Introduction

Programming the Android Platform

Logistics

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Goals

- Learn about
  - Mobile devices
  - Mobile device programming
  - The Android platform
- Develop interesting Android applications
  - Expect lots of programming
  - Each student will do multiple projects

- Yesterday, I was a guest on the Kojo Nnamdi Show (WAMU 88.5 FM) where I discussed the booming job market in mobile application development.
  - Tech Tuesday: Where the Jobs Are
  - http://thekojonnamdishow.org/audio-player?nid=19939

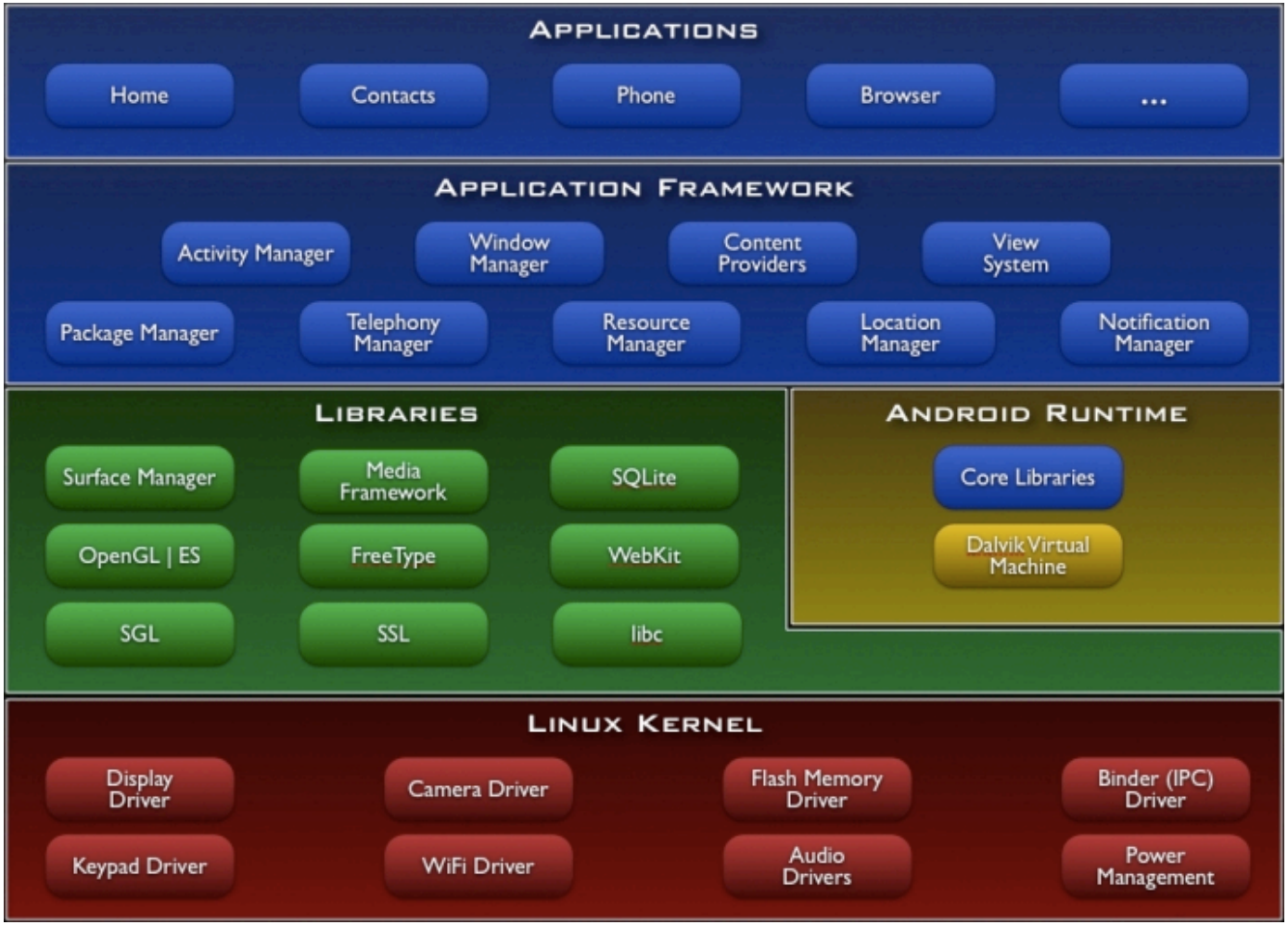
Class Organization

- Mix of lecture and programming exercises
  - ½ presentation
  - 1/2 laboratory exercises & semester project
- Organization will remain flexible
  - Will change as needed

The Android Platform

- A software stack for mobile devices:
  - Operating system, middleware & key applications
- Use Android SDK to create applications
  - Libraries & development tools
- Lots of documentation
  - http://developer.android.com/
  - Start browsing today!

