

TWL Introduction

2009/06/08

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Table of Contents

1	Introduction	6
2	DSi Features	7
2.1	New Style of Play Using Two Cameras	7
2.2	Improved Processing Capacity for Images and Sound with DSP Implementation	7
2.3	Saving Downloaded Software on the DSi	7
2.4	Restricting the Launching of Applications	7
2.4.1	Region Controls Added	7
2.4.2	Parental Controls Added	8
2.5	Support for Commercial SD Memory Cards	8
3	Hardware Changes	9
3.1	CPU	9
3.1.1	Improved Operation Speed	9
3.2	Memory	9
3.2.1	Increased Main Memory Size	9
3.2.2	Increased Internal Work RAM Size	9
3.3	DMA	9
3.3.1	DMA Controller Added	9
3.4	Sound and Microphone	9
3.4.1	Improved Sound and Microphone Performance	9
3.4.2	Auto Sampling Hardware Processing Implemented	10
3.5	Wireless Communication	11
3.5.1	Wi-Fi Module Specifications Changed	11
3.5.2	Prohibition of Wireless Communication Added	11
3.5.3	LED Indicating Wireless Communication Status Added	11
3.6	Other Changes	12
3.6.1	Thinner Profile	12
3.6.2	Larger LCD Size	12
3.6.3	GBA Slot Removed	12
4	Software Changes	13
4.1	Types of Software	13
4.1.1	Compatible Hardware	13
4.1.2	Media Access from Applications	14
4.2	Nintendo DS Software	14
4.3	Nintendo DSi Enhanced Software	14
4.3.1	Nintendo DSi Exclusive Software: Improved Features Over the DS/DS Lite	15
4.4	Nintendo DSi Exclusive Software	16

4.5	NAND Application Proprietary Features	16
5	Development Environment	17
5.1	Hardware Configuration.....	17
5.1.1	IS-TWL-DEBUGGER	17
5.1.2	IS-TWL-CAPTURE	18
5.1.3	TWL Test Unit / TWL Flash Card	19
5.1.4	Flash Writer.....	19
5.2	Software Configuration	19
5.2.1	Compiler.....	20
5.2.2	TWL-SDK.....	20
5.2.3	TWL-System	20
5.2.4	Middleware for TWL.....	20
6	Additional Documents to Read.....	21

Tables

Table 2-1	Configurable Languages and Usable Character Types by Market.....	8
Table 2-2	Markets and Rating Organizations	8
Table 3-1	DS/DS Lite Power LED and DSi Wireless LED Blinking Specifications	11
Table 4-1	List of Supported Software Types.....	13
Table 4-2	Media Access According to Application Type	14

Figures

Figure 3-1	CODEC and Peripheral Module Block Diagrams	10
Figure 3-2	Nintendo DSi Microphone Position	10
Figure 5-1	Development Tools Connection Diagram	17
Figure 5-2	IS-TWL-DEBUGGER	18
Figure 5-3	IS-TWL-CAPTURE	18
Figure 5-4	TWL Test Unit / TWL Flash Card.....	19
Figure 5-5	Hierarchical Structure of Libraries and Middleware	20

Revision History

Revision Date	Description
2009/06/09	Initial version.

1 Introduction

This document is intended for experienced Nintendo DS/DS Lite software planners/developers. It provides information about Nintendo DSi (named *TWL* during development) features, content additions and changes from Nintendo DS/DS Lite, and an overview of the development environment.

2 DSi Features

The following sections introduce the DSi features.

2.1 New Style of Play Using Two Cameras

The DSi includes two 640x480 pixel cameras (300,000 pixels maximum). One faces outward and the other inward. The two cannot be used at the same time, but by switching between the two, you can photograph what you see or yourself. The resulting photograph data can be accessed through the TWL-SDK library. The DSi cameras enhance fun by allowing users to distort photographs, change the colors, and add graffiti.

2.2 Improved Processing Capacity for Images and Sound with DSP Implementation

The DSi uses a digital signal processor (DSP) to process image and sound signals. Image or sound data can be encoded and decoded, sounds can be generated, and the generated sounds can be mixed for output.

Use the DSP via the TWL-SDK libraries. The TWL-SDK also provides components for signal processing and image conversion.

