

## Implementation of Smartphone using ARM9 and Embedded Linux operating system: A survey approach

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### ABSTRACT

As the features of mobile phones are being enhanced and the performance is being greatly improved, the generic operating systems are being incrementally used in mobile phones. However, since the mobile phones have different requirements in both features and performance compared with desktop or server systems, the operating systems for generic systems could not be used without customization and modification. This paper describes the Linux-based smartphone. Current popular smartphones, which are quite expensive, all are developed to face to the high-end market. This paper is based on the smartphone system which is low-cost, low-consumption and facing the mass market. This system, based on free Linux operating system, saves development charges. Adoption of ARM9 processor increases the level of integration and dependability, as well as reduces power consumption. With the function of PDA and wireless communication, this smartphone system sets up a powerful, stable and low-price performance, which possesses significant practical prospective in the mass market.

*Keywords* - ARM9, GSM modem, Linux System, Qtopia, Smartphone

### I. Introduction

The portion of high-performance, multi-functional smartphones are being dramatically increased in wireless phone market [1]. With the development of 3G technology in the world, mobile internet and cloud computing have been the world's two major application technology, and they are developing rapidly. Meanwhile, the demand of mobile terminals is growing day by day, such as smart phones and tablet PCs. In order to meet higher data rate and better user experience, the performance of the microprocessors has been more and more important.

Nowadays, ARM9TM and ARM11TM processor families are still widely licensed around the world and provide cost-effective solutions for many of today's applications, but the ARM 9 processor is relatively small [2] [4]. ARM 9 processor is based on the ARMv7 architecture and has the ability to scale in speed from 600MHz to greater than 1GHz [3]. And it has high performance, superscalar micro architecture and NEON TM technology for multi-media and SIMD processing. So the ARM 9 processor can meet

the requirements for power-optimized mobile devices and performance optimized consumer applications requiring higher Dhrystone MIPS.

This paper focused on Linux system which is open source as the cellphone operating system, decreasing the developing cost. In addition, with open source code, developers can customize their Linux operating system and the third party application program, which greatly improves development flexibility. Linux system is a development trend of future smartphone operating system. Smartphone based on ARM9 and Linux system is the trend for the mass market, with the virtue of excellent expandability, low-cost and high dependability. As the result, smartphone based on ARM9 and Linux system demonstrates significant research values.

### II. General Description

Embedded system can be divided into hardware layer and software layer in general. Hardware layer is composed of hardware equipment, containing all hardware resource. Software layer is composed of system software and application software. Building the supporting platform, operating system makes software system and application system relatively independent. Modifications of hardware won't affect application program. File system

manages documents of operating system, providing interactive interface between users and operating system. GUI provides users with convenient graphical interface.

Users can operate their smartphone directly through graphical interfaces. Application program performs the function with users' needs. This layer with classic embedded system structure is used for smartphone system.

### III. Hardware Description

Here we discuss about the design methodology of touch screen based data transmission. The hardware design consists of S3C2440 ARM9 processor with touch screen, serial port, GSM modem. The touch screen is interfaced to mini2440 development board. And the developed drivers for data transmission are loaded onto ARM9 board using Qtopia operating system which runs on Linux kernel [5]. The data receiving and transmitting

in the SMS format is done by using GSM modem..The on board UART interfaces UART0 and UART1 to connect PC COM ports. UART0 is used to perform command line operation of the board on PC and UART1 is used to communicate with PC from board using touch screen.

### 3.1 S3C2440 ARM microprocessor

Implementation of drivers to touch panel for the Samsung S3C2440 is to be develop ARM9 architecture and Samsung's S3C2440A 16/32-bit RISC microprocessor. Samsung S3C2440A is designed to provide hand-held devices and general applications with low-power, and high-performance micro-controller solution in small die size. The ARM processor is a Reduced Instruction Set Computer (RISC). The S3C2440 is a 32 bit microcontroller that internally integrates ARM920T of the ARM Company [6]. ARM920T implements 5-stage pipeline architecture and separate 16KB Instruction cache and 16KB Data cache which are used for faster performance. The S3C2440 have some integrated on-chip functions such as LCD controller, RAM controller, 3 paths UART, 4 paths DMA, 4 path with PWM of Timer, parallel I/O port, 8 channels of 10-bit ADC, the interface of touch screen, I2C interface, two USB interface controllers, two channels SPI, the main frequency of S3C2440 up to 400MHz [7].

