The Development of Android Software and Kernel Files by Using Example of Wi-Fi Adaptor

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Abstract

The embedded systems such as smart phone, tablet, pocket or pad personal computers and driving navigator, etc. are very popular now. The operating system (OS) of embedded system should be reduced size, operate quickly, user-friendly, more functions and energy saving etc. Many manufacturers are studying for embedded systems, for example, Apple Ltd is for iOS, Google Ltd is for Android and Microsoft is for Windows mobile. The world's major researchers and scholars begin to study the Android OS on the embedded system, recently. In this paper, the Android kernel files and Wi-Fi applications are demonstrated by using the smart phone educational kit. The steps of manufactures for Android kernel files and Wi-Fi applications are implemented on the Android educational development kit called DMA 6410. The experimental results reveal that these results possess good execution performances of Android kernel files and good abilities of accessing Google map by using example of Wi-Fi adaptor.

Keywords: *Android, Wi-Fi, Embedded systems, Software.*

1. Introduction

Embedded systems contain processing cores that are either microcontrollers or digital signal processors (DSP). The key characteristic, however, is being dedicated to handle a particular task. Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are produced in order to benefit from economies. The Android kernel files are logical steps based on the bottom layers of Linux operating system (OS) [1]. The purposes of kernel files are to allocate memory and switch the central processing unit (CPU) to different execution threads. The major software of Android kernel files are files system, network interfaces and boot-loader, etc.

The Google Ltd. launched the open Android operating system platform in November 2007 and announced the establishment of a union organization called the Open Handset Alliance (OHA). Google Ltd. also promotes the Android for smart phone OS and related application softwares. In addition to the Google Ltd., the alliance organization has includes many manufacturers of smart phone developments, telecommunications companies and application software development companies. The Android OS, in addition to be sent to the phone, meanwhile, it can be developed as embedded systems. Android is the world's most popular mobile platform. With Android, all the Google application packages (Apps) can be used plus there are more than 600,000 Apps and games available on Google Play to keep them entertained, alongside millions of songs and books, and thousands of movies. Android devices are already smart, and will only get smarter, with new features which won't be found on any other platform [2].

Android has become the most popular smart phone platform, recently, and a number of online advertising companies have now positioned Android as the popular smart phone platform worldwide [3]. The various components of Android are designed as a stack, with the 'Applications' forming the top layer of the stack, while the Linux kernel forms the lowest layer. To jump start the Android development, the Android software development kit (SDK for Linux) can be download from web. It includes sample projects with source code, development tools, an emulator, and of course all the libraries which is necessary to build an Android applications. Life is made a lot simpler with the Eclipse plug-in for Android development, called the Android Development Tools (ADT). It basically brings the power of the IDE to Android development [4]. In the process of Eclipse, it has acquired a large user base and a multitude of applications have been built on it. Eclipse is built as a plugin-based framework. Its users can simply use it as an IDE, but they can also extend or build their own plugins from the existing ones [5]. Many research results have been developed recently. For example, an Android-based 3G phone is developed to establish enterprise applications of ground monitoring of aircraft loading and production activities at the airfield, and use the event mechanism to coordinate the production work of System Operation Control Department (SOC), cargo and aircraft maintenance factory [6]. A general process for data collection of Android devices is developed by exploring special device boot modes and Android's partitioning schema [7]. To support collaboration of teams of mobile users by enabling anytime and anywhere access to shared contact data [8].

The applications of Android systems are developed very widely [9-15]. In [9], they study to integrate a cloud computing mechanism into the Android platform, allowing service providers to upload their telematic bundles onto storage clouds using a provisioning server. In [10], they intend to explore different perspectives, features & suitability of android for mobile devices & comparison between Android, Symbian & Windows mobile OS. In [11], they examine the level of accuracy that can be achieved in precision positioning by using built-in sensors in an Android smart phone. In [12], Android based mobile phone has been completely tested and analyzed in Egypt roads using realistic data. In [13], an Android phone application, GeoTools, has been created to assist geologists with the collection of field data, as well as data management. In [14], the authors integrate 3G communication technology, Android embedded system and aquaculture-cages remote monitoring, which makes up for the deficiency of the traditional aquaculture-cages monitoring. In [15], they present how to communicate between different heterogeneous context aware platforms as WComp and OpenORB by using Android and Web Services.