The Android Architecture



http://developer.android.com/guide/basics/what-is-android.html

Linux Kernel

- Abstraction layer between HW & SW
- Provides services such as:
  - Security
  - Memory & process management
  - Network stack
  - Device driver model

Linux Kernel (cont.)

- Android-specific components
  - Binder – IPC
  - Android shared memory
  - Power management
  - Alarm driver
  - Low memory killer
  - Kernel debugger & Logger

Native Libraries

- C/C++ libraries
  - System C library
    - bionic libc
  - Surface Manager
    - display management
  - Media Framework
    - audio/video
  - Webkit
    - web browser engine
  - OpenGL ES, SGL
    - graphics engines
  - SQLite
    - relational database engine
  - SSL
    - secure sockets layer

Android Runtime

- Support services for executing applications
  - Core Libraries
  - Dalvik Virtual Machine

Core Libraries

- Core Java classes
  - android.*
  - java.*, javax.*
  - junit.*
  - org.apache.*, org.json.*, org.xml.*
- Doesn't include all standard Java SDK classes
  - developer.android.com/reference/packages.html
  - www.zdnet.com/blog/burnette/java-vs-android-apis/504

Dalvik Virtual Machine

- Applications typically written in Java
  - Do not run in a standard Java virtual machine
- **dx** program transforms java classes into .dex-formatted bytecodes
- Bytecodes executed in Dalvik Virtual Machine
- Applications typically run in their own processes, inside their own instance of the the Dalvik VM

Dalvik Virtual Machine (cont.)

- Dalvik VM designed to run on a handset
  - Slow CPU
  - Little RAM
    - e.g., 64Mb total, ~10Mb available at runtime
  - No swap space
  - Limited battery life

Dalvik Virtual Machine (cont.)

- Some Dalvik design choices
- One .dex file for multiple classes
- Modified garbage collection to improve memory sharing
- Optimizations applied at installation time
- Register-based, rather than stack-based

Dalvik Virtual Machine (cont.)

- Memory
  - .dex file has common constant pool for multiple classes
  - Modified garbage collection to improve memory sharing
- CPU
  - Optimizations at installation time
  - Register-based, rather than stack-based

Using Registers

- Expected benefits over stack-based VMs
  - Avoids slow instruction dispatch
  - Avoids unnecessary memory accesses
  - More efficient instruction stream

Dalvik Virtual Machine (cont.)

```
public static long sumArray(int[] arr) {
    long sum = 0;
    for (int i : arr) {
        sum +=    i;
    }
    return sum;
}
```

Java Bytecode

```
0:  lconst_0
1:  lstore_1
2:  aload_0
3:  astore_3
4:  aload_3
5:  arraylength
6:  istore      4
8:  iconst_0
9:  istore      5
11: iload       5
13: iload       4
15: if_icmpge   36
18: aload_3
19: iload       5
21: iaload
22: istore      6
24: lload_1
25: iload       6
27: i2l
28: ladd
29: lstore_1
30: iinc        5, 1
33: goto        11
36: lload_1
37: lreturn
```

% javap –c ClassName

Dex Bytecode

```
0000: const-wide/16 v0, #long 0 // #0000
0002: array-length v2, v8
0003: const/4 v3, #int 0 // #0
0004: move v7, v3
0005: move-wide v3, v0
0006: move v0, v7
0007: if-ge v0, v2, 0010 // +0009
0009: aget v1, v8, v0
000b: int-to-long v5, v1
000c: add-long/2addr v3, v5
000d: add-int/lit8 v0, v0, #int 1 // #01
000f: goto 0007 // -0008
0010: return-wide v3
```

```
% dexdump –d classes.dex
```

Register-based vs stack-based VMs:*

- 30% fewer instructions
- 35% fewer code units (1-byte vs. 2-byte instructions)
- 35% more bytes in the instruction stream
  - but can consume instructions two bytes at a time

- * See www.youtube.com/watch?v=ptjedOZEXPM

Application Framework

- 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 and common navigation stack

Application Framework (cont.)

- Package manager
  - Manages application packages
- Telephony manager
  - State of telephony services
- Resource Manager
  - Manages non-code resources: strings, graphics, and layout files
- Location manager
  - Access to system location services
- Notification Manager
  - Notify users when events occur

Applications

- Standard apps include:
  - Home – main screen
  - Contacts – contacts database
  - Phone – dial phone numbers
  - Browser – view web pages
  - Email reader – Gmail & others
- Your App!

Assignment

- Lab will help you set up your own laptop for Android programming