LSI Platform HSDPA

Technology Reports

Terminal Platform to Support Advanced Mobile Phone Functions

In response to the demand for advanced mobile phone functions, we expanded the functions of a single-chip LSI that integrates the baseband processor and the application processor, developed common software, and adapted the system to the global environment. Using the mobile terminal common platform that we have developed reduces the burden of FOMA terminal development and allows efficient development of globally capable terminals with advanced functions.

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1. Introduction

There is increasing demand for higher speed and advanced functionality such as high-speed data communication, international roaming, and high-speed 3D drawing for games for mobile terminals, and the burden of terminal development is also increasing year by year.

To cope with this issue, NTT DOCOMO joined with the semiconductor manufacturer Renesas Technology Corp. to develop a single-chip Large Scale Integration (LSI) device that integrates the baseband processor and application processor (SH-Mobile G1)[1][2], and then brought in three terminal manufacturers (Fujitsu, Ltd., Mitsubishi Electric Corp. and Sharp Corp.) to begin joint development of a common mobile terminal platform (hereinafter referred to as the "terminal platform") in April 2006 (**Figure 1**). In addition to the integrated single-chip LSI (SH-Mobile G2)[*1], the terminal platform development includes peripheral devices such as a power supply IC and a wireless transceiver circuit IC, and common software such as an OS, device driver, and middleware to run on the LSI.

The SH-Mobile G2 aims for higher application processor capability to meet the demand for higher speed and advanced functionality. Higher speed in the baseband processor was also achieved with the High Speed Downlink Packet Access (HSDPA)[*2] and Enhanced Data rates for Global system for mobile communications Evolution (EDGE)[*3] communication functions [3].

In this article, we outline the development of the terminal platform, which has been adopted for the FOMA 905i series successively since November 2007 in response to the demand for more advanced functions in mobile terminals.

2. Development Background and Effects

Terminal development always involves strict requirements for improved quality, lower cost and shorter development time. In developing products that have advanced mobile terminal functions as a competitive edge, it is necessary to go beyond simple

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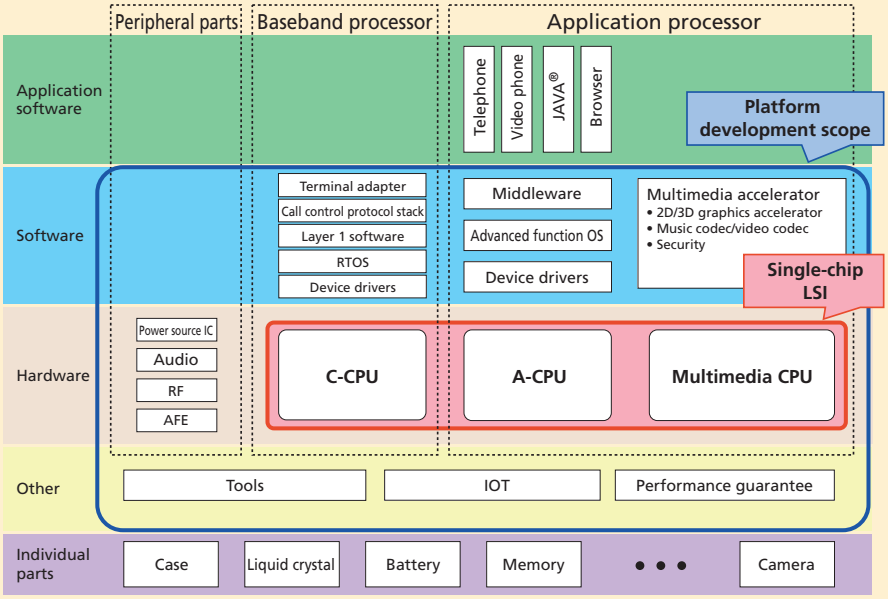
*1 **Integrated single-chip LSI (SH-Mobile G2)**: A product of Renesas Technology Corp. that succeeds the SH-Mobile G1 used by terminal manufacturers. The SH-Mobile G2 shipped as a sample in September 2006 and mass production began in the third quarter of 2007.