The Wireless Fidelity (Wi-Fi) Alliance defines Wi-Fi as any wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards. However, since most modern WLANs are based on these standards, the term "Wi-Fi" is used in general English as a synonym for "WLAN". The Wi-Fi is a popular technology that allows an electronic device to exchange data wirelessly by using radio waves over a computer network, including high-speed Internet connections and it can connect to a network resource such as the Internet via a wireless network access point (AP) [1]. Each wireless router broadcasts a signal that is received by devices in the area. These devices have the capability to measure the strength of the signal. This strength is converted to a number, known as received signal strength indicator (RSSI). Wi-Fi devices, such as smart phones, typically perform this conversion automatically in order to provide signal strength information to applications running on it [11]. The security assessment of the Android framework-Google's software stack for mobile devices has been discussed. The high-risk threats to the framework and suggestions of several security solutions for mitigating have also been provided [16].

In this paper, the Android development kit embedded of ARM-11 based Samsung 6410 CPU [17] called DMA 6410 manufactured by *DMATEK Ltd, Taiwan* [18] is used to do empirical test of accessing Google map by using Wi-Fi. The experimental results reveal that the good performances are possessed.

2. The Development of Android Software

Android Application is developed by software development kits (SDK) issued by android web [2]. It is combined of many tools such as JDK(Java Development Kit), Eclipse, ADT(Android Development Tools), Android SDK and Linux kernel, etc. All these developed Android applications must be based on this operating system (OS) of Linux. In this paper, the Ubuntu Linux OS is used.

The installation steps are described as follows. At first, to install Java JDK-> install Eclipse-> install Android SDK-> install ADT. After this procedures of installation are completed, the file folder of 'android-sdk-windows' will be appeared in folder of disk C: . This path of file folder must be set appropriate to be pointed by other applications. The setting steps are from clicking on the icon of 'My Computer' at first, then click right mouse button, select 'Contents' and click the right of mouse button to enter the screen of 'system'-> setting 'system Properties'-> 'Advanced'-> 'environment settings'-> 'environment variables'-> 'system variables'-> press 'edit' to find a variable field of 'Path'-> paste file folder of "JDK" and "SDK" into this field of variables. Finally, the installation is completed and the ADT can be run smoothly. The development environment diagram is shown as in Fig. 1. The Java software development kit is necessary for compiling the library files of Android applications. At first, the tool called 'Putty' is used to communicate the Java machine. In the environment of Putty, we can compile the head file and C language file of Android by using the command of 'javah -classpath'. This command will generate the necessary file of type of '.h' which is used to define the ports of every devices on Android systems. In order to compile all these applications software to be '.apk' file successfully, they must be configured with the Android kernel files system which will be discussed in next section.

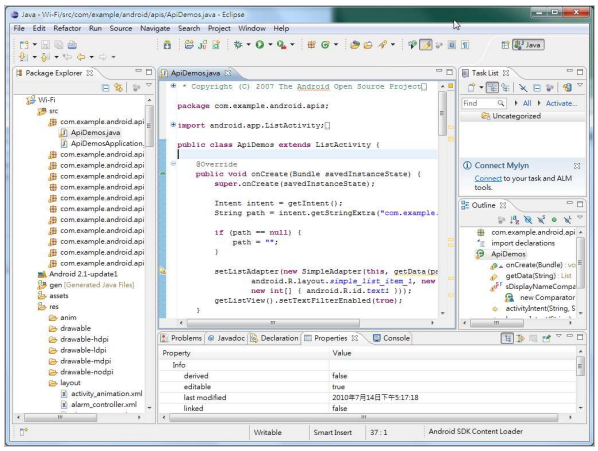

Fig. 1 The development environment diagram of Eclipse

3. The Manufacture of Android Kernel files

The architecture of Android platform can be found in [4, 9, 10, 19]. By analyzing the codes of Android kernel and comparing to the standardize Linux kernel, they analyze and discuss the difference between Android kernel and standard kernel and the advantage of Android. Meanwhile, they point out the position of Android in the Linux kernel system to compile a customize kernel on the Linux or Ubuntu system [9, 19]. Android is not just an operating system but provides a complete software stack including a middleware and some built in applications. Android architecture is composed of different layers, with the Linux kernel layer at the bottom. This layer provides various hardware drivers and acts as a hardware abstraction layer. It is also responsible for memory and power management functionalities of Android. The Android native libraries written in C and C++ sit above the kernel layer. These libraries provide some core functionalities. Next is the Android runtime layer which is composed of two principle components namely Dalvik Virtual Machine and Android core libraries. Android runtime is specially designed as an optimized environment to meet the requirements of running on an embedded system i.e., limited battery life, CPU speed and memory. Dalvik virtual machine executes its own byte-code represented by dex (Dalvik EXcutable) files. The second component of Android runtime is the collection of class libraries written in Java programming language, which contains all of the collection classes and inputs/outputs (I/O) utilities. In Dalvik, the code responsible for calling class loaders is present in three major files, that is, Class.c, Internal Native.c and JNI.c. The two broad categories of classes in Dalvik are system classes and (what we informally term as) standard classes. [20].

