Imaging Application Platform Using MB86S62 Application Processor

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Imaging solutions using application processors means providing customers with an application platform that includes software and evaluation boards based on Fujitsu's extensive image-processing technologies. Customers who manufacture assembled products (set makers) can use this platform to develop and market multi-function products in a shorter period of time. In combination with Fujitsu's Milbeaut image processor, this platform provides a high-performance image processing system that can provide customers with a competitive edge over other makers. This paper presents a specific example of this imaging application platform using Fujitsu's MB86S62 application processor.

1. Introduction

Today's smartphones and tablets are evolving at a dramatic pace. Being capable of functions and applications that were inconceivable just a few years ago, they are now becoming an integral part of business and everyday life. This epic development can be attributed to the use of application processors on the terminal side to maintain sufficient processing speeds and to stress-free, routine Internet access made possible by the creation of a communication infrastructure centered around Long Term Evolution (LTE).[1] As a result, a wide variety of compelling services are coming to be provided by interlinking terminal-side applications with the cloud.

Looking forward, we can expect advanced user interfaces developed for smartphones and tablets to be applied to a variety of products, which suggests that image processing using application processors will become increasingly important.

At the same time, a company would need cutting-edge process technologies to fabricate such application processors for achieving novel products in a demanding market and to enable it to differentiate itself from its competitors. However, the development of LSI circuits using 40-nm and beyond process technologies means an explosive increase in the difficulty of layout and the amount of labor for testing, thereby extending the development period and increasing the development costs compared to existing technologies. As a result, the development of LSI circuits using advanced technologies increases risk and becomes a major factor in reducing the customer's return on investment (ROI) when developing individual products. In short, it makes new development projects all the more difficult.

This state of affairs suggests a new business opportunity in providing new solutions for easing the customer's load (development costs, software development) in relation to 40-nm and beyond process technologies.

Against this background, semiconductor manufacturers who develop application processors are, of course, targeting the smartphone and tablet markets, but they are also indicating a desire to participate in the on-vehicle and digital-consumer-electronics markets. In contrast, customers who are makers of assembled products (set makers) are beginning to move in the direction of system integration using existing application processors to reduce development costs and risks instead of developing new, proprietary LSI circuits. This trend is providing Fujitsu—which excels in the application-specific integrated circuit (ASIC) business—an impetus for revolutionizing the way it supports set makers.

In particular, Fujitsu is focusing on applications that can exploit the company's extensive expertise in image processing technology and is providing its customers with an application platform that includes software and evaluation boards. In this way, Fujitsu has achieved a solution for providing application-processor-based development while enabling the customer to incorporate its proprietary logic to achieve original functions in much the same way as can be done with conventional ASICs. Furthermore, by combining this platform with Fujitsu's Milbeaut image processor, customers can use this application platform as an imaging platform in a manner different from what can be offered by other application processor vendors.

This paper presents a specific example of using this imaging application platform in conjunction with Fujitsu's MB86S62 application processor.

2. Imaging application platform using MB86S62

The concept of an imaging application platform is shown in **Figure 1**.

The idea here is to provide a user-friendly platform that exploits Fujitsu's ASIC technology developed over many years and its image processing technology centered about its Milbeaut image processor. In addition to excelling in power consumption, performance, and device area (and therefore lowering costs) by integrating software and hardware based on advanced CPU/GPU devices, this platform provides a highly competitive multimedia framework featuring a sequence of image processing functions including sensing, analysis and processing, compression and decompression, and display and output. The platform provides customers with value by reducing costs and accelerating delivery through a platform geared to imaging-related application-specific standard products (ASSPs), by boosting existing business and facilitating the creation of high-value-added products, and by contributing to the creation of new businesses.

The configuration of this platform is shown in **Figure 2**. It consists of a system-on-a-chip (SoC) based on application processors, Linux[2] and Android[3] board support packages (BSPs), and a multimedia framework comprised of Fujitsu image processing functions. This platform makes for easy system development since it allows the customer to create original applications on