2.3 Saving Downloaded Software on the DSi

The system NAND memory consists of 256 MB of flash memory. The system menu (DSi Menu), internal software (system NAND applications), save data, download sales DSi software (NAND applications), etc., are stored in the system NAND memory.

2.4 Restricting the Launching of Applications

2.4.1 Region Controls Added

Unlike the DS/DS Lite, the Nintendo DSi uses region (market) settings. Launching, language selection, and other settings are restricted by region controls for Nintendo DSi Enhanced and Nintendo DSi Exclusive software. (DS software is not restricted except for applications created for China.)

The systems for each of the four regions (markets)—Japan (JP), North America (US), Europe (EU), and Australia (AU)—have different settings.

Table 2-1 Configurable Languages and Usable Character Types by Market

Market	Configurable Language	Usable Character Type
Japan (JP)	Japanese	Hiragana, katakana, alphabet, diacritics, numbers, and so on
North America (US)	English, French, Spanish	Same as above
Europe (EU)	English, French, Spanish, German, Italian	Same as above
Australia (AU)	English	Same as above

2.4.2 Parental Controls Added

When a guardian wants to prevent an underage user from viewing inappropriate content, Nintendo DSi features can be restricted.

For DSi Enhanced or DSi Exclusive software running on a Nintendo DSi, startup restrictions are performed based on the rating information set by the software and the system's Parental Controls.

The organizations that rate software differ according to market.

Table 2-2 Markets and Rating Organizations

Market	Rating Organization
Japan (JP)	CERO
North America (US)	ESRB
Europe (EU)	USK, PEGI, BBFC (varies by country)
Australia (AU)	AGCB

In addition, the wireless exchange of photo data and user-created content can be restricted when a wireless-communication partner cannot be identified.

2.5 Support for Commercial SD Memory Cards

The DSi includes an SD Memory Card slot to support SD/SDHC memory cards. The cards can be used not only for system NAND applications such as Nintendo DSi camera or DSi sound, but also as backup for the system NAND memory.

However, restrictions for accessing SD memory cards exist. See section 4.1.2 Media Access from Applications for more information.

3 Hardware Changes

This section describes the major hardware changes from the DS/DS Lite. For details, including recently fixed hardware bugs, see the “Differences with NITRO” section in the *Nintendo DS/TWL Programming Guidelines*.

3.1 CPU

3.1.1 Improved Operation Speed

The clock frequency was doubled to 134 MHz from 67 MHz for the DS/DS Lite.

Note: Because the system clock did not change, this does not necessarily convert to twice the operation speed.

3.2 Memory

3.2.1 Increased Main Memory Size

The main memory is 16 MB, which is four times that of the DS/DS Lite.

3.2.2 Increased Internal Work RAM Size

The DSi includes three new 256KB shared memory (WRAM-A/B/C) modules. The newly added memory is shared by all the processors. By switching master processors (accessible processors), data exchange can be performed quickly between processors. However, WRAM-A is dedicated for system use, so the memory cannot be allocated freely by applications.

