App Development for Mobile Devices

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Announcement

- Not yet...

Lecture 1
Introduction to Android

Today's Topics

- Android Introduction
- Java crash course

Android

What is Android?

- An open source software stack that includes
  - Operating system
    - Linux operating system kernel that provides low level interface with the hardware, memory management, and process control.
  - Middleware
    - A run time to execute Android applications including Dalvik virtual machine and core libraries.
  - Key mobile applications
    - Email, SMS, PIM, web browser, and etc.
  - Along with API libraries for writing mobile applications.
    - Including open-source libraries such as SQLite, WebKit, and OpenGL ES.
- Open-source development platform for creating mobile applications.

Android SDK Features

- No licensing, distributions, or development fees or release approval processes.
- GSM, EDGE, and 3G networks for telephony and data transfer
- Full multimedia hardware control
- APIs for using sensor hardware including accelerometer and the compass.
- APIs for location based services
- IPC
- Shared data storage
- Background applications and processes.
- Home screen widgets, Live Folders.
- HTML5 WebKit-based web browser
- And many more…

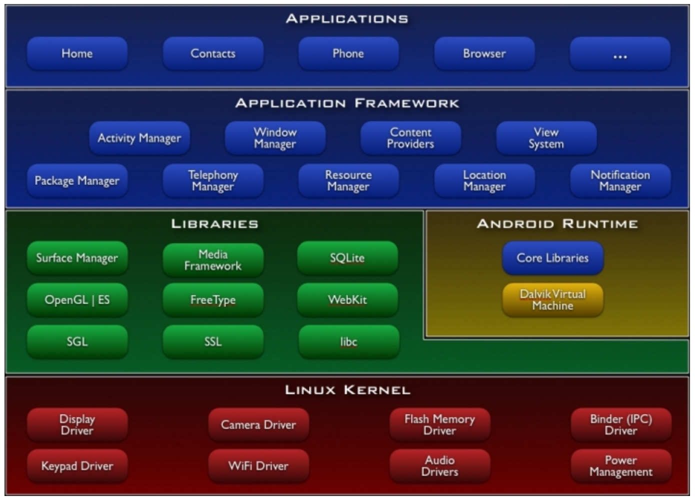
Introducing the Development Framework

Android SDK

- The Android SDK includes
  - The Android APIs
    - The core of the SDK
  - Development tools
    - These tools let you compile and debug your app.
  - The Android Virtual Device Manager and Emulator
    - Android Emulator:
      - You can see how your applications will look and behavior on a real Android device
      - All Android applications run within Dalvik VM.
  - Documentations
  - Sample code
- No IDE
  - There is no dedicated IDE for Android.
  - Eclipse IDE:
    - Android has a special plug-in for Eclipse IDE (ADT Plugin for Eclipse) for creating Android projects.
    - ADT Plugin tightly integrates Eclipse with the Android Emulator and debugging tools.

Android Software Stack

Android architecture



Application Framework

- Android offers developers the ability to build rich and innovative applications.
- Developers have full access to the **same** framework APIs used by the core applications.
- Underlying all applications is a set of services, including
  - Views
    - can be used to build an application, including lists, grids, text boxes, buttons, and even an embeddable web browser
  - Content Providers
    - enable applications to access data from other applications (such as Contacts), or to share their own data
  - A Resource Manager
    - provides access to non-code resources such as localized strings, graphics, and layout files
  - A Notification Manager
    - enables all applications to display custom alerts in the status bar
  - An Activity Manager
    - manages the lifecycle of applications and provides a common navigation backstack

Libraries

- A set of C/C++ libraries used by various components of the Android system.
  - System C library
    - Tuned for embedded Linux-based devices
  - Media Libraries
    - Based on PacketVideo's OpenCORE; the libraries support playback and recording of many popular audio and video formats, as well as static image files
  - Surface Manager
    - Manages access to the display subsystem and seamlessly composites 2D and 3D graphic layers from multiple applications
  - LibWebCore
    - A modern web browser engine which powers both the Android browser and an embeddable web view
  - SGL/ 3D libraries
    - SGL: underlying 2D graphics engine
    - An implementation based on OpenGL ES 1.0 APIs; the libraries use either hardware 3D acceleration (where available) or the included, highly optimized 3D software rasterizer
  - FreeType
    - bitmap and vector font rendering
  - SQLite
    - A powerful and lightweight relational database engine available to all applications

Android Run-time

- Android includes a set of core libraries that most of the functionality available in the core libraries of the Java programming language.
- Every Android app runs in its own process with its own instance of the Dalvik virtual machine.
- The Dalvik VM executes files in the Dalvik Executable (.dex) format.