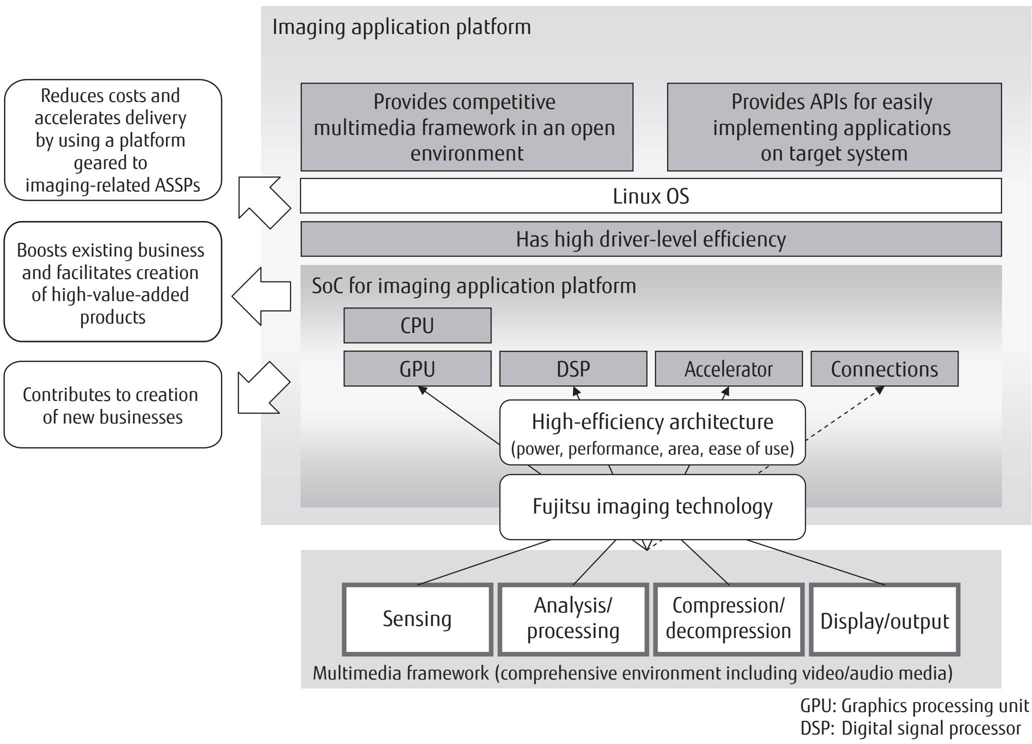


Figure 1
Concept of imaging application platform.