3.3 DMA

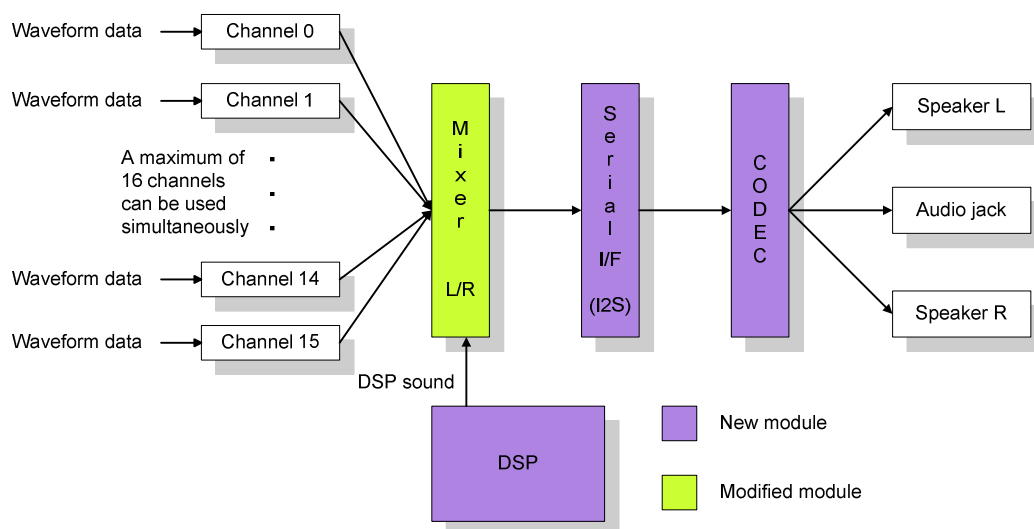
3.3.1 DMA Controller Added

In addition to the DS/DS Lite DMA, the DMA implementation supports block transfer and arbiter type selection. Data transfer without passing through the CPU is performed quickly between memories or devices.

3.4 Sound and Microphone

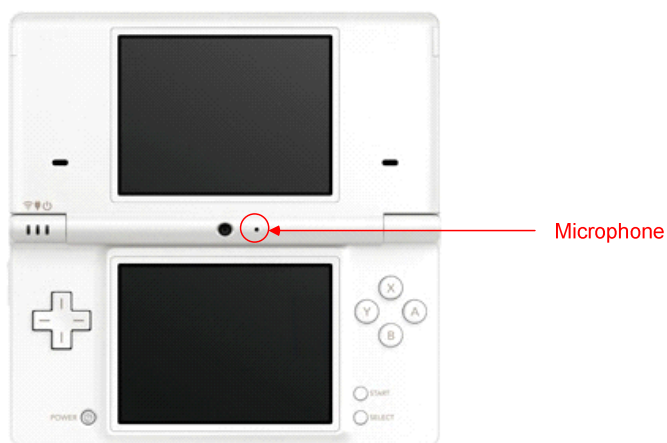
3.4.1 Improved Sound and Microphone Performance

Changes were made to the specifications for both the CODEC module that converts analog and digital signals, and for the peripheral modules, resulting in improved sound and microphone performance.

Figure 3-1 CODEC and Peripheral Module Block Diagrams

The CODEC has two types of operational modes. The first is a DS/DS Lite compatible mode and the second is the newly added TWL mode. In TWL mode, you can select the microphone input sampling frequency and fine-tune the gain.

The microphone position was changed to the inside of the hinge (to the right of the inside camera, at center). For applications that use the microphone, therefore, the conditions for speaking into the microphone (line of sight, how the unit is held, and so on) may differ slightly from the DS/DS Lite.

Figure 3-2 Nintendo DSi Microphone Position

3.4.2 Auto Sampling Hardware Processing Implemented

With the DS/DS Lite, microphone auto sampling is processed in software by the sub-processor; with the Nintendo DSi, it can be processed in hardware by the CODEC. This processing only occurs during TWL mode. The sub-processor load can be reduced, as can the loss of performance caused by simultaneously using wireless communications and the microphone.

In addition, auto sampling of the touch panel can also be processed by the hardware. For this reason, even if microphone sampling is performed at the same time as touch panel sampling, the time lag that occurred with software processing is absent and high-quality sound data can be acquired.

3.5 Wireless Communication

3.5.1 Wi-Fi Module Specifications Changed

The Wi-Fi module specifications were changed and augmented.

- IEEE802.11b/g acceleration
- Lower wireless-module power consumption
- Updated for wireless-security protocols WPA/WPA2

Although the DS/DS Lite only supported the WEP protocol, the Nintendo DSi also supports the more secure WPA and WPA2 protocols. The Wi-Fi module for which the specifications were modified is compatible with DS/DS Lite, so wireless communication with DS/DS Lite users can occur without problems.

3.5.2 Prohibition of Wireless Communication Added

A wireless-off mode (to prohibit wireless communication use) was added to the wireless communication features. When the user sets the wireless-off mode, no wireless communication features, including those in existing DS software, can be used.

3.5.3 LED Indicating Wireless Communication Status Added

An LED to indicate the wireless communication status was added. With the DS/DS Lite, the power LED blinked whenever wireless communications occurred, regardless of the wireless signal output state. This addition also allows the signal output status to be displayed.

