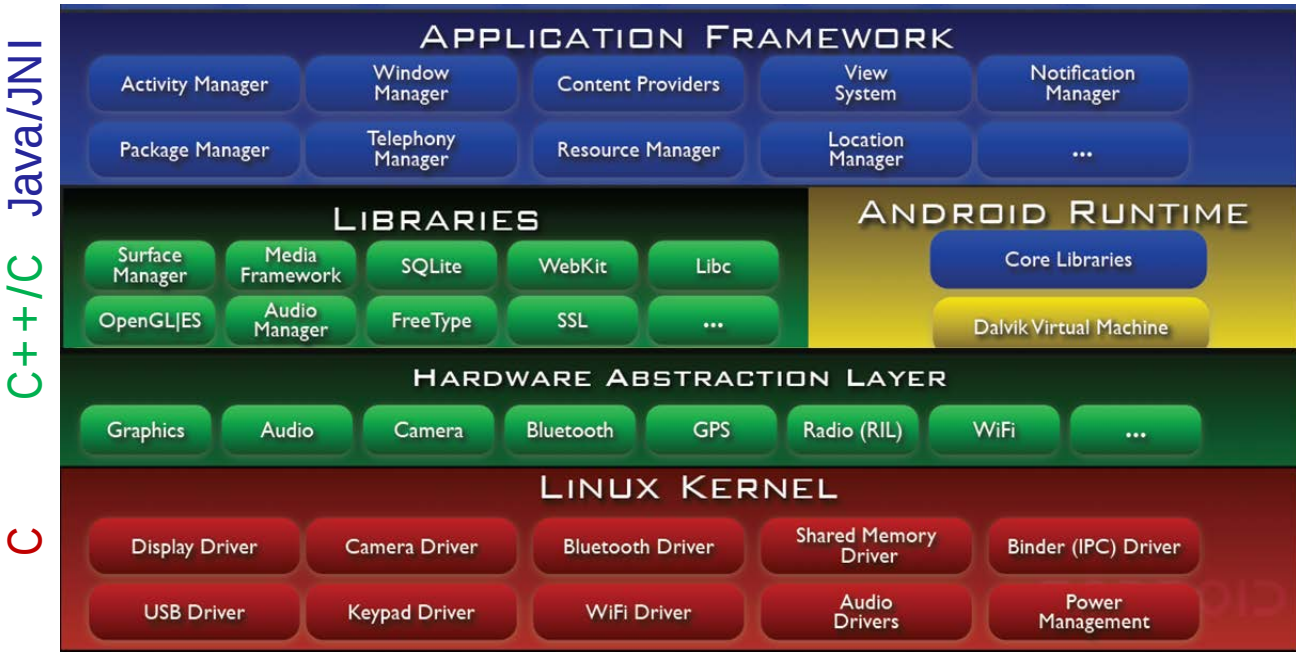
  - Middleware, including
    - GUIs
    - Telephony services
    - Camera
    - Multimedia
    - App frameworks
    - App Distribution
    - etc.



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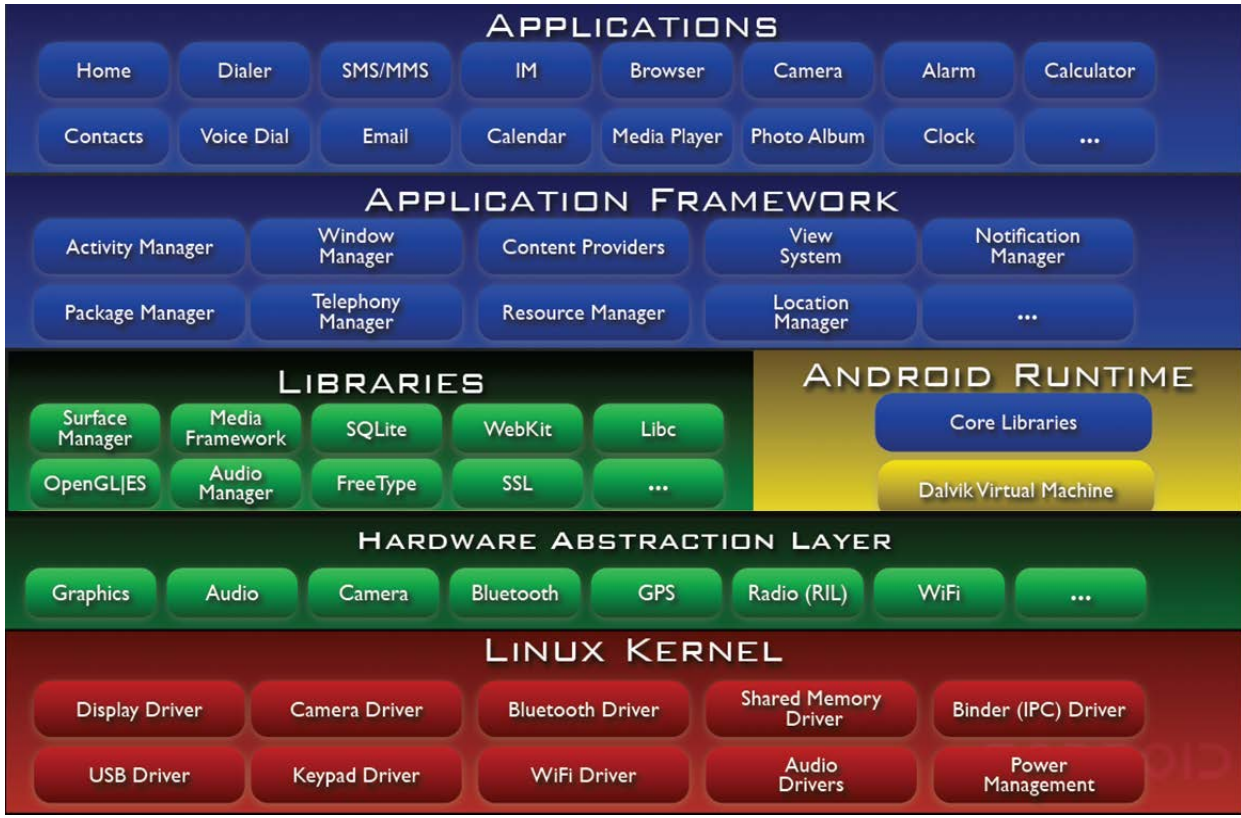
  - Common set of apps



See developer.android.com/guide/basics/what-is-android.html for more

Linux Kernel

C

- Provides infrastructure mechanisms to manage mobile device resources
  - Memory, process, & thread management
  - Network & inter-process communication stack
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- Android-specific enhancements
  - Binder – optimized inter-process communication (IPC)
  - Android shared memory
  - Power management
  - Alarm driver
  - Low memory killer
  - Kernel debugger & Logger

en.wikipedia.org/wiki/Android_(operating_system)#Linux has more info

Hardware Abstraction Layer (HAL)