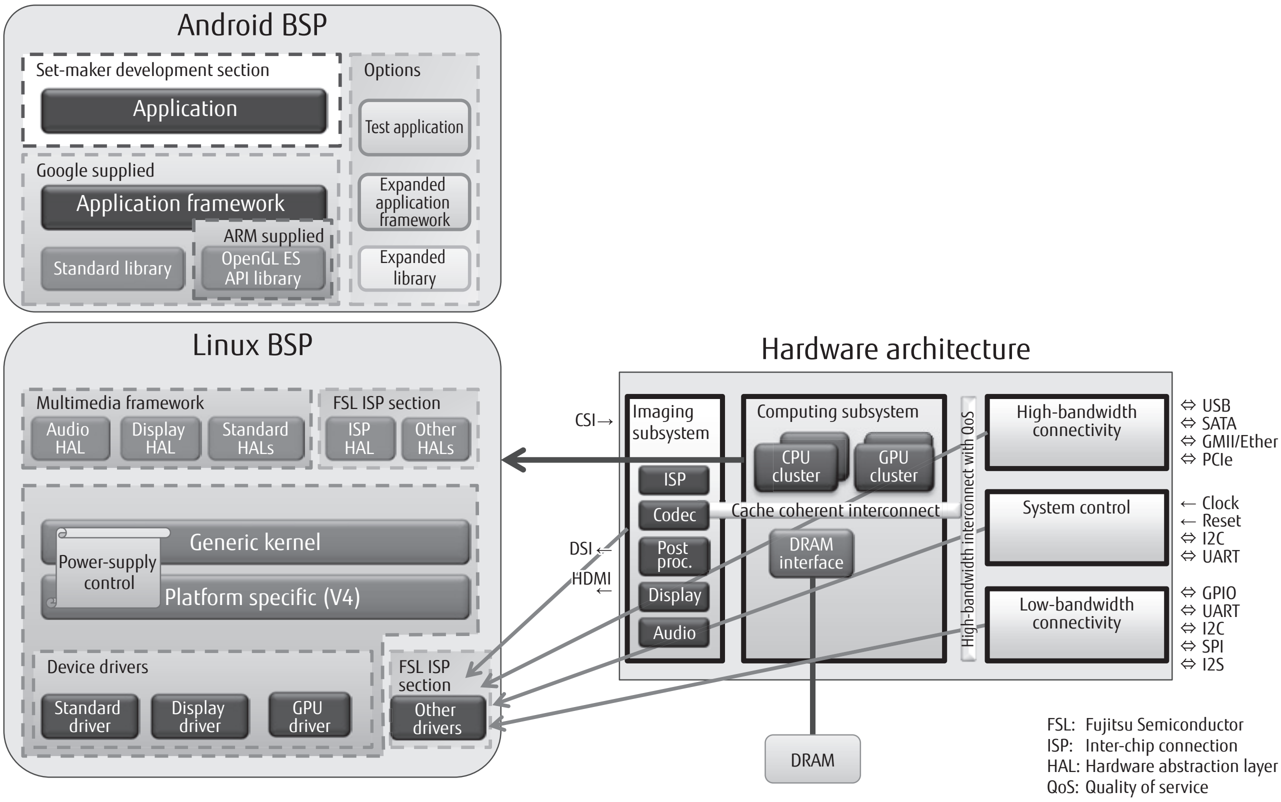


Figure 2
MB86S6 platform configuration.

top of these Linux and Android BSPs.

The following subsections describe the hardware and software configuration of this platform and associated features.

2.1 MB86S62

A block diagram of the MB86S62 application processor is shown in **Figure 3**, and its main specifications are listed in **Table 1**. In developing this platform, much attention was paid to achieving greatly reduced power consumption and high-performance image processing. The hardware measures taken to achieve these goals and key MB86S62 features are described below.

1) Low-power process

The use of an advanced 45-nm, low-power process in this application processor has reduced power consumption and lowered costs.

2) ARM Cortex™-A8 processor

The MB86S62 incorporates an ARM core, a well-known embedded processor, which achieves a maximum operating frequency of 1 GHz. This core integrates a primary instruction/data (I/D) cache of 32 KB and a secondary cache of 256 KB.

3) Powerful and extensive multimedia functions

The MB86S62 features two camera input interfaces. The main interface supports up to 8 megapixels (Mpixels) using a MIPI (Mobile Industry Processor Interface)[4] camera serial interface (CSI) or an 8-bit parallel interface. The sub-interface supports up to 3 Mpixels using an 8-bit parallel interface. The video codec supports a variety of video standards including MPEG-2,[5] H.264,[6] and VC-1.[7] It supports, in particular, Full HD 1080p at 30 fps encoding/decoding and 720p dual encoding. The audio codec supports various audio standards such as MP3[8] and AAC and various interfaces including I^2S[9] and SPDIF.[10]

4) 3D graphics engine

The MB86S62 integrates a 2D/3D graphics hardware accelerator supporting OpenVG1.1[11] and OpenGL ES2.0 and featuring a dual core having a processing ability of 30 MPoly/s and 400 Mpixel/s.