Android architecture is shown in Fig. 2, which consists four layers. The bottom layer is Linux kernel, up to library and runtime layer which is a collection of Android libraries and runtime virtual machine; third layer is framework layer that manages Android applications in runtime; top layer is application layer which is native or third-party applications [4, 9, 10, 19]. These layers are described as follows.

- The lowest layer is Linux kernel which manages core services such as device hardware drivers, process and memory management, security, network, and power management. The kernel also acts as an abstraction layer between the hardware and the rest of the software stack.
- Android includes various C/C++ core libraries running on top of the kernel. The Android Libraries layer consists of two parts as Libraries which are all written in C/C++. They will be called through a Java interface and it includes the Surface Manager, 2D and 3D graphics, Media Codecs like MPEG-4 and MP3, the SQL database SQLite and the web browser engine WebKit. Second part is Android Runtime which includes a set of core libraries that provides most of the functionality available in the core libraries of the Java programming language. Second is Dalvik virtual machine (DVM) which is a register-based architecture and runs Java applications with the Dalvik Executable (.dex) format which is optimized to allow multiple VM instances to run at the same time.
- The Framework layer is a software that is used to implement a standard structure of an application for a specific operating system. With the help of managers, content providers and other services programmers it can reassemble functions used by other existing applications. Every Android application 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 which is optimized for minimal memory footprint. Android has built in integrated browser based on the open source WebKit engine & built in powerful SQL database engine called SQLite**,** use for structured data storage. Android support for common audio, video, and still image formats such as AAC, MPEG4, H.264, MP3, AMR, & contains Rich development environment including a device emulator, tools for debugging, & a plug-in for the Eclipse.
- The application framework provides the classes used to create Android applications. It also provides a generic abstraction layer for hardware access and manages the user interface and application resources. Application layer using API libraries is the uppermost layer which provides a set of core applications including an email, SMS program, calendar, maps, browser, contacts, etc. All applications are written using the Java programming language. It should be mentioned that applications can be run simultaneously; it is possible to hear music and read an email at the same time.

In this paper, the kernel files of Android are manufactured by some tools; there are Vmware or VirtualBox running in OS environment of Microsoft™ Window™ installed in personal computer (PC), network communication tools such as 'Putty', 'Tera Term' or 'Tftp' etc. The compressed zip type files are released from *DMATEK Ltd, Taiwan*. The operation steps are described as follows.

Step 1: To install tool of Vmware to open virtual host server to communicate the virtual server of Samba in Window™.

Step 2: To install tool of Putty to translate files between Linux and Window™. All kernel files can be unziped and made in Putty to manufacture Android boot and image files.

Step 3: To install tool of Tera Term to burn these kernal files into flash memory of target by using the Ethernet port.

Step 4: To configure the parameters by using the Tera Term to open and run the devices.

In next section, the example of Wi-Fi will be demonstrated to reveal the effectiveness and performances for these steps of manufacture for boot and kernel files.