- User space C/C++ library layer that defines the interface Android requires hardware "drivers" to implement
- The HAL helps to decouple
  - Android platform logic from hardware interface
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- Motivation for a user-space HAL
  - Not all components have standardized kernel driver interfaces
    - Android has specific requirements for hardware drivers
  - Kernel drivers are GPL, which exposes proprietary intellectual property of Android
    - Implementations of HAL components are often *not* open-source

See tidsp.es.ncku.edu.tw/cinfon/resource/slides/11102012_02_final.pdf

Native C/C++ Libraries

- **System C library**
  - bionic libc
- **Surface Manager**
  - display management
- **Media Framework**
  - audio/video streaming
- **FreeType**
  - library for rendering fonts
- **Webkit**
  - web browser engine
- **OpenGL ES, SGL**
  - graphics engines
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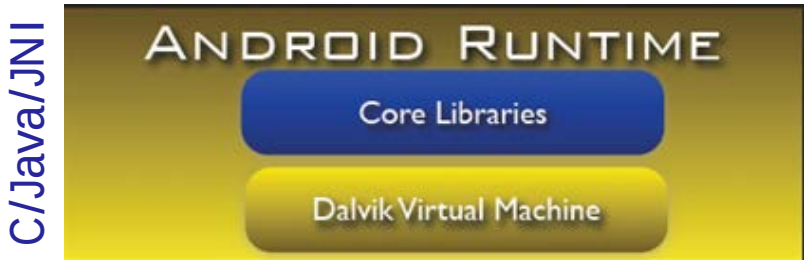
developer.android.com/tools/sdk/ndk/index.html has info on Android NDK

Android Runtime



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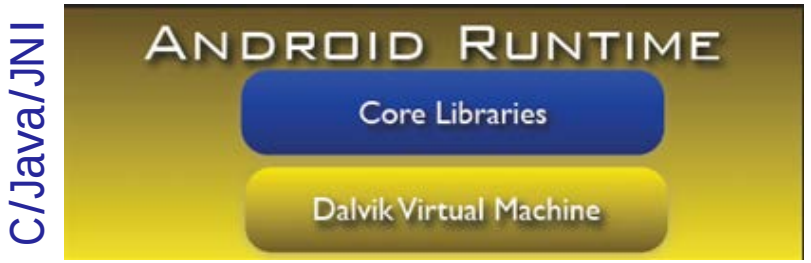

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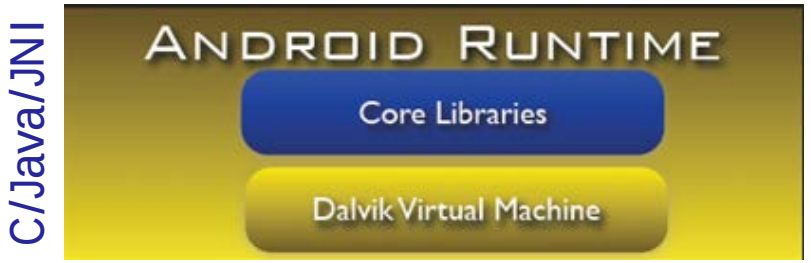

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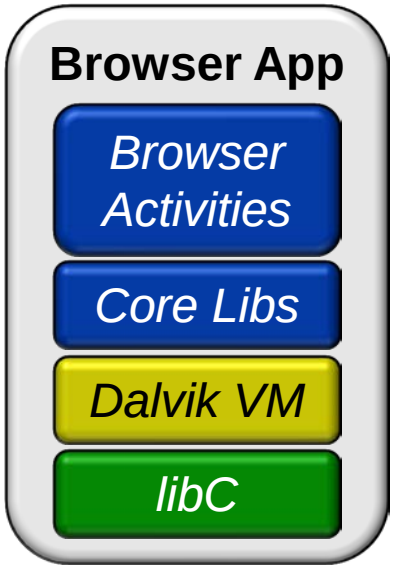
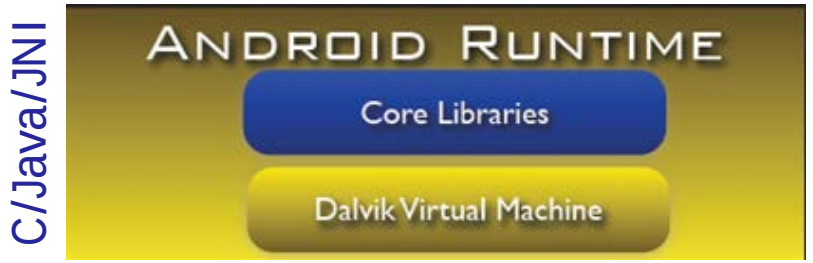


See en.wikipedia.org/wiki/Dalvik_(software) for more on Dalvik

Android Runtime



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      - java.*, javax.*
      - junit.*
      - org.apache.*, org.json.*, org.xml.*

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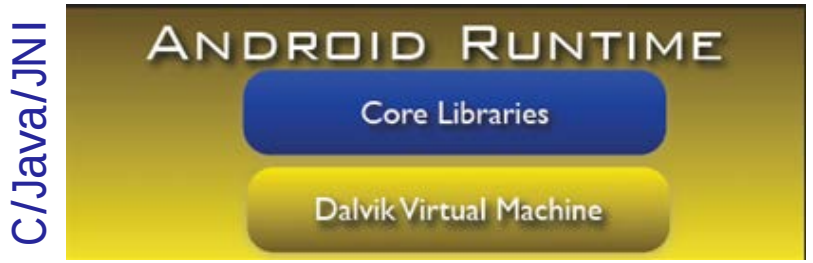

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      - org.apache.*, org.json.*, org.xml.*
    - Doesn't include all standard Java SDK classes

en.wikipedia.org/wiki/Comparison_of_Java_and_Android_API has more info

Application Frameworks

Java/JNI

- Provide services that are essential to the Android platform
- **Window Manager**
  - Manages top-level window's look & behavior
- **View System**
  - Lists, grids, text boxes, buttons, etc.
- **Content Providers**
  - Inter-application data sharing
- **Activity Manager**
  - Application lifecycle & common navigation stack
- **Package Manager**
  - Manages application packages
- **Telephony Manager**
  - State of telephony services
- **Resource Manager**
  - Manages non-code resources: strings, graphics, & layout files
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Applications