### 3.2 UNIVERSAL ASYNCHRONOUS RECEIVER/TRANSMITTER (UART)

A universal asynchronous receiver/transmitter, abbreviated UART is a type of "asynchronous receiver/transmitter", a piece of computer hardware that translates data between parallel and serial forms. UARTs are commonly used in conjunction with communication standards such as EIA RS-232, RS-422 or RS-485. The universal designation indicates that the data format and transmission speeds are configurable and that the actual electric signaling levels and methods typically are handled by a special driver circuit external to the UART. A UART is usually an individual (or part of an) integrated circuit used for serial communications over a computer or peripheral device serial port. UARTs are now commonly included in microcontrollers. A dual UART, or DUART, combines two UARTs into a single chip. Many modern ICs now come with a UART that can also communicate synchronously; these devices are called USARTs (universal synchronous/asynchronous receiver/transmitter).

### 3.3 GSM modem

A wireless modem is a type of modulator-demodulator which connects to a wireless network instead of using telephone or cable television lines.

A mobile Internet user can connect using a wireless modem to a wireless Internet Service Provider (ISP) to get Internet access. Mobile phones, smartphones, and PDAs can be employed as data modems to form a wireless access point connecting a personal computer to the Internet (or some proprietary network) [7]. In this use the mobile phone is providing a gateway between the cellular service provider's data network technology and Point-to-Point Protocol (PPP) spoken by PCs. Almost all current mobile phone models support the Hayes command set, a standard method of controlling modems. To the PC, the phone appears like an external modem when connected via serial cable, USB, IrDA infrared, Bluetooth wireless. This GSM modem is used to send and receive data using AT commands such as

AT+CNGS = Send Message.

AT+CNGF = Preferred Message format.

AT+CNCR = Read Message.

AT+CNGD = Delete Message.

AT+CNMI = New Message Indication.

AT+CPMS = Preferred Message Format

### 3.4 Memory module

This system adopts Flash memory and SDRAM memory. As the internal memory of smartphone system, SDRAM is designed for transfer, storage and read-write internal data in the system. SDRAM adopts two 32MB memory chips HY57V561620CT-H which are spliced to the data bus of 32 bit width, thus increasing the speed of data access. 64M NAND Flash, of which the type is K9F1208U0M, serves as the flash memory of the system. As the hard disc of the system, Nand Flash is mainly used for storage of system boot, OS Kernel, file system, graphical interfaces and application program.

## IV. Software Description

Software design is the key to embedded system. Without powerful software as support, any hardware would not take effect. Software design of smartphone mainly include the following:

### 4.1 Transplant U-Boot

At first, cross-compiling environment is built, which is a code generated from one platform and used in another platform. For this system, it is generated in PC and can run on the development board. Transplanted U-boot will be done after installing the cross compilation tool-chain and configuring the development environment. U-Boot is at the boot loader stage. Boot loader is the first software code after system powers up. It initializes the hardware equipment and builds up the map of memory space.



Then the hardware and software environment of the system may be suitable for the OS Kernel boot.

#### 4.2 Transplant Linux kernel

OS kernel is the centre of the operating system. A complete operating system includes more tools, libraries, application programs and kernel source. Linux kernel source can be downloaded from Internet free of charge. This system uses Linux-2.6.32.2 kernel source. Firstly, customize Linux kernel source and modify the source code. Add processor support, Nand flash chip support and Yaffs2 file system support. Dispose the program module in order to support the hardware module of MINI2440 development board. Then, cross-compile the kernel source to generate zImage. At last, download the mapping file to NAND Flash memory.

#### 4.3 Load file system

By building, canceling, reading and writing, modifying an copying files, file system can access files by name and make access control. After Linux system startup, root file system must be mounted firstly. If not mounted from designated equipment, the system will be treated as making mistakes and quit startup. This system adopts Yaffs2 file system. As a kind of JFS designed for NAND flash memory in embedded system, Yaffs2 has the characteristics of high efficiency, short mount time and small memory requirement.