Java Crash Course

Java

- A programming language
  - Syntax is very similar to C++ but different!
- A virtual platform
  - Java virtual machine is a software machine or hypothetical chip.
    - Note: The Dalvik virtual machine in Android is optimized for small footprint machine.
  - Bytecodes (cross-platform binary code)
    - .class binary file of bytecodes
- A class libraries
  - APIs for GUI, data storage, I/O, networking, and etc.

Java language

- No code outside of the class definition.
- Single inheritance only.
- Only one top level public class in a file
  - The file name should be same as the public class name.

Java Bytecode &Virtual Machine

- Bytecode (the `class` file)is an intermediate representation of the program.
  - You can consider bytecode as the machine code of the Java Virtual Machine.
- Java interpreter starts up a new virtual machine when it runs a Java bytecode.

Package and Reference

- Packages and import
  - A package is a bunch of classes and interfaces.
    - Library of classes
  - You can import packages that you need.
    - Example) `import android.os.Bundle`
- Reference
  - No pointers!
    - Java doesn't have pointer variables.
    - Reference variables are equivalent in concept.
  - Objects and Arrays are reference types
    - Primitive types are stored as values

Creating Objects

- Point p;
  - Note for C++ programmer.
    - This doesn't create the object of Point class.
    - This is only declaration of a variable.
    - Remember there is no pointer in Java.
- `Point p = new Point(1, 2);`
  - This allocates an object.
- Garbage collector
  - It reclaims unused memory.
  - You don't need to free unused objects.

Reference

- Example

  -
    ```
    int x = 10;
    int y = x;
    // x has a separate memory space from y
    ```

  -
    ```
    Point p = new Point(1, 2);
    Point q = p;
    // q is a reference to p;
    // there is only one copy of Point object in the memory
    ```

Passing Arguments

- Primitive type:
  - Pass by value:
    - The called method has a copy of the value.
    - The method cannot pass changed value in the argument to the caller.
- Reference type:
  - Pass by reference:
    - The called method has a copy of the reference.
    - The method accesses the same object!

Inheritance

- Keyword **`extends`** to inherit from a superclass.
- Example

  -
    ```
    package edu.kettering.hellokettering;

    import android.app.Activity;
    import android.os.Bundle;

    public class HelloKettering extends Activity {
        /** Called when the activity is first created. */
        @Override
        public void onCreate(Bundle savedInstanceState) {
            super.onCreate(savedInstanceState);
            setContentView(R.layout.main);
        }
    }
    ```

Developing for Mobile Devices

Design Considerations

- Small and portable mobile devices
  - Offer exciting opportunities for software development.
  - But consider limitations
    - Low processor power
    - Limited RAM/permanent storage capacity
    - Small screen size
    - High costs associated with data transfer
    - Slow data transfer rates with high latency
    - Unreliable data connections
    - Battery life!
- Designing for Android
  - Performance
  - Responsiveness
  - Seamlessness

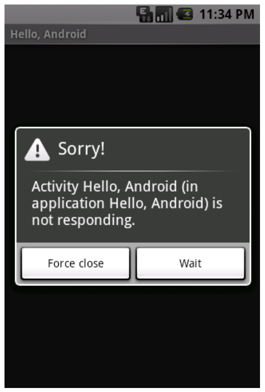
Designing for Performance

- Being fast and efficient
  - http://developer.android.com/guide/practices/design/performance.html
  - Avoid creating short-tem temporary objects.
    - Fewer objects created mean less-frequent garbage collection
  - Avoid internal getter/setters
    - Excellent habits for C++, but not for Android.
    - Direct field access is about 7x faster than invoking a trivial getter.
  - Use `static final` for constants
  - Use enhance for loop syntax

Designing for Responsiveness

Application Nor Responding (ANR)

- Activity Manager and Window Manager monitor application responsiveness.
- Android display the ANR dialog when it detects one of following conditions
  - No response to an input event within 5 seconds
  - A `BroadcastReceiver` hasn't finished executing within 10 seconds
- How to avoid ANR?
  - When an Android app runs on a single thread, any lengthy operation (network, database, computationally expensive calculation) could invoke the ANR.
  - Consider making a child thread to do the lengthy operation.



Activity Hello, Android (in application Hello, Android) is not responding.

Designing for Seamlessness

- Your application can cause problems under the multitasking environment when you ignore seamlessness issues.
- Be a good citizen!
  - Save instant state
    - Keep in mind that Android is a mobile platform.
    - Another app can pop up any time over your own app
  - Use a thread when you need to do a lot.
    - Avoid the ANR.
  - Use multiple screens when necessary.
  - Design your UI to work with multiple screen resolutions
  - Assume the network is slow
  - Don't assume touchscreen or keyboard
  - Do conserve the device battery

Questions?