5) Display functions supporting three-screen display and XGA

Featuring a 24-bit RGB interface and a MIPI display

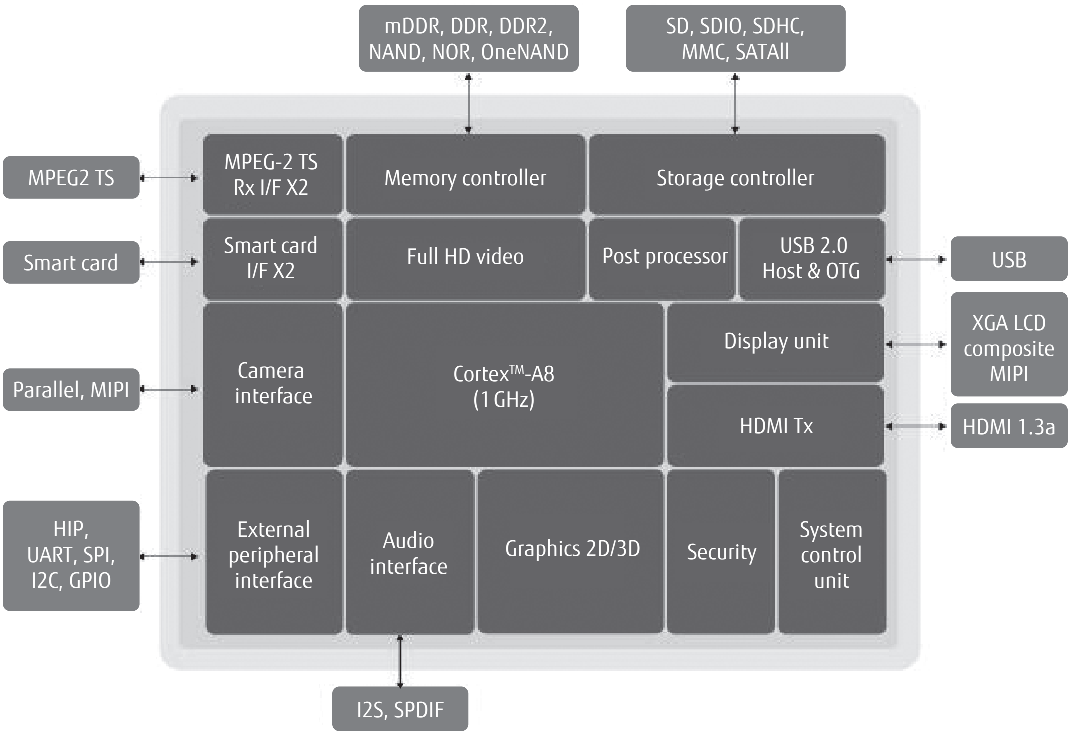


Figure 3
MB86S62 block diagram.

Table 1
MB86S62 main specifications.

Item	Specifications
CPU	ARM Cortex™-A8, max. 1 GHz
Video	1080p @30 fps encoding: MPEG-4, H.264 (720p dual encoding)
	1080p @30 fps decoding: MPEG-2/4, H.264, VC-1, RV8.9.10, H.263 mode support, Divx streaming
Graphics	OpenGL2.0/OpenVG1.1 (30 MPoly/s, 400 Mpixel/s)
Display	XGA LCD I/F and dual LCD support (24-bit RGB or MIPI DSI/3D deinterlacer)
Camera	Dual cameras (8 Mpixels and 3 Mpixels)
Interfaces	USB Host × 1, OTG × 1 PHY built-in MPEG-2 TS RX × 2 and SPI × 3, SmartCard I/F × 2 SD/MMC/SDIO/SDHC I/F SATAII/HDMI
Package	19 mm × 19 mm 620-pin FBGA (0.65-mm pitch)

serial interface (DSI), the MB86S62 supports an XGA-size (1024 × 768) LCD interface and dual LCD display. It can also support a three-screen display by combining the dual-LCD function with a High-Definition Multimedia Interface (HDMI)[12] or a TV (NTSC or PAL) interface.

6) Low-power consumption through power-supply management

Mounted on the MB86S62 is a system control unit designed to lower power consumption by changing the power mode (normal, idle, stop, sleep, deep sleep) as needed, controlling the operating current by clock gating, and performing power gating on individual macro functions (leakage current can also be controlled).

The MB86S62 application processor is mounted in a 19-mm-square fine-pitch ball grid array (FBGA) package supporting external dynamic random access memory (DRAM). We are now in the process of developing a system in package (SiP) version of this application processor. We will use chip stacking as shown in **Figure 4** to save space on the mounting board and to further reduce power consumption.

2.2 Evaluation environment

2.2.1 Overview of developer tool kit using MB86S62

The developer tool kit (DTK) is equipped with MB86S62 peripheral devices and a variety of interfaces, making it easy to achieve desired functions.

Evaluation boards for development purposes using the MB86S62 application processor are shown in **Figure 5**. Specifically, the DTK for developing software such as driver middleware is shown in Figure 5(a), and a tablet for developing applications is shown in Figure 5(b). The tablet can be connected to an extension board to construct a debug environment nearly equivalent to that of the DTK.

The DTK includes BSPs for both Linux and Android systems given their popularity in the market. These BSPs enable the customer to concentrate on upper-level development directly related to product specifications without having to be concerned for the most part about lower-level design.

2.2.2 DTK basic functions

- LCD: 800 × 480 pixels
- Double data rate (DDR) RAM capacity: 512 MB (system), 256 MB (media)
- NAND flash memory: 8 GB (multi-level cell, MLC)
- USB[13] on-the-go (OTG) converter cable
- Non-crossing serial cable