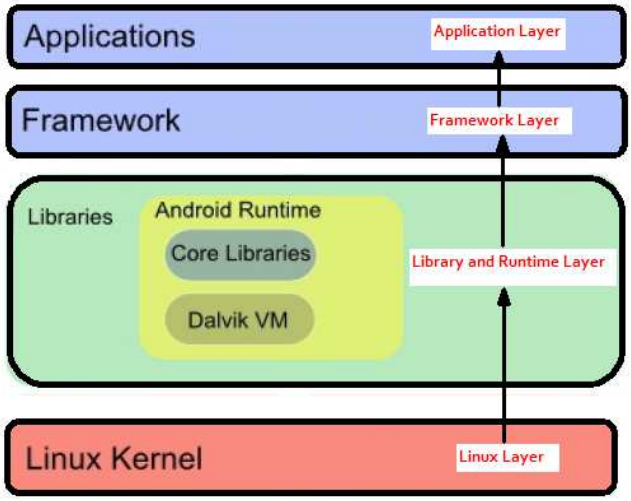

Fig. 2 The diagram of Android Architecture

4. Experimental Results

The hardware is manufactured by different design, the kernel files must provided by the manufacture company. In this paper, the DMA 6410 is used which is manufactured by *DMATEK Ltd., Taiwan*. All the necessary source files of Linux kernel, Android cross compile tools and make files, etc. are released from this company. The hardware of kit is shown in Fig. 3 which is called DMA 6410. This is a friendly using, researching and teaching development kit. In this kit, the Samsung S3C6410 mobile processor is used to give designers an unbeatable combination of 3D performance and low power in a cost-effective package. This is a 32-bit ARM11 RISC microprocessor with AXI 64-bit bus delivers up to 667MHz of processing performance. It can power next-generation handhelds, such as mobile Internet devices and 3D UI-enhanced multimedia phones, as well as personal navigation devices that display detailed images like buildings and landmarks. Memory support includes dual DRAM and flash/ROM external memory ports for parallel access. The DRAM port can support mobile DDR, standard SDRAM memory while the flash/ROM port supports NAND flash, NOR flash and ROM [17].

In this section, the kernel files and software setting of Wi-Fi are executed on the DMA 6410 kit which has been shown in Fig. 3. At first, the boot file must be copied in SD card to start the target. The needed image files which are manufactured by the aforementioned steps should be burned into target through Ethernet line between PC and DMA 6410. There are five image files which are 'u-boot', 'kernel', 'ramdisk', 'userdata' and 'system' files. Then, we can use the tools of Tera Term and Tftp to set the network parameters and to burn the aforementioned five kernel files into flash memory of target. The implementation diagram is shown in Fig. 4. The Baud rate is set as 115200, the Baud rate setting diagram of Tera Term is shown in Fig. 5. The target IP is set as 192.168.2.144, server IP is set as 192.168.2.110, then save these settings which is shown in Fig 6. The active setting for Wi-Fi is implemented by using the command of 'ifconfig' in Tera Term also. The setting commands are listed as follows and the implementation diagram of Wi-Fi is shown in Fig. 7.

#ifconfig wlan0 up
#wpa_supplicant –Dwext –iwlan0 –
c/system/etc/wifi/wpa_supplicant.conf&
#netcfg wlan0 dhcp
#setprop net.dns1 xxx.xx.xxx.xxx (where the 'x' implies your DNS IP which can be checked by using command of 'ipconfig' on window console).

The screen images diagram of burning process on PC is shown in Fig. 8. After this process is completed, the Wi-Fi can be active and connected with AP. Finally, the web browser can be open and accessed; for example, the Google map is accessed and shown in Fig. 9.

