Android Porting Concepts

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***Abstract*—This paper discusses the basic concepts involved in porting android to any hardware. In this paper, we discuss in detail the layered architecture of Android, the layer to which developers gain access and the working of the architecture.**

Here, we also discuss how Android works on any hardware and the concepts that outline the porting of Android onto any hardware. This paper discusses about the linux kernel used for Android and the Android file system made with Android images.

Keywords: Android, Porting, Kernel, File System

I. INTRODUCTION

A mobile operating system or a mobile OS is an OS for handheld devices or mobiles. The operating system controls a mobile device—just like Mac OS, Linux or Windows controls a desktop computer or laptop. However, what differentiates them are their light weight applications, their simplicity and how they majorly deal with the wireless versions of broadband and local connectivity, mobile multimedia formats, and different input methods.

Smartphones have the following characteristics:

- ✓ They are handy and small.
- ✓ Multiple, Frequent and continuous connectivity
- ✓ Products diversity
- ✓ Open platform
- ✓ Limited memory

Smartphones in today's age are found to be based on a number of different Operating Nokia's Symbian OS, Apple's IOS, RIM's BlackBerry OS, Microsoft's Windows Phone OS, Linux, Palm WebOS, Google's Android, Samsung's Bada (operating system) and Nokia's Maemo. Android, Bada, WebOS and Maemo are in turn built on top of Linux, and the iPhone OS is derived from the BSD and NeXTSTEP operating systems, which all are related to UNIX.

TABLE I. MARKET SHARE OF DIFFERENT SMARTPHONE OPERATING SYSTEMS.

Source	**IDC (International Data Corp.)**
Date	*2010*
Symbian OS	40.1%
BlackBerry OS	17.9%
Android	16.3%
iOS (Apple)	14.7%
Windows Mobile	6.8%

Table 1, shows the market share of different Smartphone Operating Systems. As we see, Android's market has caught up very fast, as compared to other OS which have been in the market for more time than Android.

II. ANDROID

Android is an operating system for mobile devices such as mobile phones, tablet computers and netbooks. Android is developed by Google and is based upon the Linux kernel and GNU software. Android, which was later positioned in the Open Handset Alliance in July 2005, was initially developed by Android Inc. (a firm purchased by Google). According to NPD Group, unit sales for Android OS smartphones ranked first among all smartphone OS handsets got currently sold in the U.S. The first phone to run the Android operating system was the HTC Dream, released on 22 October 2008.

Fig 1. Android Logo

A. Android Releases

Google has updated Android from time-to-time, and has released the following versions:

- ✓ 1.5 (Cupcake) - released April 2009
- ✓ 1.6 (Donut) – released September 2009
- ✓ 2.0 / 2.1 (Eclair) - released October 2009
- ✓ 2.2 (Froyo) - May 2010

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With the release of the latest version, Android has come up with the following enhancements on the previous versions:

- ✓ Compared to the older versions Android 2.2 has a great compiler which helps the system Apps open faster than before.
- ✓ Google Promises 2x Faster performance compared to the older versions
- ✓ Rendering of Javascript is now faster compared to previous versions
- ✓ Google Android browser is faster and support for Adobe Flash is really a great advancement in the version.
- ✓ Speed and Performance boost is really a great advancement in this version

B. Android Availability

Android costs nothing and the source code is freely available. Its license terms are commercial-friendly, basically, one can do whatever he feels like with it, without the intention of blaming Google, if anything goes wrong. The one exception to this rule is the Linux kernel, which is licensed under the GNU Public License. Because of this, manufacturers must release their device's Linux kernel source code after product shipment.

The Android Software Development Kit (SDK) consists of a debugger, libraries, a handset emulator, documentation, sample code, and tutorials.

C. Linux Basis

As we have seen, Android is based on a Linux kernel. Android works on Linux kernel 2.6.x of the Linux kernel tree.

Google has come up with various versions of Android, each of which is based on different Linux versions such Android 1.5 (Cupcake) based on Linux Kernel 2.6.27, 1.6 (Donut) based on Linux Kernel 2.6.29, 2.0 / 2.1 (Eclair) based on Linux Kernel 2.6.29, 2.2 (Froyo) based on Linux Kernel 2.6.32 and so on.

III. ANDROID ARCHITECTURE

The Android operating system software stack consists of four divisions viz. Applications, Application Framework, Libraries and Linux kernel.