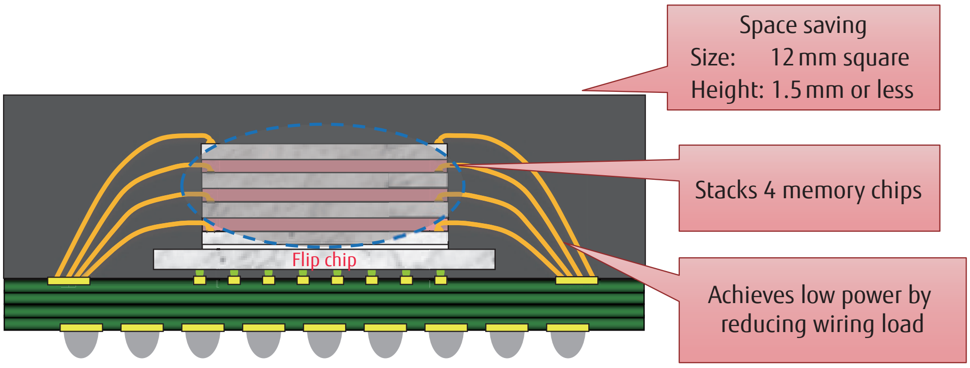
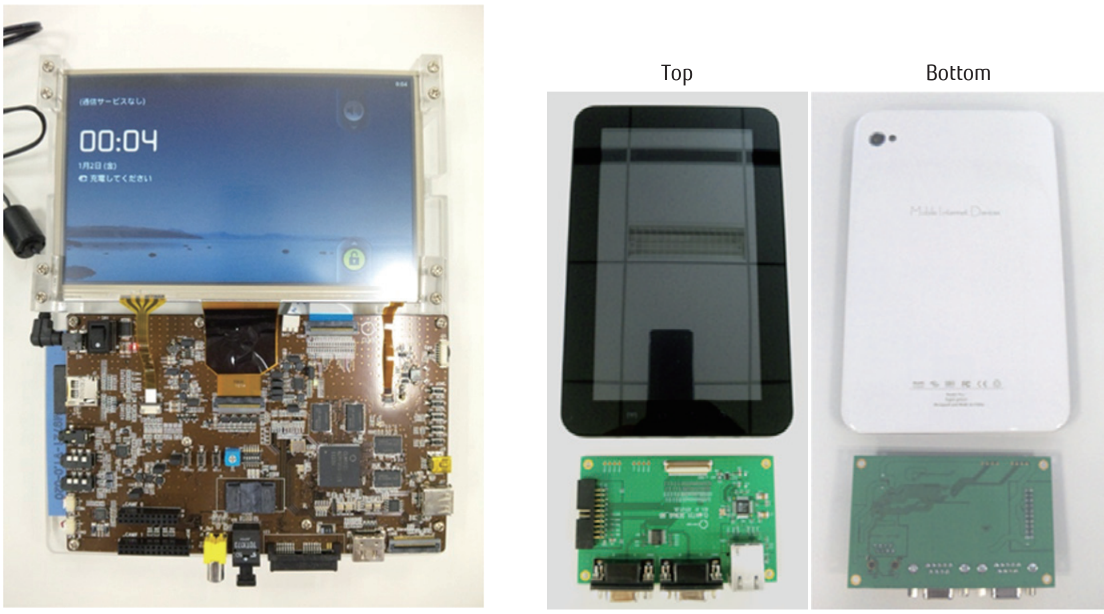


Figure 4
Example SiP configuration.



(a) DTK for software development

(b) Tablet for application development

Figure 5
Evaluation boards for development using MB86S52.

- Stereo speakers
- 5-V, 2-A adapter
- 3.7-V single-cell battery (max: 4.2 V)

2.2.3 DTK function details

1) Power-supply functions

A main power-supply switch and a light-emitting diode (LED) power indicator are included.

Two types of power-supply feeds are provided:

- 5-V AC
- 3.7-V DC (single-cell battery)

2) Evaluation functions

The customer can perform product evaluation by connecting the main DTK board to a personal computer via a debug board using any of the following means:

- Ethernet
- JTAG
- RS-232C
- USB

3) External device functions

The following functions are provided for connecting to external devices:

- NAND flash memory
- Universal asynchronous receiver/transmitter (UART1)
- Secure Digital (SD)[14] Ch0/Ch1
- USB host: USB host connector
- Camera interface 0: parallel camera board
- Camera interface 1: parallel camera board
- MIPI slave: MIPI camera board
- Micro SATA (Serial AT Attachment) interface[15]: external 1.8-inch SATA hard-disk drive (HDD)
- Digital TV connector: Digital TV board

4) Display/operation functions

The following display functions and operation keys are provided:

- Touch panel: 7-inch LED LCD
- Home, menu, back, volume up/down

5) Input/output terminals

The following input/output functions are provided:

- Microphone/line input
- Headphone output
- Stereo speakers (8 ohm)
- CVBS (color, video, blanking, and sync) Out
- S/PDIF (Sony/Philips Digital Interconnect Format)
- HDMI

6) Switch functions

Switches for performing resets and selecting operation modes are provided as follows:

- Power switch
- Reset switch
- CPU reset switch
- Boot-mode setting switch

2.2.4 Software configuration

This platform envisions applications in the form of mobile terminals (including tablets) and other digital devices having equivalent functions. It considers Android and Linux to be the basic system OSes and frameworks.

