Development of 2G/3G Dual-System Communication Software

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Abstract

This paper is intended to introduce the dual-system communication software used in the 2G/3G dual communication system incorporated in the Medity2 chipset developed by NEC Electronics. This software features the GSM technology, digital baseband control with parallel task operation and a status-dependent power save control that is designed to achieve both 2G/3G dual communications and energy save.

Keywords

cellular phone, W-CDMA, GSM, dual system, power consumption reduction

1. Introduction

Cellular phones have recently been improving their functions and performances and targeting not only Japan but have set their sights on the global market. W-CDMA (Wideband Code Division Multiple Access) that belongs to the 3rd-generation cellular phone systems is most popular in Japan. However, many areas in other countries can use only the GSM (Global System for Mobile Communication) that belongs to the 2nd-generation cellular phone system. So cellular phone terminals that are compatible for worldwide destinations are required to be equipped with the W-CDMA/GSM dual-mode compatibility. This paper will describe the communication software used with "Medity2," the W-CDMA/GSM dual cellular phone solution of NEC Electronics.

2. Trends in Cellular Phone Technology

When cellular phone trends are monitored globally, we find that the W-CDMA system has entered the stage of massive dissemination in Europe, Asia-Pacific region, the Middle East, Africa and North America, but the GSM system that belongs to the 2nd-generation communication system still has a share of about 80% (**Fig. 1**). As a result, the cellular phone terminals for worldwide use still need to mount a dual mode function in order to enable compatibility with both the W-CDMA and GSM systems.

Medity2 implements a highly functional W-CDMA/GSM dual cellular phone system with the following features.

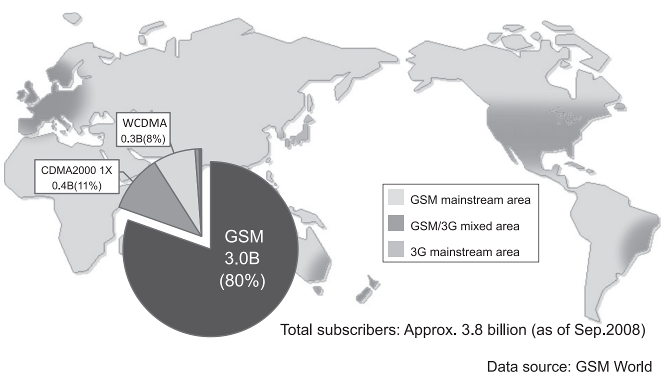

Fig. 1 Trends in the cellular phone subscribers worldwide.

- Dual compatibility with W-CDMA and GSM (900/1800/1900 bands).
- Auto priority network selection/user-guided selection functions.
- W-CDMA/GSM system switching/international roaming.
- Video telephone function.
- Compatibility with high performance for applications including 3D video games.
- One-chip implementation of Application and Communication Controller blocks.
- Integration of W-CDMA/GSM baseband processors for reduction of chip mounting area, power consumption and cost.

Medity2 implements high-performance application processor and communication processor blocks in a single chip and the processor block integrates the W-CDMA baseband processor and the GSM baseband processor in order to reduce the chip mounting area, power consumption and cost.

3. Outline of Dual Cellular Phone System

The configuration of the Medity2 dual cellular phone system and the features of the communication controller block are as follows (**Fig. 2**).

- 3GPP Release99 compatibility.
- W-CDMA/HSDPA functions (Category 6) and HSUPA interface function.
- GSM/GPRS/EDGE (Class 12) functions.

Medity2 is composed of two blocks including the application and communication controller blocks, which are controlled by the ACPU (Application CPU) and CCPU (Communication CPU) respectively. The application controller block accepts the connection of various peripheral hardware devices such as the LCD, keypad and microphone/speaker, and incorporates the middleware for the camera, audio codec, etc. The communication processor block includes the CCPU and baseband processors. The W-CDMA baseband processor is compatible with the HSDPA (High Speed Downlink Packet Access) function. It also incorporates the HSUPA (High Speed Uplink Packet Access) interface to enable easy extension of the HSUPA function.

The GSM baseband processor introduces the IP (Intellectual Property) of other manufacturers and is compatible with GSM as well as GPRS (General Packet Radio Service) that belongs to the 2.5th-generation communication system and EDGE (Enhanced Data GSM Environment) technology, which is the succeeding GPRS. The introduction of the IP allows Medity2 to implement a dual cellular phone system with introducing a high-quality GSM system in a short development period.