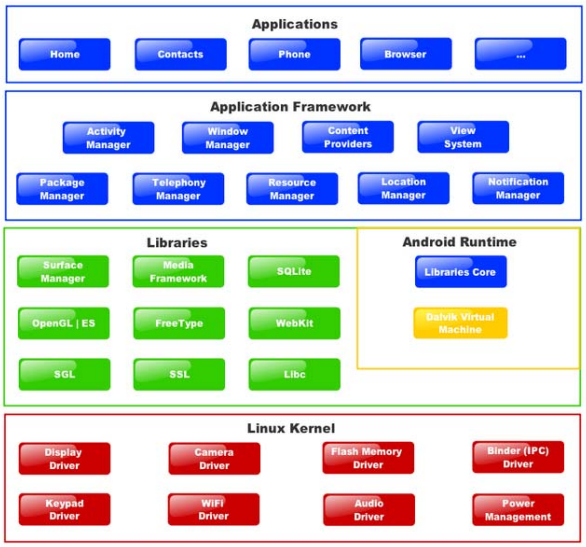

Fig 2. Android Architecture

- ✓ Applications: basic applications include an email client, SMS program, calendar, maps, browser, contacts, and others. All applications are written in Java programming language.
- ✓ Application Framework: the developers have full access to the same framework APIs used by applications base. The architecture is designed to simplify the reuse of components, any application can publish its capabilities and any other application can then make use of those capabilities (subject to safety rules framework). This same mechanism allows components to be replaced by the user. All the applications work on a set of services which include
  - ❖ Views
  - ❖ Content Providers
  - ❖ Resource Manager
  - ❖ Notification Manager
  - ❖ Activity Manager
- ✓ Libraries: The various components of Android are based on a set of core C / C + + libraries. The developers are exposed to these functionalities through the Android application framework.
- ✓ Runtime Android: Besides the core libraries, Android also consists of a set of base libraries, which are Java based. Every Android application runs its own process, with its own instance of the Dalvik virtual machine, featuring JIT(Just In Time) compilation.

  It has been ensured that a device can run multiple Dalvik VMs efficiently. Dalvik executes files in

the Dalvik Executable (. dex), which uses much lesser memory.

- ✓ Kernel – Linux: The Linux kernel acts as an intermediate layer between hardware and the software stack. Android depends on it for services such as security system, memory management, process management, network stack and driver model.

The Android code consists of 3 million lines of XML, 2.8 million lines of C, 2.1 million lines of Java, and 1.75 million lines of C++.

IV. PORTING ANDROID

Porting Android refers to putting Android onto a compatible hardware, whose technical specifications are known to support Android.

A. Minimum Hardware Requirements

The minimum hardware requirements that are required to support Android 2.1 and higher versions are as follows:

- ✓ QVGA (240 x 320 pixels) touchscreen
- ✓ Virtual keyboard support
- ✓ Must have a USB connection that connects to a standard USB-A port
- ✓ 92MB RAM
- ✓ 150MB user storage
- ✓ 2-megapixel camera
- ✓ Home, Menu, and Back functions available at all times
- ✓ Wireless high-speed data standard capable of supporting 200Kbps; like EDGE, EV-DO, HSPA, 802.11g (Android 1.6 requires Wi-Fi)
- ✓ Accelerometer
- ✓ Compass
- ✓ GPS receiver
- ✓ Bluetooth transceiver

However, the point to be borne in mind here is that there is practically no minimum hardware specification which can stop one from porting Android to a device. The restrictions imposed by requirements are merely for versions.

This is evident from the fact that Android has been running on extremely low configurations like that of Digital photo viewers and other devices.

B. Obtaining & Compiling Android Source Code

The source code can be downloaded using git or repo from the link http://android.git.kernel.org/.

To compile the Android code, 'make' command needs to be used. The parameters to be used with 'make' differ according to the build variant being desired.

After compilation, we receive three images, namely: Ramdisk.img, userdata.img and system.img in the mydroid/out/target/product/generic folder.

C. Android On Emulator

Android provides a QEMU based emulator with the SDK, which can be used to test applications before they are loaded onto the phone.

This emulator can also be used for testing of the kernel and the compiled Android images.

This feature has been tested by us for Linux kernel 2.6.29 Goldfish (as Goldfish is the kernel which is required for emulator) and Android 2.1 (Froyo).

The Linux kernel was first obtained using git from http://android.git.kernel.org. The kernel was cross compiled using the inbuilt toolchain provided with Android source code- arm-eabi.

Having cross-compiled the Linux kernel, it was used with the obtained Android images on the emulator. The environment variable 'ANDROID_PRODUCT_OUT' stores the location of the Android images to be used. The kernel can be used by setting the '-kernel' option with the emulator.