Table 3-1 DS/DS Lite Power LED and DSi Wireless LED Blinking Specifications

Nintendo DSi ¹		DS/DS Lite ¹	
		Wireless LED	Power LED
Wireless Mode	Off	Always Off	Always On ²
	On	Always On	Always On ²
During Wireless Communication	No signal output	Lit	Blinking
	During signal output	Blinking	Blinking

1. The Nintendo DSi has an LED to indicate the Wireless state; DS/DS Lite has an LED to indicate the Power state.

2. Because the DS/DS Lite does not have a wireless on/off mode, the LED status is always on.

3.6 Other Changes

3.6.1 Thinner Profile

The Nintendo DSi is thinner than the DS/DS Lite. When the DSi is closed it has a thickness of 18.9 mm, compared to 21.5 mm for the DS Lite.

3.6.2 Larger LCD Size

The LCD is larger than that of the DS/DS Lite; the size increased from 3.0 to 3.25 inches. However, there is no change in the number of dots that can be displayed.

3.6.3 GBA Slot Removed

The GBA Game Pak slot was removed. When in DS/DS Lite compatible mode (NITRO-compatible mode), a determination that no Game Pak has been inserted is made.

4 Software Changes

This section describes the major changes from the DS/DS Lite related to software and software types. For more information, see the *TWL-SDK Application Development Guide*.

4.1 Types of Software

There are three types of Nintendo DSi software. In addition to the traditional Nintendo DS/DS Lite software, two other types were added.

- Nintendo DS Software

This is the traditional DS/DS Lite software type. The only compatible application format is a Nintendo DS Card. This is called *DS software* below.

- Nintendo DSi Enhanced Software (TWL Hybrid Software)

This is software for the DS/DS Lite and the Nintendo DSi. It is compatible with the DS/DS Lite. It operates as DS software when run on a DS/DS Lite, but runs as software that can use Nintendo DSi features when run on the DSi. The compatible application formats are Game Cards and NAND applications. However, Nintendo DSi Enhanced NAND applications must be for the purposes of using the DS Download Play clone-boot feature. This is called *DSi Enhanced* software below.

- Nintendo DSi Exclusive Software (TWL Limited Software)

This is software for the Nintendo DSi. It operates only on the Nintendo DSi. The compatible application formats are Game Cards and NAND applications. This is called *DSi Exclusive* software below.

4.1.1 Compatible Hardware

Hardware compatibility depends on the software type.

Table 4-1 List of Supported Software Types

Software Type	DS/DS Lite	DSi
Nintendo DS Software	O	O ¹
DSi Enhanced Software (Card and NAND Applications) ²	O	O
DSi Exclusive Software (Card and NAND Applications)	X	O

1. Sections of software applications that use the GBA slot will not operate.

2. NAND applications do not run on DS/DS Lite systems.

4.1.2 Media Access from Applications

The media that can be accessed differs according to the application (card or NAND).

Table 4-2 Media Access According to Application Type

	Accessing Game Cards	Accessing System NAND Memory	Accessing SD Cards
Card Applications	Possible	Prohibited	Prohibited
NAND Applications	Prohibited	Possible	Prohibited in principle

Note: Accessing an SD card from a NAND application is prohibited in principle because of the security risk. However, access for debugging purposes is possible for DEBUG and RELEASE builds. For more information specific to media access, see the *Nintendo DS/TWL Programming Guidelines*.

4.2 Nintendo DS Software

This is the traditional DS/DS Lite software type. Although the portions of DS software that use the GBA slot do not run, all other portions operate the same as on a DS/DS Lite. It is also possible to identify whether the hardware is a DS or a DSi system. This is also called NITRO-ROM software.

4.3 Nintendo DSi Enhanced Software

This is software for the DS/DS Lite and the Nintendo DSi. It is compatible with the DS/DS Lite. It operates as DS software when run on a DS/DS Lite, but runs as software that can use Nintendo DSi features when run on the DSi. This is also called HYBRID ROM.

When you are developing DSi Enhanced software, consider the following with respect to supporting DS/DS Lite systems.

- Increased Labor for Testing and Debugging

Verification testing for both DS mode and DSi mode is required. In particular, you need to test and debug applications that support wireless communication for both DS mode and DSi mode.