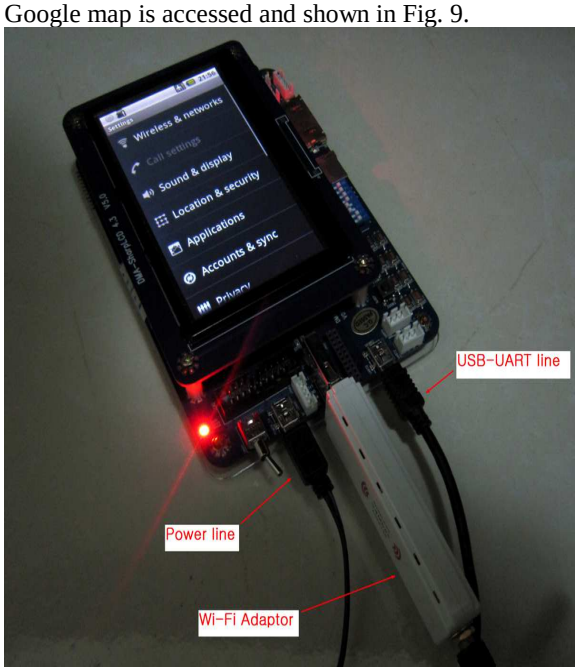

Fig. 3 The diagram of DMA 6410 development kit

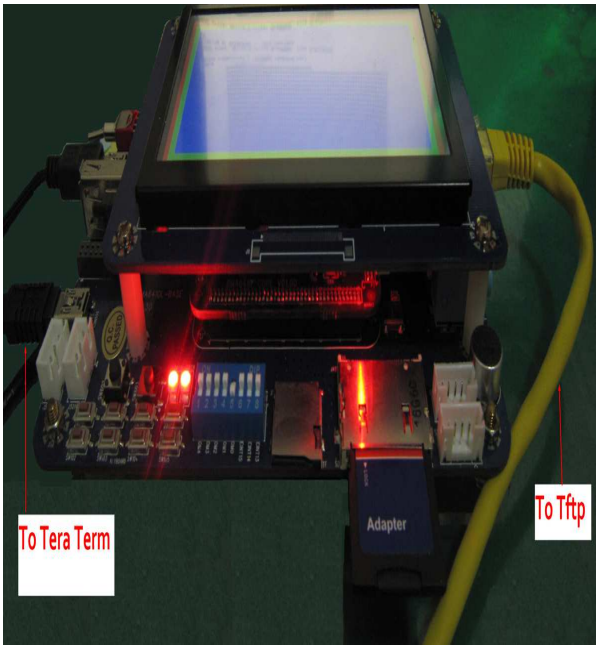

Fig. 4. The implementation diagram of setting Tera Term and Tftp

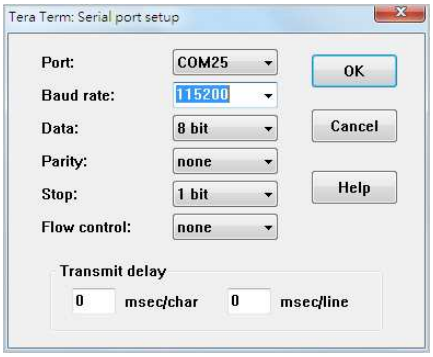

Fig. 5. The Baud rate setting diagram of Tera Term

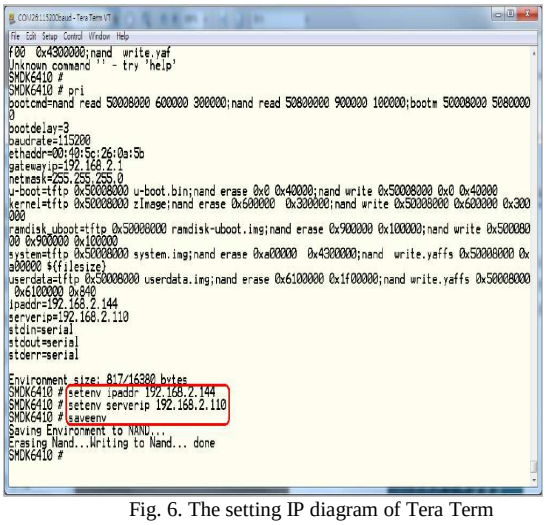

Fig. 6. The setting IP diagram of Tera Term

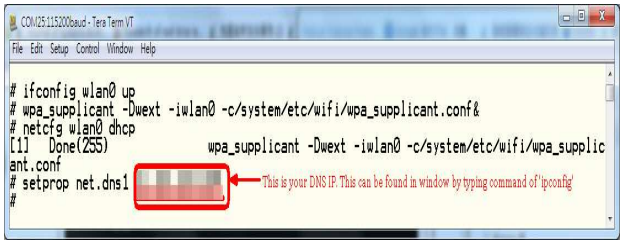

Fig. 7. The active implementation diagram for Wi-Fi

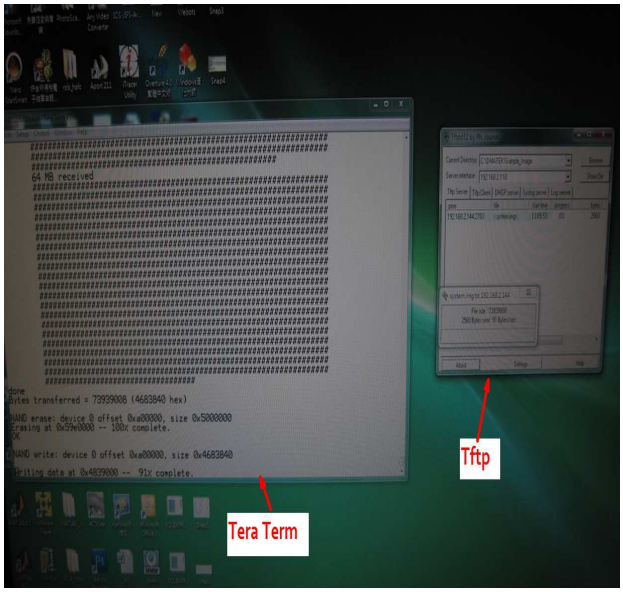

Fig. 8. The burning process diagram on PC

Fig. 9. The diagram of accessed Google map

5. Conclusions

In this paper, the Android kernel files and boot files are manufactured under some tools of Vmware and Tera Term successfully; meanwhile, the demonstration of wireless network accessing ability by using Wi-Fi adaptor is also verified successfully. In this paper, the experimental results are implemented on the educational development kit named as DMA 6410 which is manufactured by DMATEK Ltd., Taiwan. The successful results reveal the good effectiveness of the software and satisfied performances of Wi-Fi adaptor.

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