*2 **HSDPA**: A high speed downlink packet transmission technology based on W-CDMA and standardized by 3GPP. It optimizes the modulation method and coding rate according to reception conditions at the mobile terminal.



AFE: Analogue Front End
Java®: A registered trademark of Sun Microsystems, Inc.

Figure 1 Scope of terminal platform development

improvement of hardware performance and construct a terminal platform that greatly expands the scope of common software components in joint development as well. To reduce terminal cost, it must be a mobile terminal platform that is adopted in the global market. In this chapter, we describe jointly-developed common software, globalization and their effects.

2.1 Higher Terminal Development Efficiency through Joint Development

Here we describe the scope of the development. Previously joint development had targeted the hardware (LSI) and device drivers, but the terminal platform extended joint development to the communication software and advanced function Operating System (OS), thus both reducing additional development by each terminal manufacturer and having test items in common. Multiple terminal manufacturers using common software allows earlier achievement of high quality.

This approach can reduce the work of development and testing for the common parts for each terminal manufacturer, yet allows manufacturers independence in focusing on development for differentiating their products (**Figure 2**).

2.2 Coping with Globalization

With international development in view, our terminal platform is compatible with the GSM/General Packet Radio Service (GPRS)[*4] and EDGE that are widely-used in Second-Generation mobile communication systems (2G) throughout the world in addition to the Third-Generation mobile communication system (3G) world standard W-CDMA.

In this terminal platform, the 2G/3G dual-mode uses a single shared antenna that can be switched for use with 2G or 3G. When the 3G is in the standby state, the terminal searches for a 2G signal and vice versa, eliminating the need for two antennas.

Furthermore, an InterOperability Test (IOT) with multiple network ven-

*3 **EDGE**: A packet communication standard that extends the Second-Generation (2G) GPRS and is one of the IMT-2000 international standard. GSM is a 2G worldwide mobile communication system that is widely used in Europe and Asia.

*4 **GPRS**: A packet switching service available on GSM network.

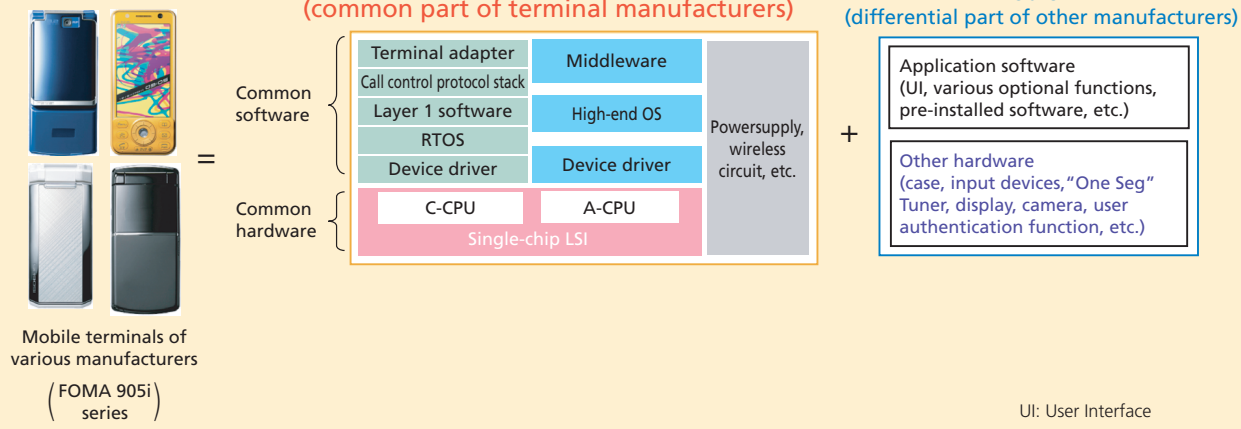


Figure 2 Mobile terminal platform

dors is also implemented for the 2G/3G dual-mode function to check interoperability with the many network devices provided by operators in Asia, Europe and other countries.

Adopting this terminal platform reduces the verification work related to terminal interoperability and facilitates coping with the international roaming function.