Java/JNI

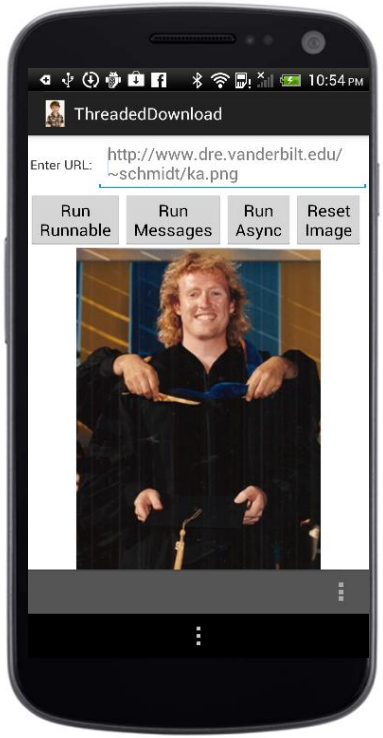
- Some standard apps include:
  - **Home**
    - main screen
  - **Contacts**
    - contacts database
  - **Calendar**
    - track schedules
  - **Camera**
    - take photos & videos
  - **Phone**
    - dial phone numbers
  - **Browser**
    - view web pages
  - **Email reader**
    - Gmail & others
  - **Media player**
    - Play songs & watch movies
  - **SMS/MMS**
    - Instant messaging

All apps written using Java (Android frameworks use many JNI calls to C/C++)

Key Types of Android Components

- **Activity**
  - Represents a single screen with a user interface

1: Activity calls downloadImage() with image URL



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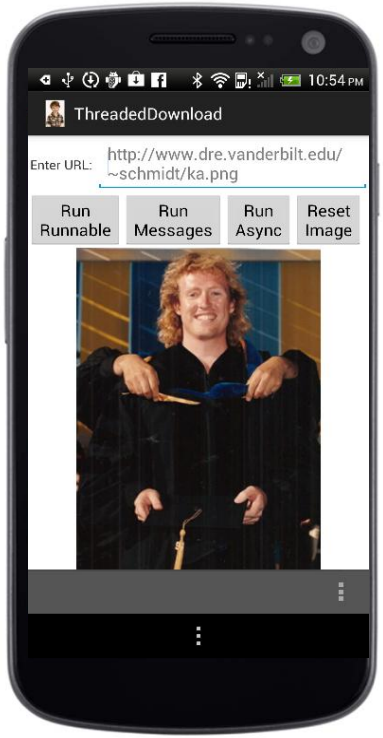

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    - Apps can have multiple Activities

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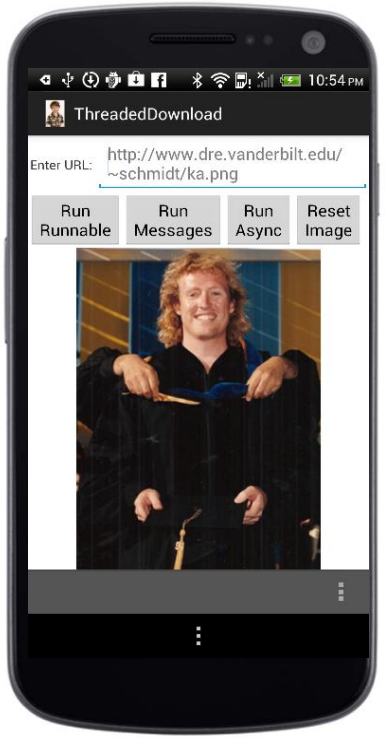

See developer.android.com/guide/components/activities.html for more info

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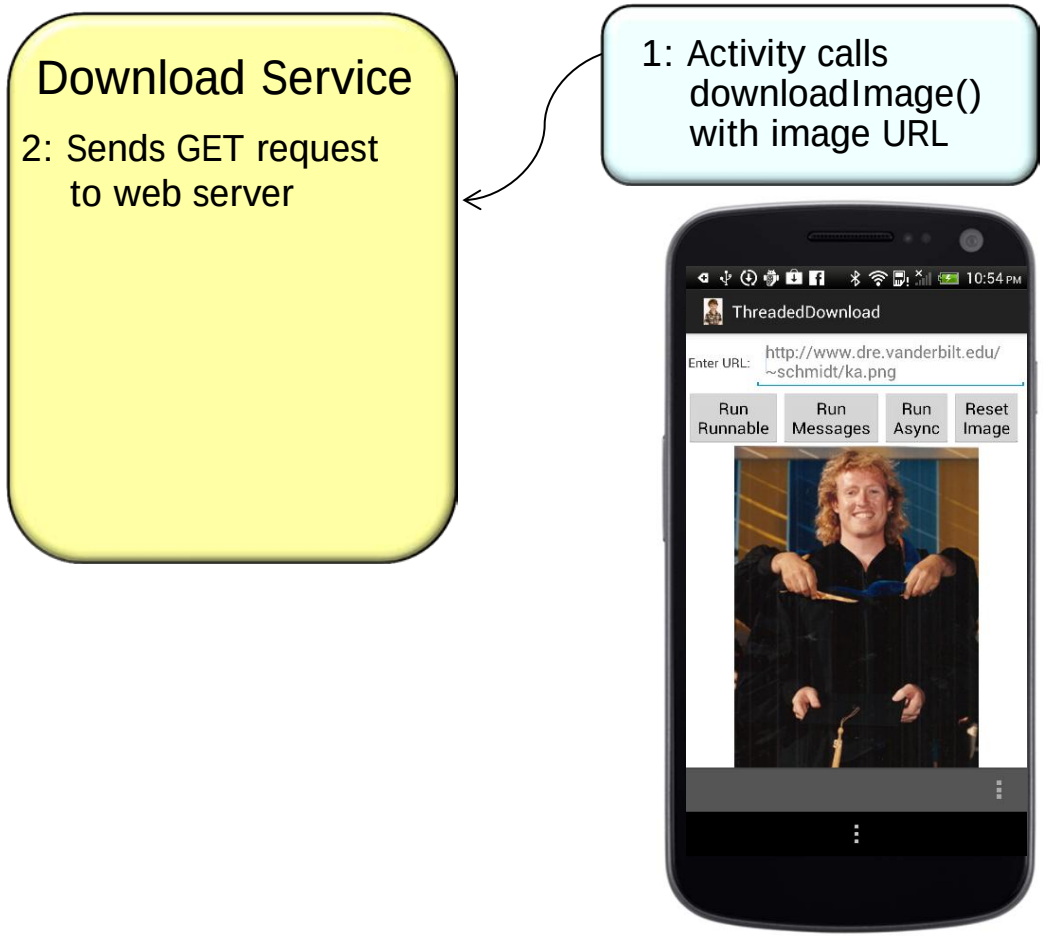