The basic configuration of the Android system is shown in **Figure 6**. It features the following five layers.

1) Application

Android applications run in this layer.

2) Application framework

This layer provides various services for Android applications.

3) Library/Android runtime

This layer consists of the following basic library groups.

- SQLite
- Libc
- WebKit
- OpenGL ES (OpenGL for Embedded Systems)
- Core library
- Dalvik virtual machine (VM)

4) Hardware abstraction

This layer provides hardware abstraction to separate actual hardware from the Android system.

5) Linux kernel

The use of a Linux kernel means that device drivers developed specifically for Linux use can be used as-is.

The advantage of introducing the Android system into this application platform is that development tools—such as the following—are already provided.

- Android SDK (Software Development Kit)
- Android NDK (Native Development Kit)

Either or both of these tools can be used depending on the requirements and specifications of the target product.

This application platform enables the creation of an image-processing library based on a multimedia

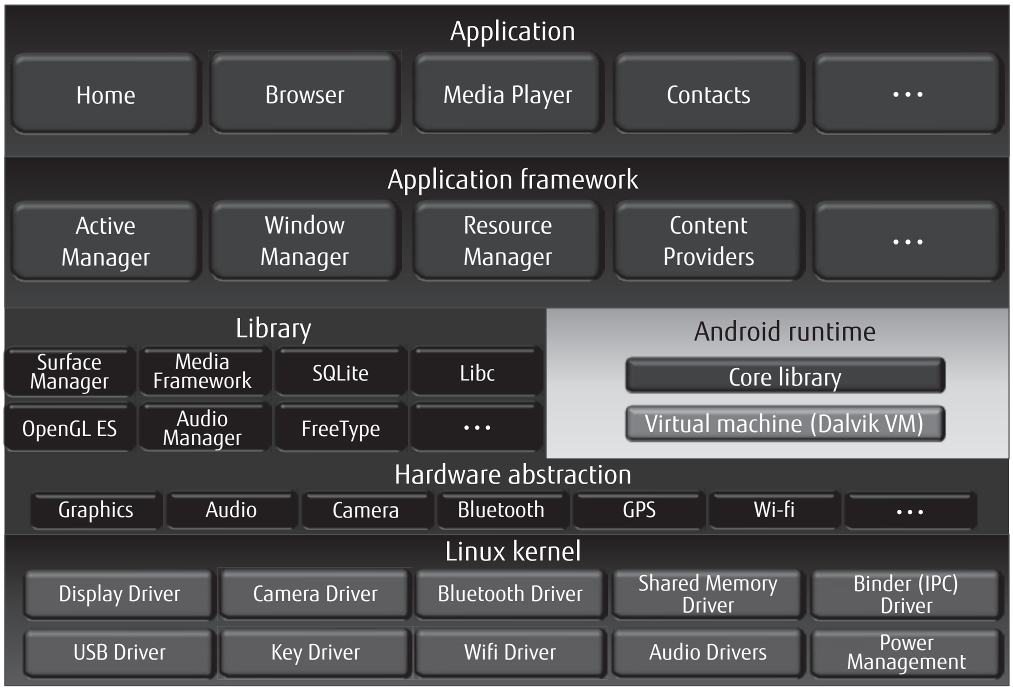


Figure 6
Basic configuration of Android system.

library (OpenMAX/GStreamer)[16] and 2D/3D graphics library (OpenVG/OpenGL ES), which constitute a general-purpose media framework for embedded devices.

These media libraries make extensive use of hardware-assist functions, enabling the desired level of video performance to be achieved with low power consumption.

Introducing the Android system in this way enables the customer to focus on application development based on standard application programming interfaces (APIs). Moreover, the use of the OpenGL ES/OpenMAX framework negates the need to create software assets based on APIs associated with SoC-unique technology. This provides the customer with shorter development periods and reduced labor requirements.