3. Terminal Platform Functions and Features

Our terminal platform extends the functions of the baseband processor and application processor and increases their speed (**Table 1**). The circuit scale is also 1.4 times as large as the conventional LSI, but the chip is implemented with the same die[*5] size as the conventional LSI (**Figure 3**). The scope of common development is also expanded by the addition of software. This chapter describes the functions and features of the baseband processor and application processor.

Table 1 Comparison of hardware functions

	SH-Mobile G1	SH-Mobile G2
C-CPU	ARM926 (104 MHz)	ARM926 (130 MHz)
A-CPU	ARM926 (208 MHz)	ARM1136 (390 MHz)
Multimedia CPU	SH4AL (312 MHz)	SH4AL (390 MHz)
3D graphics accelerator	MBX-L (78 MHz)	MBX-L (130 MHz)

ARM: A 32-bit RISC CPU architecture being developed by the ARM Corporation of the U.K. and widely used for embedded devices and low power applications.
MBX-L: Graphics accelerator supplied by Imagination Technologies of the U.K.
SH4AL: CPU supplied by Renesas Technology Corp.

3.1 Baseband Processor

As previously, the main hardware components are a Communication Central Processing Unit (C-CPU)[*6], a W-CDMA circuit and a GSM/GPRS circuit, but the W-CDMA circuit conforms to HSDPA Category 6[*7] (transmission speed of 3.6 Mbit/s), the GSM/GPRS circuit conforms to EDGE, and the processing capability of the C-CPU is improved to enable high-speed data communication. The software also has the same basic configuration as previously, with the mobile wireless communication protocol stack running on the micro Industrial The Real-time Operating system Nucleus (μITRON)[*8] of Real-Time Operating System (RTOS)[*9]. The scope of the current development extends from device drivers to terminal adapters.

3.2 Application Processor

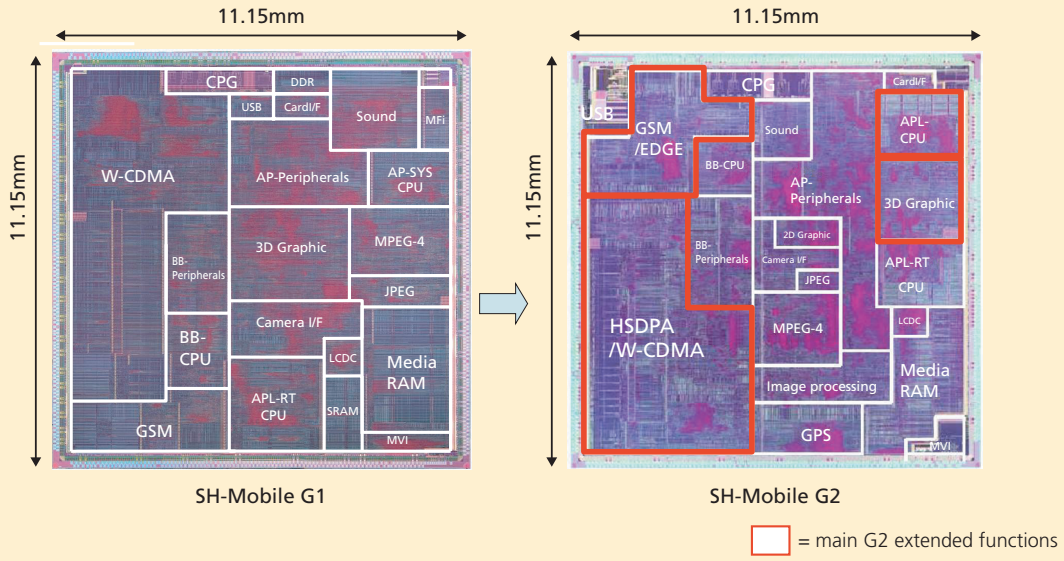
The application processor is configured conventionally, with mainly an

*5 **Die**: The integrated circuit part of a semiconductor chip.

*6 **C-CPU**: Generic name for the CPU in charge of communications and call control processing in a mobile terminal.