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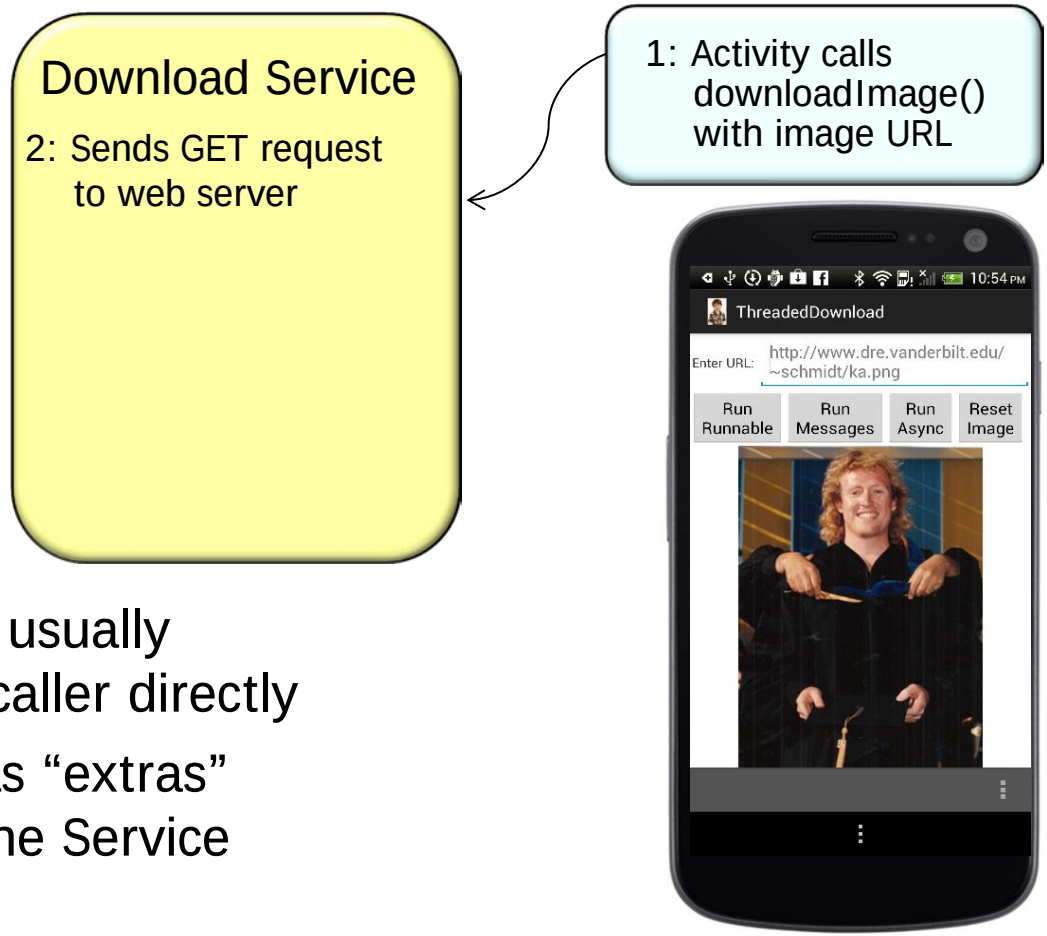

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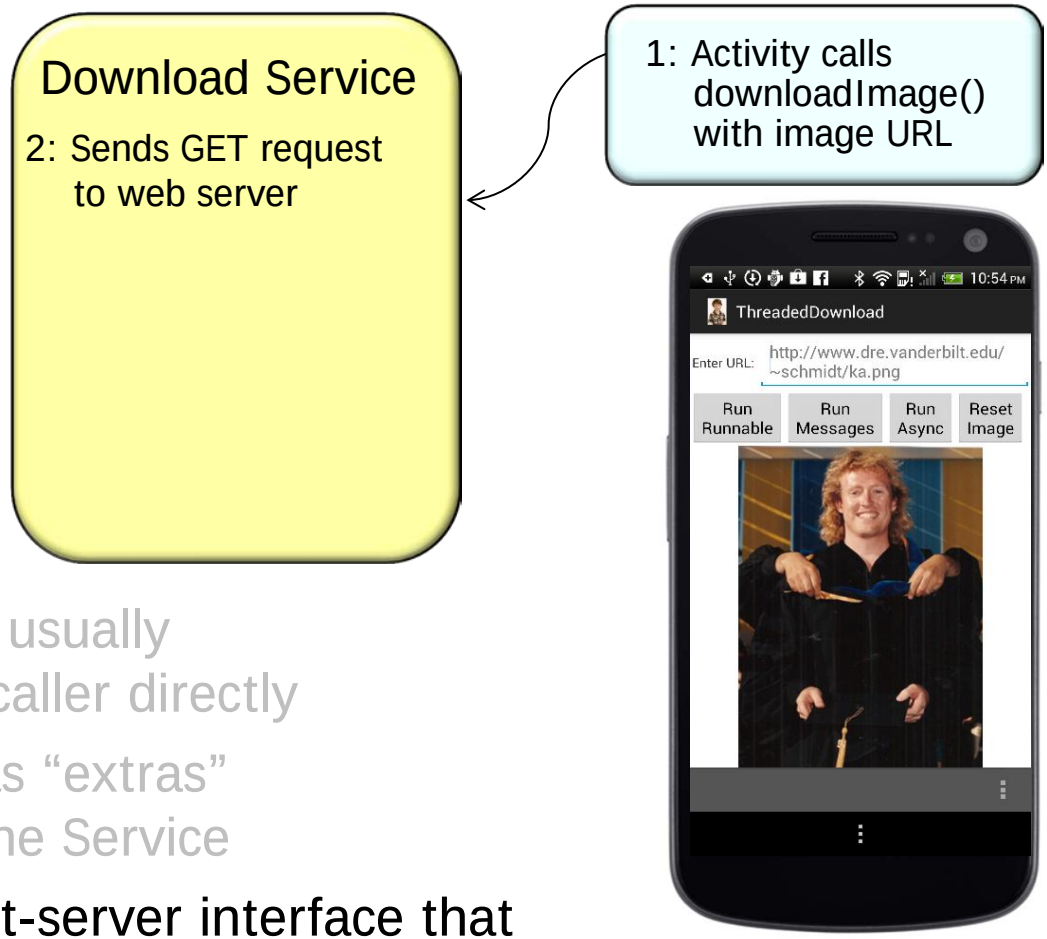
    - *Bound Service* – Offers a client-server interface that allows components to interact with the Service
      - e.g., via the Android Interface Definition Language (AIDL) & Binder RPC