D. Android On Hardware

Android kernel, which is basically a 2.6.x Linux Kernel patched for Android, acts as an interface between the hardware and the Android OS.

We need to ensure that the kernel is compatible with the Target Hardware and with Android, and thus ensure compatibility between Android and the Hardware.

E. Android Kernel

First of all, the Linux kernel needs to be compiled according to the hardware. The configuration file (defconfig/.config file) must be modified to match technical specifications of the hardware. The hardware specifications of the hardware can be determined using tools available on the net (eg. WURFL Database, which stands for Wireless Universal Resource File).

This ensures that the particular version of kernel would run on the hardware and support any File System which has been built for the hardware.

Once we have the correct configuration file, the kernel needs to be patched to support the hardware. If the kernel is from the Linux kernel tree, it needs to be patched to support Android also. If the kernel is Android kernel, patches only to support the Platform need to be applied.

The patches make the kernel compatible to Android and the platform (Fig. 3).

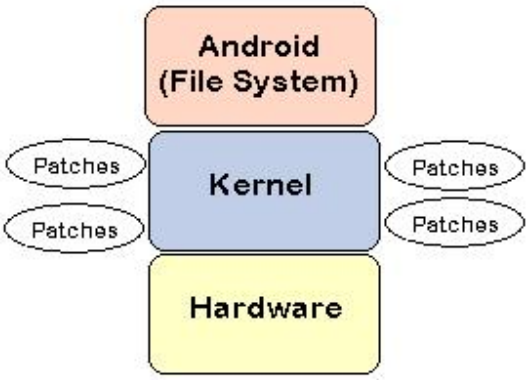

Fig 3. Android on Hardware

Patches basically call inbuilt functions with certain parameters in order to maintain compatibility between the target hardware and Android.

As the kernel acts as an intermediary between Android and the hardware, ensuring the kernels compatibility with the hardware (by means of the configuration file) and with Android (by means of patches) also ensures compatibility between Android and the Hardware which is our motive.

With the desired configuration file and patches, the kernel needs to be recompiled to obtain the zImage. This cross-compilation must be done using the correct toolchain.

F. Android File System

Having obtained the zImage of the patched kernel, we need to load it into the phone. Boot_usb utility may be used for this purpose.

Once the kernel has been loaded into the phone, it searches for a File System. We need to provide the kernel with a File system which contains Android images.

A file system is a hierarchy of directories (also referred to as a directory tree) that is used to organize files on a computer system.

There are two types of file systems which can be used in practice:

- ✓ Root File System: The root file system is the file system that is contained on the same partition on which the root directory is located, and it is the file system on which all the other file systems are mounted (i.e., logically attached to the system) as the system is booted up (i.e., started up).

  In case of Mobile Phones, we generally place the root file system on the SD card, and hence Android can boot up every time we insert the SD Card and switch-on the phone.
- ✓ Network File System: A network file system is a file system that acts as a client for a remote file access protocol, providing access to files on a server.

  This file system can be accessed via the USB, however, here the file system which is Android in our case would only be accessible when the phone is attached to the computer.

Depending upon the file system, the parameters to be passed when the kernel is loaded onto the phone differ. These parameters specify where the file system resides and are used by the kernel to load it.

The File System can be built using the Android4ASM Utility.

V. CHALLENGES IN PORTING ANDROID

The following challenges may be faced during porting Android onto any hardware:

- ✓ The bootstrap loader in the Linux kernel, to load Android, must be chosen carefully because if the boot loader is not appropriate, the errors never mention it.
- ✓ Besides the kernel and other drivers, the GUI of Android needs to be compatible with the target platform.
- ✓ Creating patches so that the Linux Kernel is compatible with android and android in turn is compatible for the mobile phone.
- ✓ Sometimes, the changes made in the android kernel and codes for the QEMU Emulator do not work well with actual Hardware.

VI. CONCLUSION

With all upcoming applications and mobile services, Google Android is stepping into the next level of Mobile phones.

Android participates in many of the successful open source projects, the recent most being the porting of Android on any other Hardware as described in this paper.

Because of minimum hardware requirements, Android has the benefit of being developer friendly in terms of porting. Now that it is possible to run Android on any Mobile phone that fulfils its requirements, it can be explored even more by the developers. Users can port Android to their phone and test it before they actually decide to buy an Android phone.

Also, ease in porting has encouraged more and more OEMs to base their mobiles on Android, which explains the reason for ecstatic growth of Android in the market.

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