*7 **HSDPA Category 6**: HSDPA categorizes terminals according to receiving capability, with Category 6 indicating a maximum data communication rate of 3.6 Mbit/s.

*8 **μITRON**: An RTOS (see *9) provided by the TRON Association and used widely such as in mobile terminals. Its compact configuration makes for easy loading onto various types of processors.



APL-RT CPU: APpLication-Real Time CPU
AP-Peripherals: APplication-Peripherals
AP-SYS CPU: APplication-SYStem CPU
BB-CPU: Base Band - CPU
BB-Peripherals: Base Band-Peripherals

CPG: Clock Pulse Generator
DDR: Double Data Rate
JPEG: Joint Photographic Experts Group
LCDC: Liquid Crystal Display Controller
Media RAM: Media Random Access Memory

MFi: Melody Format for i-mode
MPEG-4: Moving Picture Experts Group phase 4
MVI: Mobile Video Interface
SRAM: Static Random Access Memory

Figure 3 LSI die

Application CPU (A-CPU)[*10], a multimedia CPU, and multimedia accelerator[*11], but in developing our terminal platform, we decided on functions and performance and developed hardware and software based on various multimedia services assumed to be in demand for FOMA terminals. As shown in **Table 2**, FOMA 905i series is equipped with many new functions such as the Wide-Video Graphics Array (WVGA)[*12] display, 3D graphics games, Music and Video Channels, the multimedia processing functions needed to implement the "One Seg" service, Keitai-Osagashi Service, emergency location notification function, and any other location service using a highly-sensitive Global Positioning System (GPS). Those functions take advantage of this terminal platform, which has motivated the development of more attractive products.

Table 2 905i functions and relation to the terminal platform

Main functions of 905i	Terminal platform function
Global mobile phone	W-CDMA/GSM/GPRS/EDGE
High-speed i-mode	HSDPA Category 6 (3.6 Mbit/s)
High quality wide VGA LCD	VGA or better
High quality camera	8 megapixel, image stabilization
Music & Video Channel	H.264, MPEG-4, WMV VGA 30 fps (frame per second)
Music player	Approx. 20 H (WMA)
3D graphics games	OpenGL ES1.1 (2.3 Mpoly/s)
PC connection	USB2.0 High speed
"One Seg" compatible	Software for "One Seg"
GPS compatible (Keitai-Osagashi Service, emergency location notification function)	Built-in high-sensitivity GPS baseband

WMA: Windows Media® Audio
WMV: Windows Media® Video
Windows Media® is a registered trademark of the Microsoft Corporation in the United States and other countries.
OpenGL ES1.1 (Open Graphics Library Embedded Subset 1.1) : 3D drawing API for embedded devices.

*9 **RTOS**: An OS equipped with functions for performing real-time processing. It is used in embedded equipment such as Personal Digital Assistant (PDA) and home appliances that incorporate a CPU and software for specific applications.

*10 **A-CPU**: Generic name for the CPU in charge of application processing in a mobile terminal.

*11 **Multimedia accelerator**: High-speed processing engine for video, still images and audio.

*12 **WVGA**: A display mode indicating an image resolution with a pixel of 800 by 480.

4. Conclusion

We have described the development of a terminal platform for advanced mobile phone functionality.

This terminal platform is compatible with the GSM and W-CDMA dual-mode function, which is a de facto standard in the worldwide terminal market, and can reduce the burden of terminal development by expanding the scope of common software. We believe that with wide adoption of this platform for domestic and international terminals, the cost of FOMA terminals will continue to drop.

In future work, we will proceed with technical development for various applications that are suited to the expanded mobile phone use scenario that is assumed for the coming wireless broadband era, beginning with HSDPA Category 8[*13] (transmission speed of 7.2 Mbit/s), and to support the development of mobile terminals that have market appeal and will be used with pleasure.

REFERENCES

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*13 **HSDPA Category 8**: HSDPA categorizes terminals according to receiving capability, with Category 8 indicating a maximum data communication rate of 7.2 Mbit/s.