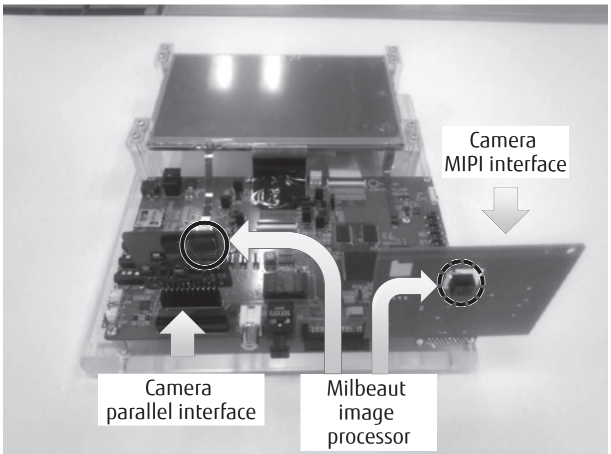


Figure 7
Application example using DTK.

3. Application example

This section presents an example of using the DTK introduced above to construct an integrated system using the Milbeaut image processor, which represents proprietary Fujitsu image-processing technology.

This system provides two channels of parallel interfaces and one channel of a MIPI slave interface; which of these three interfaces to use depends on the needs of the application product.

The configuration of this system is shown in **Figure 7**.

Software support is easily provided by introducing the Android system. Basically speaking, only device drivers need to be prepared for the user.

In this system, basic functions for handling a camera that captures images through a preview or shutter operation can be achieved by simply creating an Android application since APIs are already supported in Android. In other words, the user need not be concerned about device details.

Once such basic camera functions have been completed, the user can devote valuable time to optimizing individual features that demonstrate key product specifications. For example, the user can now:

- Analyze performance
- Make picture-quality adjustments
- Support added functions such as auto-focus

In the above way, the DTK can be used as a development platform that makes it easy to construct an integrated system. The labor that previously had to be allocated to developing an entire system can now be concentrated in that portion of the system that emphasizes those features—such as image/video quality—that differentiate the product-developing company from other companies.

4. Future developments

The computing subsystem of the MB86S62 application processor is basically the same as that of similar products from other companies. To clearly differentiate a product from the products of other companies, the measures listed below must be taken.

1) Support of non-competitive areas
- Device technology and CPU-core technology must be of the same generation or one generation ahead.
- Upgrades must be immediately made to reflect the latest versions of Linux and Android OSes, Khronos standard APIs, OpenCL, OpenCV[17], and other software.

2) Support of competitive (company-differentiating) areas
- Device technology centered about low power consumption must be enhanced.
- Image processing technology must be enhanced.
- Software assets for simplifying system integration must be developed.

Basic, custom, and two-chip platforms for achieving the above are shown in **Figure 8**. The plan is to provide three types of platforms. One is a basic platform consisting of computing and imaging subsystems [Figure 8(a)]. A single chip with this platform configuration can be provided as a one-chip solution with Linux and Android built-in. Next is a custom platform based on the above chip but embedding an application-unique section [Figure 8(b)]. The third is a two-chip platform consisting of a platform chip and