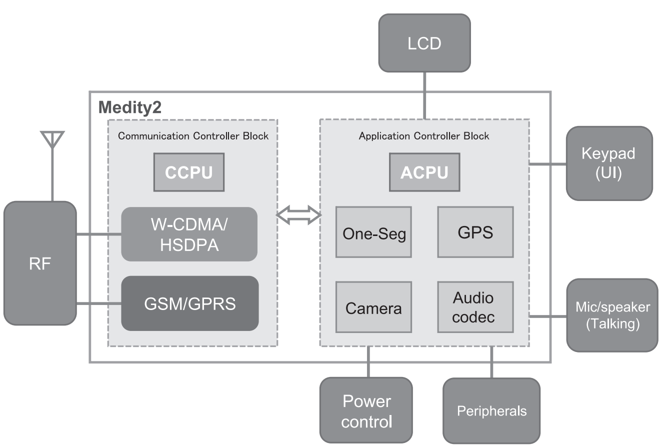

Fig. 2 Configuration of dual cellular phone system “Medity2”.

4. Implementation of the Dual Cellular Phone System

In addition to the individual connection functions to the W-CDMA and GSM networks (single operations), the dual cellular phone system is required to offer the following functions.

- Autonomous selection of W-CDMA and GSM networks.
- Handover between W-CDMA and GSM systems.
- GSM communication quality measurement during connection to W-CDMA.
- W-CDMA communication quality measurement during connection to GSM.
- Power save function.

We faced three issues to implement communication software. The first of these is to unify the interface to enable introduction of IP from other manufacturers. The second is to ensure time-base synchronization between W-CDMA and GSM to enable inter-system handover and communication quality measurements. Finally, the third issue is to provide a power save control via the software.

4.1 Communication Software Configuration

Fig. 3 shows the block diagram of the communication software.

- Protocol Stack: Dual protocol control.
- GSM LL1 (Logical Layer1): GSM protocol control.
- W-CDMA LL1: W-CDMA protocol control.
- GSM DBB (Digital Base Band): GSM transmission/reception control.
- W-CDMA DBB: W-CDMA transmission/reception control.

With the dual cellular phone system, the two components of the Logical Layer 1 (LL1) software controlling the layer 1 protocol processing of W-CDMA and GSM respectively run on the same CPU, and each of the software components is run as an independent task on RTOS (Real-Time Operating System). The communication between tasks is performed using the inter-task communication mechanism of RTOS.

The Medity2 solution incorporates the following functions for implementing a dual cellular phone system with power consumption reduction by introducing the IP of other manufacturers in the GSM system.

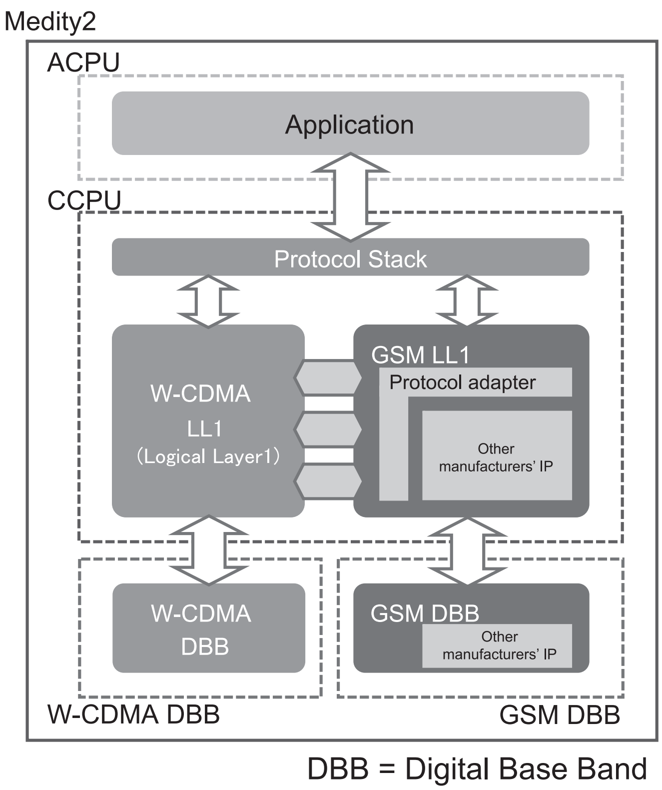

Fig. 3 Dual cellular phone system (Medity2) software block diagram.

- Protocol adapter for connection between the W-CDMA software and the IP from other manufacturers.
- Integrated clock for W-CDMA/GSM transmission/reception control.
- Integrated DAC (Digital to Analog Converter) circuit.

Since there are no standard specifications for interfacing between LL1 tasks, it is necessary to unify the interface between the IP from other manufacturers and the W-CDMA software. For this purpose, a protocol adapter is installed in the GSM LL1 task in order to unify the interface. The protocol adapter makes it possible to introduce the GSM system without affecting the W-CDMA software.