- Requires More Memory Space than DS Software or DSi Exclusive Software

In addition to the DS/DS Lite library, ROM space for storing the DSi library is required. Furthermore, when running applications, you need RAM space to temporarily store these libraries and binary code.

- Requires Rating Information

Region information and Parental Controls settings have been added to the DSi. This protects developers and enables guardians to keep harmful information from underage users. You need to provide rating information for DSi Enhanced and DSi Exclusive software.

Be sure to consider these topics during the planning phase for Nintendo DSi Enhanced software development. When you are planning software that makes use of DSi specific features, also consider developing DSi Exclusive software.

4.3.1 Nintendo DSi Exclusive Software: Improved Features Over the DS/DS Lite

4.3.1.1 Copy Protection

The Nintendo DSi Game Card has a different structure than the DS Game Card and uses stronger copy protection. For these reasons, the DSi region on the DSi Game Card cannot be copied using the DS/DS Lite procedure.

Note: Copy protection is only performed for the portion that operates as DSi Exclusive. The portion of the code that runs as DS software is recognized as ordinary DS software on the DS/DS Lite. Illegal devices, such as modchips, recognize DS software in the same way, so there is a risk of that portion being copied as DS software.

4.3.1.2 Cameras

The onboard (built-in) cameras are used via the TWL-SDK libraries. The Camera library is capable of flipping images and configuring settings for white balance, exposure, and sharpness, as well as applying effects. Possible effects include distorting or compositing photographed images.

4.3.1.3 DSP

The system DSP is used via the TWL-SDK library. It also provides components for signal processing and image conversion. Sound effects and sound playback can be performed with the DSP library.

4.3.1.4 Memory

The main memory is 16 MB, which is four times that of the DS/DS Lite. The expanded region can be used for purposes such as the following.

- As a file cache to reduce the number of accesses to the Game Card and accelerate loading
- To permanently store more voice data in memory than for DS software for purposes such as improving sound quality or adding shouting during combat
- To secure more work memory to make smarter artificial intelligence routines
- To increase the number of images used in the VRAM main memory display
- To change 3D model animation patterns to higher precision coordinates

4.3.1.5 DMA

As with the existing DMA, the newly added DMA is also used via the TWL-SDK library. From the DMA library, fast data transfer between memories can be performed without going through the CPU.

Note: Due to the priority issues with the existing DMA, we suspect that resource management could become complicated and that the behavior and the timing on the Nintendo DS would be different. Use caution with DSi Enhanced software. See the TWL Programming Manual for more information.

4.3.1.6 Sound and Microphone

Microphone auto-sampling can now be processed by the hardware. It will be easier to implement features such as voice chat during Wi-Fi communication, because the combined processing load is less than before.

4.3.1.7 Graphics

By making the VRAM bus width 32 bits, a slight increase in speed can be expected. Also, enabling the writing of 1-byte units makes it easier to write to VRAM.

4.3.1.8 Wireless Communication

The new DSi wireless module accelerates communication speed, decreases power consumption, and supports the more secure WPA and WPA2 wireless protocols. Because WPA/WPA2 is supported, we recommend using DSi Enhanced software if using Wi-Fi.

The majority of processing related to wireless communication can be handled by the DSi library, so there is no need to prepare a special program for Nintendo DSi Wi-Fi applications.

Wi-Fi supported titles can operate as before on DS/DS Lite and use the newly added wireless features on DSi systems. See section 3.5 Wireless Communication for more information.

4.4 Nintendo DSi Exclusive Software

This is software that operates only on the Nintendo DSi. It is also called LIMITED-ROM software.

Note: When Nintendo DSi Exclusive software is sold as a Nintendo DSiWare download, it is basically a NAND application. Contact Nintendo if you want to develop it as a card application.

4.5 NAND Application Proprietary Features

Because NAND applications can be saved in the Nintendo DSi system NAND memory, there are several proprietary features not available for card applications.

- The banner icon from the application can be changed using the sub-banner feature.
- The internal fonts stored in the system can be used as the application font.
- For NAND applications sold by the same publisher (same company code), save data can be read from or written to by another NAND application.
- JPEG images can be shared between NAND applications using a structure called the photograph database.