See developer.android.com/guide/components/services.html for more info

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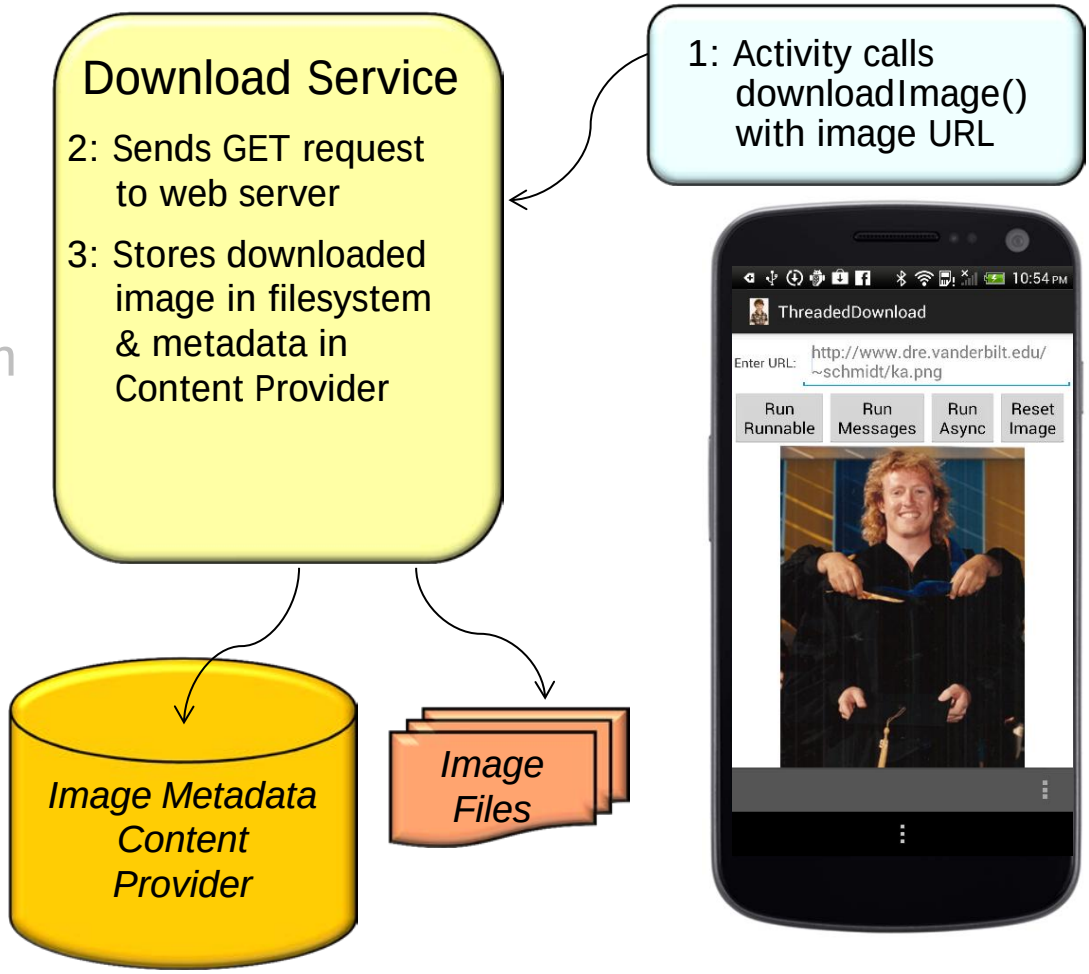

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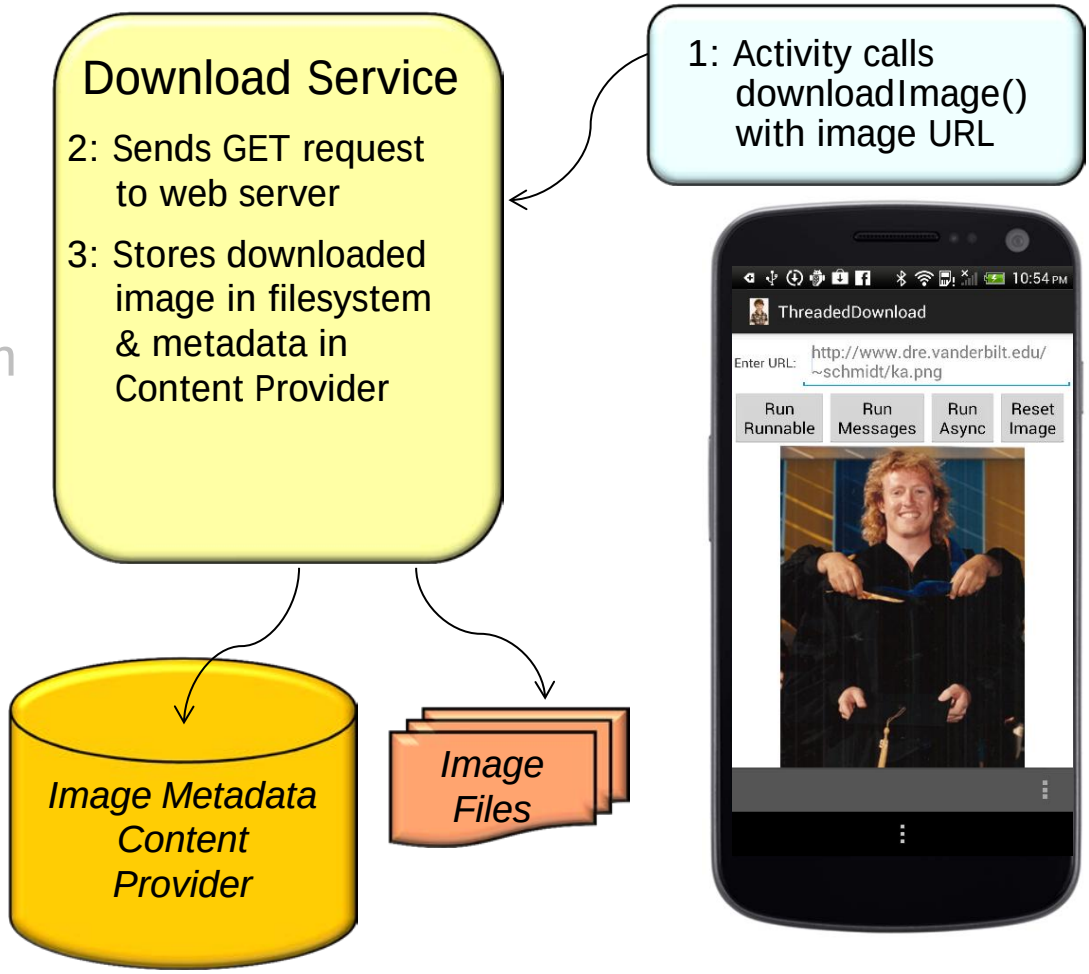
    - Data typically stored persistently in an SQLite database