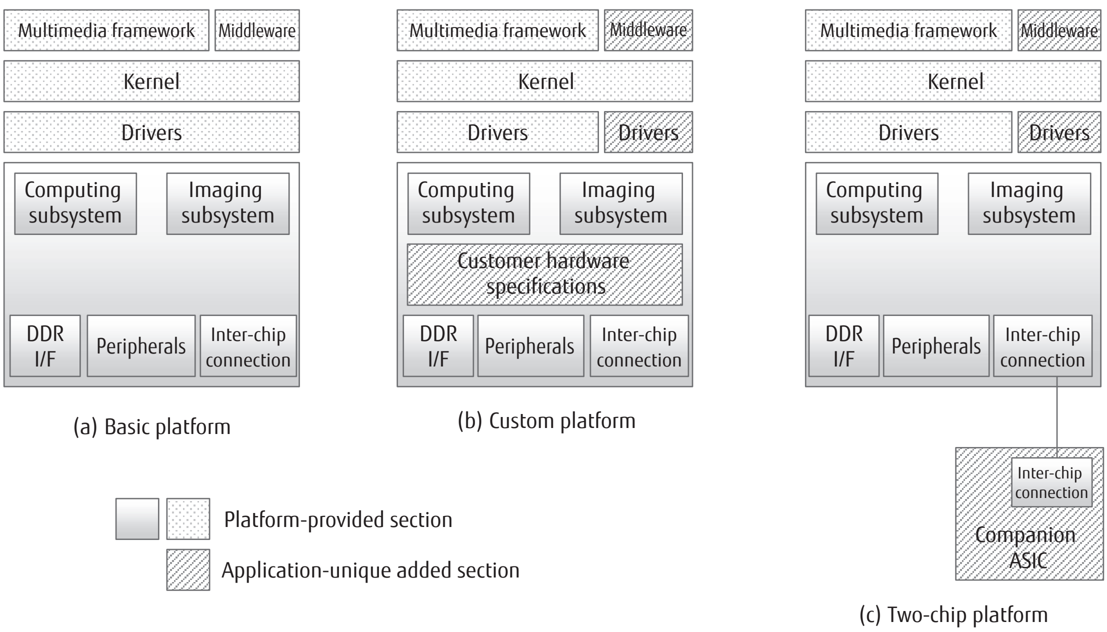


Figure 8
Platform and product expansion.

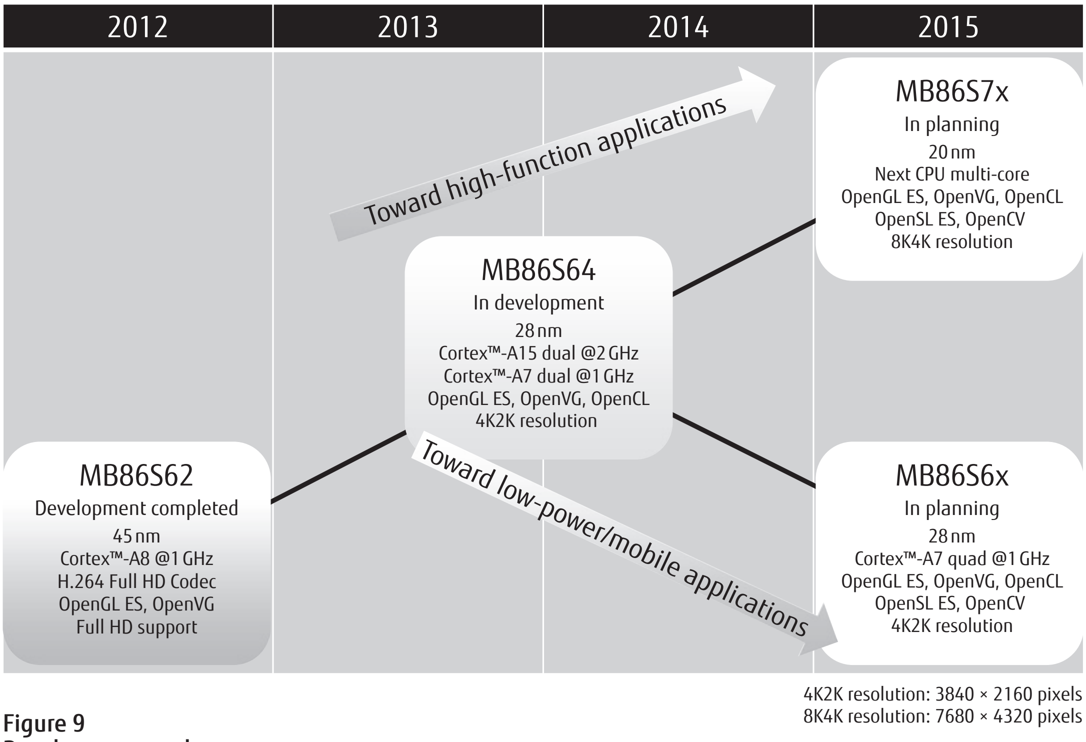


Figure 9
Development roadmap.

a companion chip that can interface via a wideband inter-chip connection [Figure 8(c)].

Our plan is to set up a platform development environment that implements the above measures and to market by fiscal 2013 a product featuring 28-nm process technology, a built-in Cortex™-A15 processor, and 4K-class video processing (**Figure 9**).

5. Conclusion

We introduced an imaging application platform using Fujitsu's MB86S62 application processor. As a future imaging solution, we envision a highly functional, interactive, cloud-linked display system probably in the form of a tablet that will find widespread use in diverse scenarios in the home, office, and public facilities. Looking forward, Fujitsu is committed to using its advanced device technologies to develop similar application platforms for 20-nm and beyond process generations and to provide an expanded lineup of image-processing solutions.

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