Note: Software size is limited to 16 MB as a maximum, including the save data region and manuals. Furthermore, there is no support for distributing additional data. Only the download feature (TWL-DWC-DL) is available with the Nintendo Wi-Fi Connection. Contact Nintendo for more information on operational rules or capacity restrictions related to Nintendo DSiWare planning and development.

5 Development Environment

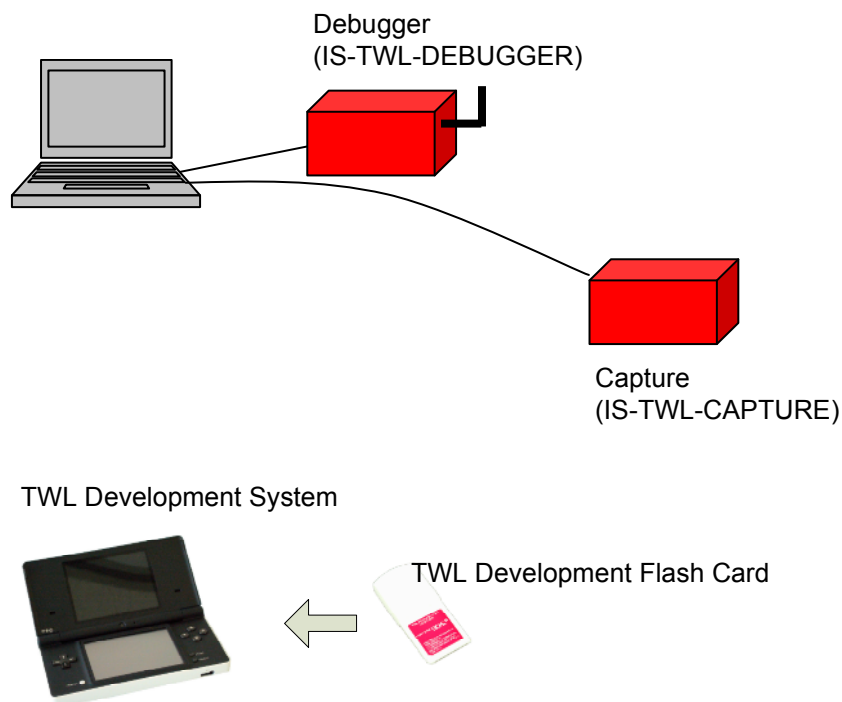
This section describes the Nintendo DSi development environment.

Note: The Nintendo DSi development environment is compatible with DS/DS Lite, and it is possible to utilize your software environment created for DS/DS Lite development. See the *TWL-SDK Migration Guide* for additional information on migration.

5.1 Hardware Configuration

This section presents the hardware configuration connection diagrams for the development tools.

Figure 5-1 Development Tools Connection Diagram



5.1.1 IS-TWL-DEBUGGER

This is the hardware and debugger software for TWL program development. Because this is for the Nintendo DSi, the hardware has no GBA slot. (DS software that does not use the GBA slot can also be developed.)

The development hardware is similar to the IS-NITRO-EMULATOR for the DS/DS Lite, but the wireless communication feature is standard.

Note: The Wired Communication option is sold separately. Contact Nintendo for more information.

Figure 5-2 IS-TWL-DEBUGGER

5.1.2 IS-TWL-CAPTURE

This is the hardware and capture software to output the DSi screen to a PC or TV. There are two types: A development version that can use DSi development flash cards and a commercial-device version that can use commercial game cards.

The development hardware is the same as IS-NITRO-CAPTURE for the DS/DS Lite, but the wireless communication feature is standard.

Figure 5-3 IS-TWL-CAPTURE

5.1.3 TWL Test Unit / TWL Flash Card

This is a commercial device and flash card for Nintendo DSi development. Because the flash card used for Nintendo DSi and DS development does not operate on a commercial Nintendo DSi, a TWL Test Unit is required.

Note: Non-standard ROMs using illegal devices such as the various “homebrew devices” do not operate on Nintendo DSi retail units, excluding existing DS/DS Lite software that operates in NITRO compatible mode. Also, commercial Nintendo DSi software does not operate on a TWL Test Unit.