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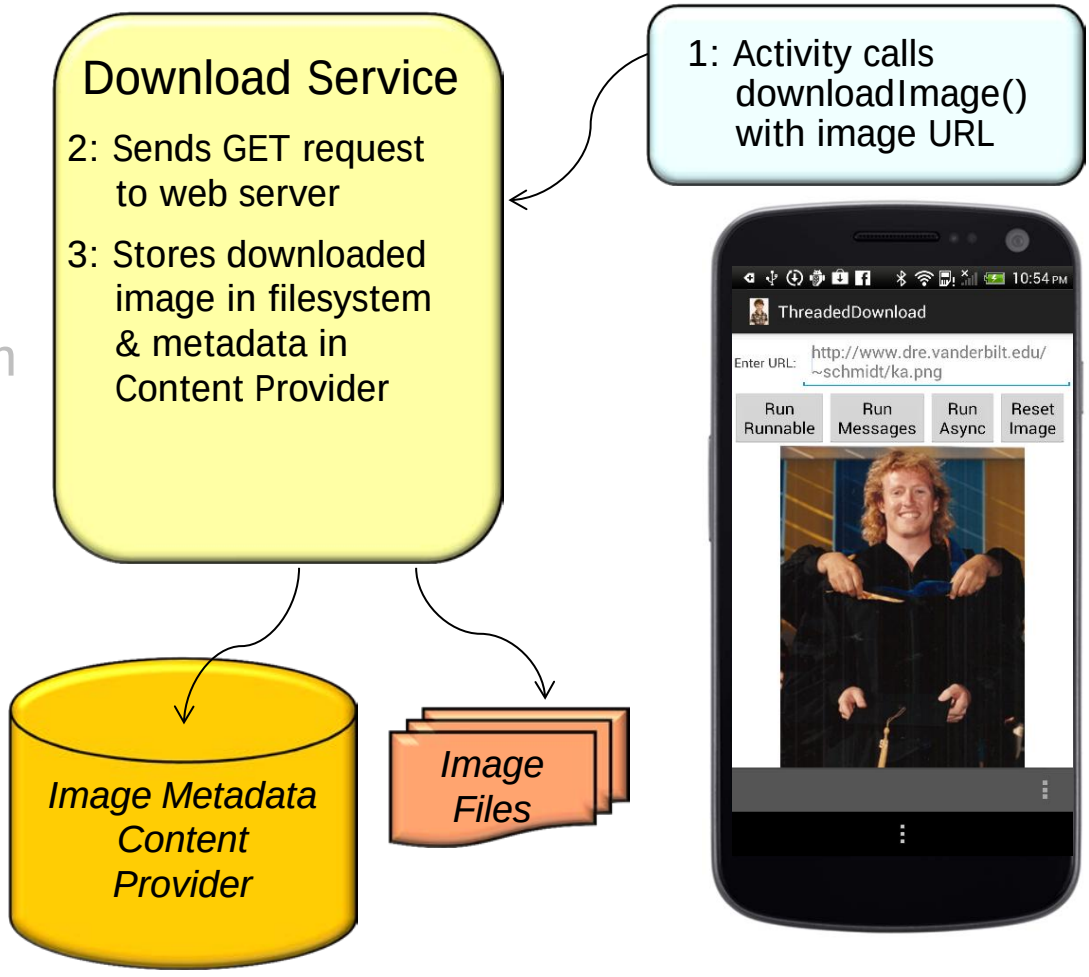
  - Represents a single screen with a user interface
- **Service**
  - Runs in background to perform long-running operations or to access remote resources
- **Content Provider**
  - Manages a shared set of application data
    - Data typically stored persistently in an SQLite database
    - Never accessed directly, but via a Content Resolver



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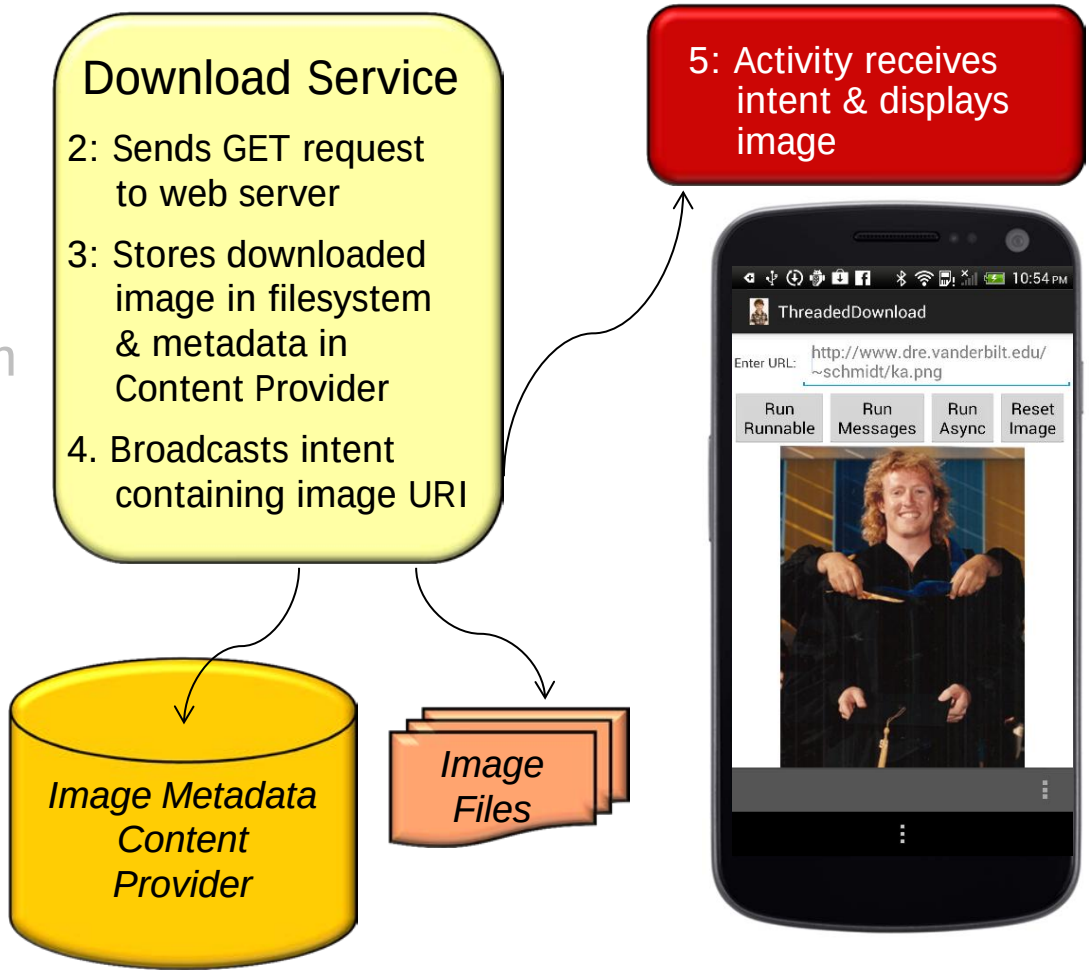