#### 4.4 Develop application program

This system adopts Otopia as the platform for application program. As a general application platform designed by Troltech and used in those consumer electronics with embedded Linux operating system, Otopia contains complete application layer, flexible user interface, window operating system, application program startup and development framework. Qtopia-2.2.0 is adopted, which is the most advanced edition in PDA Otopia. Qtopia-2.2.0 possesses PDA function. Besides this system has the function of wireless communication, including making calls, short message management, telephone directory management and network data deliver. GUI graphical interface is designed by QT Designer. QT Designer, a kind of design tool with visualized user interface, can improve the development speed of QT application program. Three interfaces are designed in the wireless communication module, containing calling, short message management and network data deliver. Interface for short message management is shown in Figure 1 The program is add to Qtopia. Tansplanting Qtopia to development board. The result is shown in Figure 2. Tansplanting Qtopia to development board. Wireless communication module adopts AT command for data deliver. Take making

and receiving calls for an example. Invoke LLI function `gprs_call()` in GSM to make a call. "ATD<phone number>," command is transferred to serial port by `gprs_call()`. Then GPRS module receives ATD command and performs corresponding operation. While receiving a call, RING signal is first transferred from GPRS module appears in graphical interface. Users can choose answering or rejecting according to their requirement. In case of the first condition, ATA command is sent by `gprs_answer()` function to serial port. Otherwise, ATA command is sent by `gprs_answer()`.



Fig.1 Message Interface

#### V. Conclusion

The method mentioned above is the way of summarizing in the realization process of data transmission in sms format using GSM modem, by using Linux operating system. GSM modem performs the data transmission using AT commands. Smartphone system with PDA function possesses the characteristics of good expandability, low power-consumption, low-cost, excellent reliability, and high popularization. As popular topic in current smartphone study, it has important theoretical and practical values.

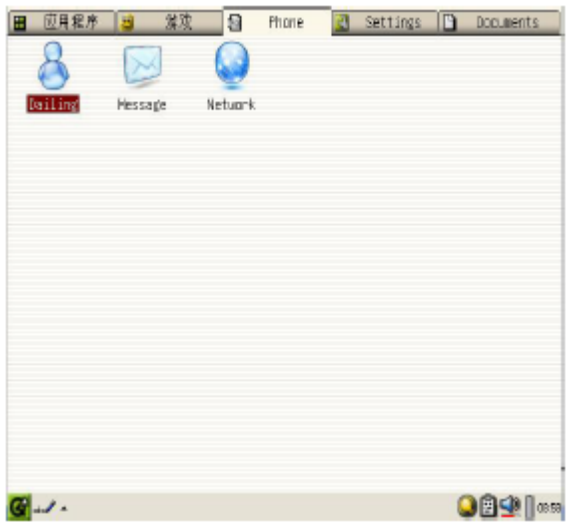


Fig.2 Smartphone application

## REFERENCES

- [1] Liviu Iftode, Cristian Borcea, Nishkam Ravi, Porlin Kang, Peng Zhou, "Smart Phone: An Embedded System for Universal Interactions", *10th IEEE International Workshop on Future Trends of Distributed Computing Systems (FTDCS'04)*, pp 88-94, May 2004.
- [2] Yanpeng Sun, Peng Peng, Yuan Zhang, "Linux Transplantation Based on The Processor S3C2440", *The Ninth International Conference on Electronic Measurement & Instruments*, 2009, pp.2- 306-2-309.
- [3] Wenyan Ci, Xueli Chen, Suhua Cai, Chunmei Xia, "Methods and skills on transplanting Linux to ARM S3C2410", *2nd International Conference on Computer Engineering and Technology*, 2010, pp.V4- 8-V4-11.
- [4] ARMV7-A architecture reference manual. Available on Request from ARM
- [5] Camacho, G.; Alducin, G.; Gutierrez, J.; Miranda, " Software Development for Local Data Transfer for Mobile Applications Using GPS and GPRS Technology" *International conference on electronics and communication*, pp.7, March 2006
- [6] Wang Guofang, Wang Wei, "The Design of interface circuit based on S3C2410 data acquisition system", *International Conference on computer modeling and simulation*, vol.3, pp.90 - 94, Sep.2010.
- [7] Ming Yang; Feilong Zhu, " The Design of Remote Update System Based on GPRS Technology" *International conference on management and service science*, vol.1, pp.1 - 4. September 2010