Figure 5-4 TWL Test Unit / TWL Flash Card

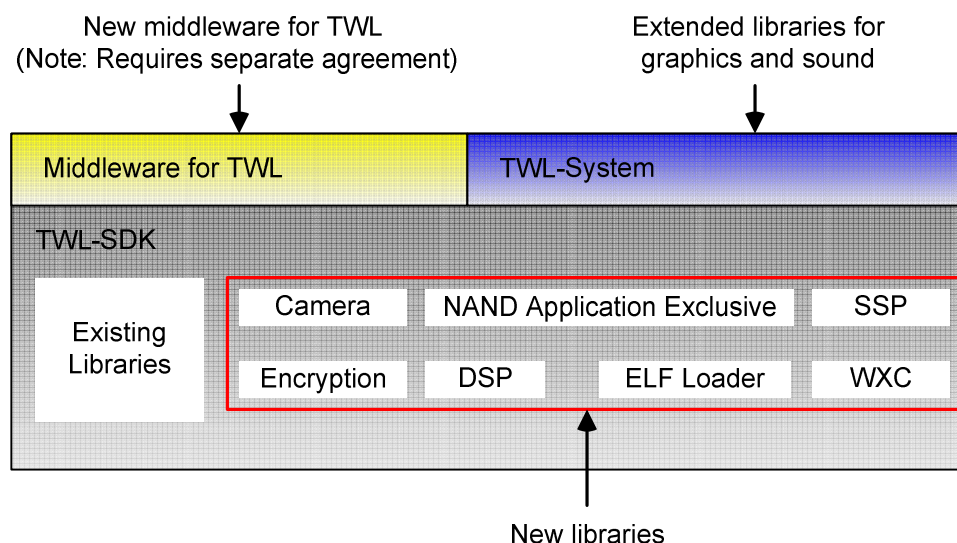


5.1.4 Flash Writer

The DS/DS Lite writer (IS-NITRO-WRITER) can be converted, for a fee, to write to TWL flash cards. Contact Nintendo for more information.

5.2 Software Configuration

This section presents the hierarchical structure of the libraries and middleware as configured by the software.

Figure 5-5 Hierarchical Structure of Libraries and Middleware

5.2.1 Compiler

The newly available CodeWarrior for Nintendo DSi integrates support for TWL-SDK features. You can also develop DS/DS Lite software.

5.2.2 TWL-SDK

The newly offered TWL-SDK is an upgrade from the NITRO-SDK. A TWL-SDK version is now available for all NITRO-SDK libraries. The TWL-SDK can also be used to develop DS/DS Lite software.

Note: In the future, the NITRO-SDK will no longer be available and support for it will end. All features will be integrated into the TWL-SDK.

5.2.3 TWL-System

This is the extended library for graphics and sound that is located on top of the TWL-SDK. NITRO-System has been renamed to TWL-System, but the two basically have the same content. It has also been updated for the TWL-SDK.

5.2.4 Middleware for TWL

This is new middleware for TWL that is located on top of the TWL-SDK. Separate agreements are required.

- Face Recognition
- Speech Converter (changes sound playback speed and pitch)

Note: Contact Nintendo if you would like to enter into an agreement.

6 Additional Documents to Read

Finally, we would like to introduce some documents you should review after reading this document.

Each of these documents is in the TWL-SDK package. The path is indicated next to the document name.

For those migrating projects to the Nintendo DSi development environment

- *TWL-SDK Migration Guide* (`docs/TechnicalNotes/AboutNitroToTwl.pdf`)

This provides information for NITRO-SDK developers who are migrating projects to the TWL-SDK development environment.

For those who want to know how to incorporate and use the TWL-SDK

- *Quick Start Guide* (`docs/README/QuickStartForSDK.pdf`)

This describes TWL-SDK installation procedures and how to create applications. You can learn basic operations by running the sample programs.

- *TWL-SDK Application Development Guidelines* (`docs/TechnicalNotes/AboutTwlApplication.pdf`)

This describes content related to the TWL-SDK. More information about the differences from the NITRO-SDK is included.

In addition, see the function reference (in the `man` directory), the programming manual (programming manual package), and the various guidelines (in each guideline package).

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