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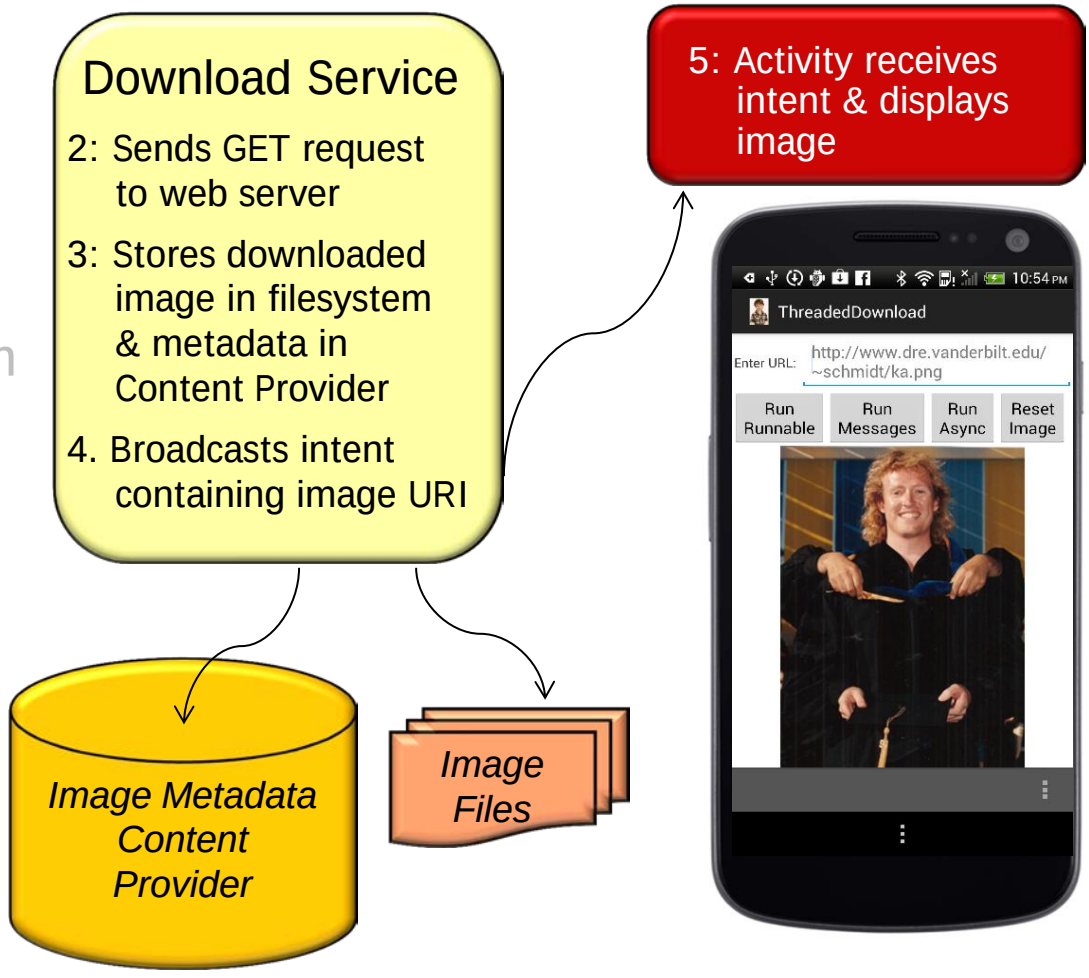
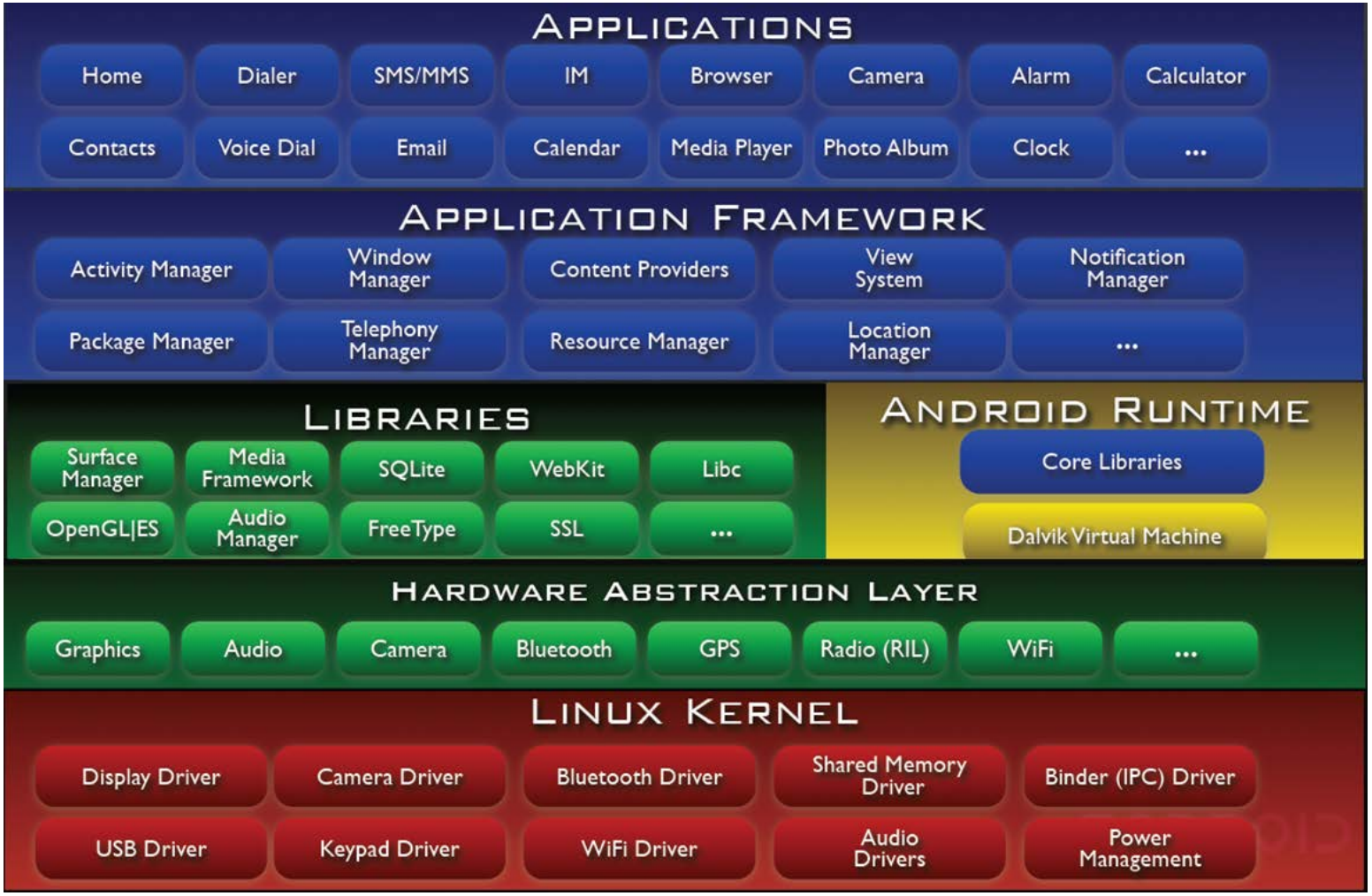
  - A component that responds to system-wide Intent broadcast announcements
    - Supports complex Intent filtering