The use of an integrated clock for the W-CDMA/GSM transmission/reception control aims at reduction of the PLL circuit and is implemented by software control so that the W-CDMA and GSM baseband processors work based on the same reference clock. The use of an integrated DAC (Digital to Analog Converter) circuit is made possible by performing

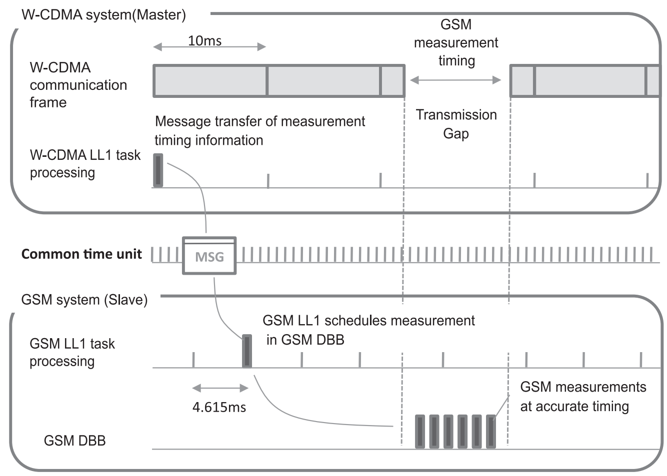

Fig. 4 Communication quality measurement in the dual cellular phone system.

exclusive control of DAC circuit via the software.

4.2 Linked Operation with Parallel Tasks

With the dual cellular phone system, the timing design of the W-CDMA software and GSM software is important in order to enable the communication quality measurements and inter-system handover. As the W-CDMA and GSM communication quality measurements are performed in the idle period to avoid interference to the other system, the timing control is required to perform the measurements in limited periods of time. This is implemented by parallel operation of the LL1 tasks of W-CDMA and GSM.

The inter-system handover requires the measurement of communication quality between the systems. The W-CDMA LL1 task and GSM LL1 task run at independent timings based on the system frame unit time of each system. In the case of dual operation, a master-slave relationship is established between them depending on whether the network being connected is W-CDMA or GSM. The communication quality measurement is performed when the master LL1 task sends the measurement request to the slave LL1 task.

When GSM communication quality is measured during W-CDMA communication, the W-CDMA LL1 task acts as the master and the GSM LL1 task acts as the slave, and measurement is performed in the section called “Transmission Gap” provided within a 10ms communication frame (**Fig. 4**).

The length of the W-CDMA communication frame is 10ms and that of the GSM communication frame is 4.615ms. The W-

CDMA LL1 task creates measurement timing information and notifies the GSM LL1 task of it.

The measurement timing information is not exchanged based on the time frames of the two systems but is based on a common time frame. The LL1 tasks convert the common time unit into the time unit of each system to calculate accurate measurement timings and schedule the measurement control into the baseband processor.

The communication software is designed to be capable of switching the master-slave relationship so that, in addition to the dual system operation, the W-CDMA only configuration or the GSM only configuration can be run on the same software by allowing the master system to run independently.

4.3 Power Consumption Reduction via Software

The dual cellular phone system (Medity2) incorporates functions for the fine control of clocks and PLL circuit. The communication software controls the clock of the baseband hardware to "start" and "stop" the system operation to reduce the power consumption. In order to reduce the chip mounting area and power consumption, Medity2 also uses common hardware and implements the exclusive control of DAC by means of software.

Also, the reference clocks used by the IP from other manufacturers and the W-CDMA baseband processor are different, Medity2 absorbs the difference by means of the software to unify the reference clock and consequently reduce the PLL circuit.

The cellular phone processes reception of incoming notification and measurement of communication quality in a few milliseconds while it is in the standby mode. In the period in which communication is unnecessary, the communication software stops the high-speed clock for use in the operation of the baseband processor and performs the discontinuous reception operation with which the timing with the base station is maintained using a low-speed clock. When measuring the communication quality of a system while the other system is communicating, the clock is turned ON only for the quality measurement period and turned OFF at other times.

The communication software performs integrated management of the exclusive control of hardware resources, the difference absorption between different reference clocks and the clock control according to the cellular phone status and whether or not the communication quality measurement is being performed. This integrated management contributes to the power save control of the entire dual cellular phone system.

5. Conclusion

As described above, we have contributed to the implementation of a dual cellular phone system that features advanced functions meeting the market needs. This has been achieved by introducing the IP from other manufacturers using a protocol adapter, time-base synchronization between W-CDMA and GSM and by the implementation of a power save control by means of newly developed software. In closing, we would like to express our deep gratitude to all of the persons concerned in the development of this innovative solution.

Reference

1) GSM World;
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