See developer.android.com/reference/android/content/BroadcastReceiver.html

Summary

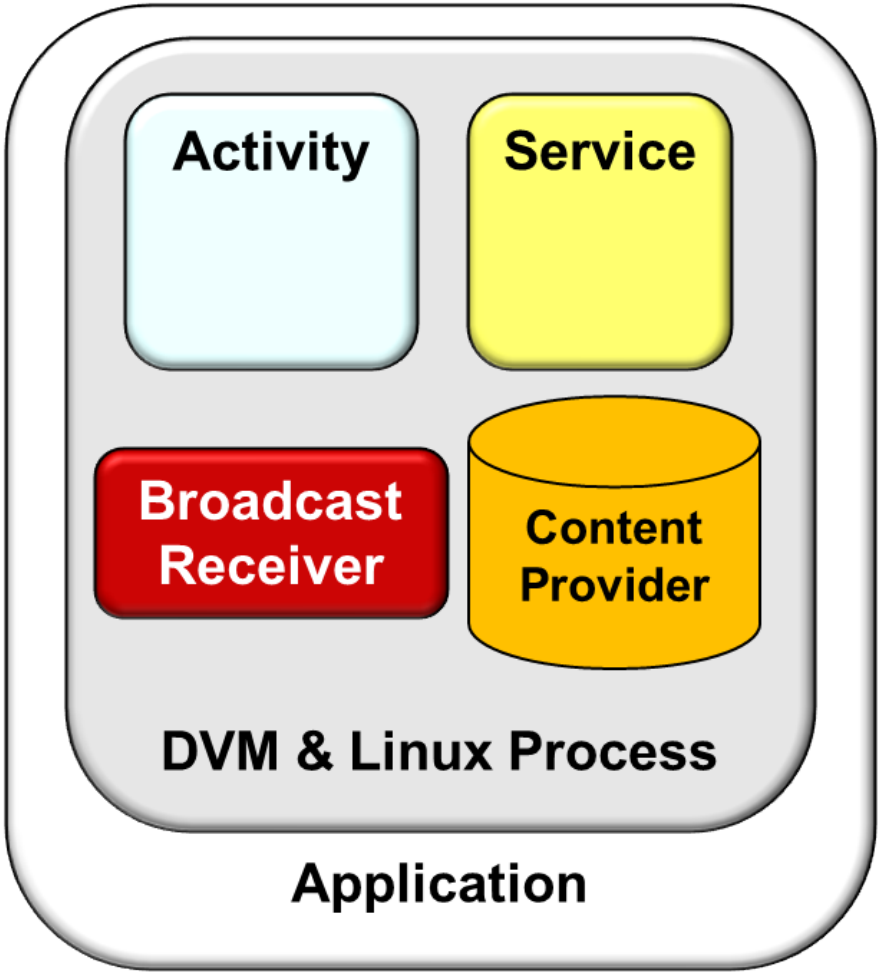
- Android defines a *layered* software stack for mobile devices



sites.google.com/site/io/anatomy--physiology-of-an-android has Android overview

Summary

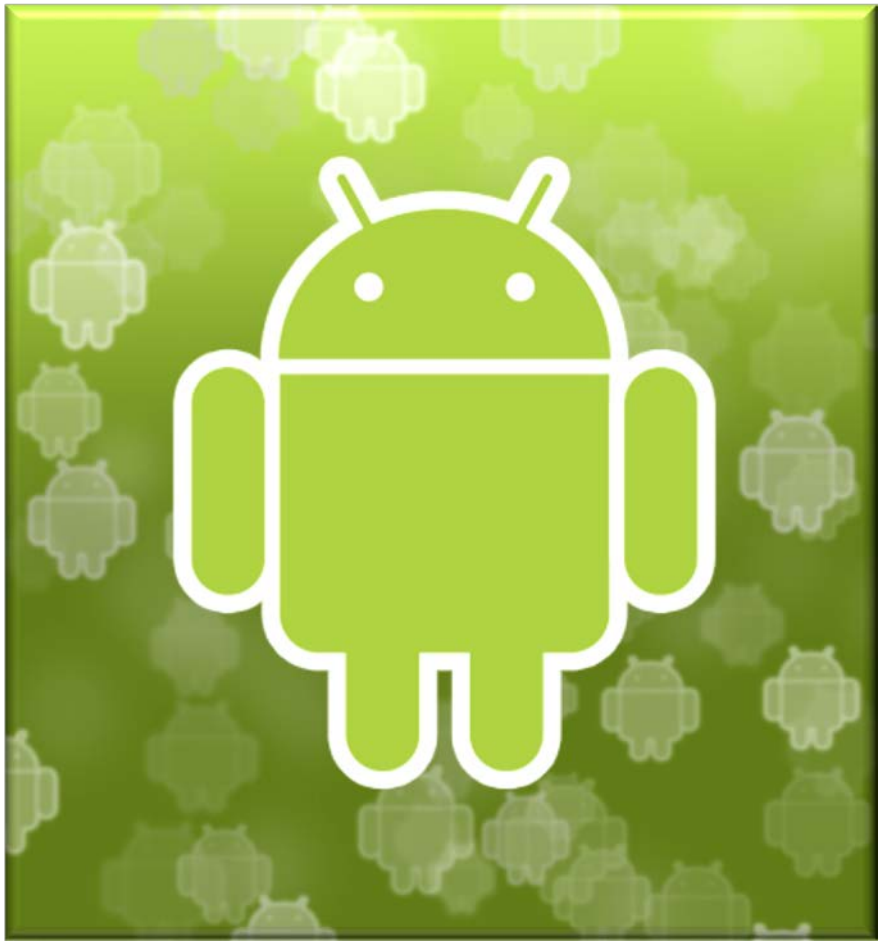
- Android defines a *layered* software stack for mobile devices
- Apps are developed using framework components that Android can instantiate & run as needed



See developer.android.com/guide/components/fundamentals.html for more info

Summary

- Android defines a *layered* software stack for mobile devices
- Apps are developed using framework components that Android can instantiate & run as needed
- Most parts of Android are available in open-source format



See source.android.com for instructions on how to obtain Android source code