



# **Intel® Platform Innovation Framework for EFI Compatibility Support Module Specification**

Revision 0.96  
April 18, 2006

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Intel order number: D56958-001

# Revision History

| Revision | Revision History  | Date    |
|----------|---|---------|
| 0.9      | First public release.   | 9/16/03 |
| 0.91     | <ul style="list-style-type: none"> <li>Added PciExpressBase parameter to EFI_COMPATIBILITY16_TABLE.</li> <li>Renamed GetOemInt15Data to GetOemIntData and expanded it to support any software INT.</li> <li>Modified PrepareToBootEfi to return BBS table. BBS Table updated to return AssignedDriveNumber.</li> <li>Added GetTpmBinary.</li> <li>Combined several LegacyBiosPlatform APIs into three APIs. Updated BBS_TABLE and EFI_COMPATIBILITY16_TABLE.</li> </ul>   | 2/01/05 |
| 0.95     | <ul style="list-style-type: none"> <li>Added following modes to EFI_LEGACY_BIOS_PLATFORM_PROTOCOL.GetPlatformInfo()</li> <li>EfiGetPlatformPciPmmSize</li> <li>EfiGetPlatformEndRomShadowaddr</li> <li>SMM_ENTRY clarification added 3/01/05</li> <li>Re-added elements to EFI_COMPATIBILITY16_TABLE that inadvertently go dropped.</li> </ul>  | 4/22/05 |
| 0.96     | <ul style="list-style-type: none"> <li>Modified EFI_IA32_REGISTER_SET structure definition to support 32bit register across Thunk interface</li> <li>Modified some field definitions in EFI_COMPATIBILITY16_TABLE and EFI_COMPATIBILITY16_BOOT_TABLE structures to ensure that the space occupied by these structures in IA32 and x64 architecture is identical.</li> <li>Reintroduced the BiosLessThan1MB field in EFI_TO_COMPATIBILITY16_INIT_TABLE to maintain compatibility with previous versions of the specification. Added the LowPmmMemory and LowPmmMemorySizeInBytes fields at the end of EFI_TO_COMPATIBILITY16_INIT_TABLE.</li> <li>Modified EFI_WORD_REGS, EFI_DWORD_REGS, and EFI_EFLAGS_REG structure definitions to make these structures identical to those used in Legacy Soft SMI so that same structures can be used in Thunk as well as in Legacy Soft SMI.</li> <li>Changed the output parameter definition in EFI_LEGACY_BIOS_PROTOCOL.GetLegacyRegion() to match the implemented code.</li> <li>Added two more allowed values HDD_MASTER_ATAPI_ZIPDISK and HDD_SLAVE_ATAPI_ZIPDISK in the Status field of HDD_INFO to include support for ZIP disk.</li> <li>Editing and formatting pass.</li> </ul> | 4/18/06 |



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## 1.1 Overview

This specification describes the high-level design of the Compatibility Support Module (CSM) code that is required for an implementation of the Intel® Platform Innovation Framework for EFI (hereafter referred to as the "Framework"). The CSM provides compatibility support between the Framework and traditional, legacy BIOS code and allows booting a traditional OS or booting an EFI OS off a device that requires a traditional option ROM (OpROM). This specification does the following:

- Describes the basic components of the CSM
- Defines how to use traditional BIOS option ROMs (OpROMs) to boot an EFI operating system (OS)
- Defines how to boot a traditional OS
- Provides code definitions for compatibility-related services, protocols, functions, and type definitions that are architecturally required by the *Intel® Platform Innovation Framework for EFI Architecture Specification*

## 1.2 Scope

This document describes the high-level design of the Compatibility Support Module (CSM) code developed for the Intel® Platform Innovation Framework for EFI (hereafter referred to as "the Framework"). This document will define how to do the following:

- Use traditional BIOS option ROMs (OpROMs) to boot an EFI Operating System (OS)
- How to boot a traditional OS

This document's primary focus is how to bind EFI and compatibility support code together. It does not define internal details of the CSM design

## 1.3 Rationale

There is always a transitional period between the introduction of a new technology and the technology that it replaces. The addition of compatibility support code to EFI bridges this transitional period. The compatibility support code allows booting a traditional OS or booting an EFI OS off a device that requires a traditional OpROM.



## 2.1 Definitions of Terms

The following definitions, except where noted, are not EFI specific. See the master Framework glossary for definitions of other Framework terms; see “Typographic Conventions” later in this section for the URL.

### **16-bit legacy**

The traditional PC environment and includes traditional OpROMs and Compatibility16 code.

### **Compatibility16**

The traditional BIOS with POST and BIOS Setup removed. Executes in 16-bit real mode.

### **CompatibilitySmm**

Any IBV-provided SMM code to perform traditional functions that are not provided by EFI.

### **CSM**

Compatibility Support Module. The combination of EfiCompatibility, CompatibilitySmm, and Compatibility16.

### **EfiCompatibility**

32-bit EFI code to generate data for traditional BIOS interfaces or EFI Compatibility Support Module drivers, or code to invoke traditional BIOS services.

### **IBV**

Independent BIOS vendor.

### **NV**

Nonvolatile.

### **OpROM**

Option ROM.

### **PIC**

Programmable Interrupt Controller.

### **PMM**

Post Memory Manager.

### **reverse thunk**

The code to transition from 16-bit real mode to native execution mode and back.

### **SMM**

System Management Mode.

### **thunk**

The code to transition from native execution mode to 16-bit real mode and back.

### **traditional OpROM**

16-bit OpROMs that are executed in real mode.

## **2.2 CSM-Specific References**

The following reference is useful for implementing CSM code. See References in the master help system for additional related specifications.

- IBM Personal System/2 and Personal Computer BIOS Interface Technical Reference. Second edition. IBM Corporation, IBM No. S68X-2341-00, 1988.

## **2.3 CSM Overview**

### **2.3.1 Legacy Overview**

This document describes the additional EfiCompatibility functionality (over the standard EFI) that is provided to support traditional BIOS (non-EFI) OSs and/or traditional OpROMs. This functionality along with the associated IBV Compatibility16 and CompatibilitySmm code is called the *Compatibility Support Module (CSM)*.

It is expected that traditional OpROM support will be required longer than traditional OS support. The figure below presents a block-diagram-level overview of how a legacy system operates using the CSM.

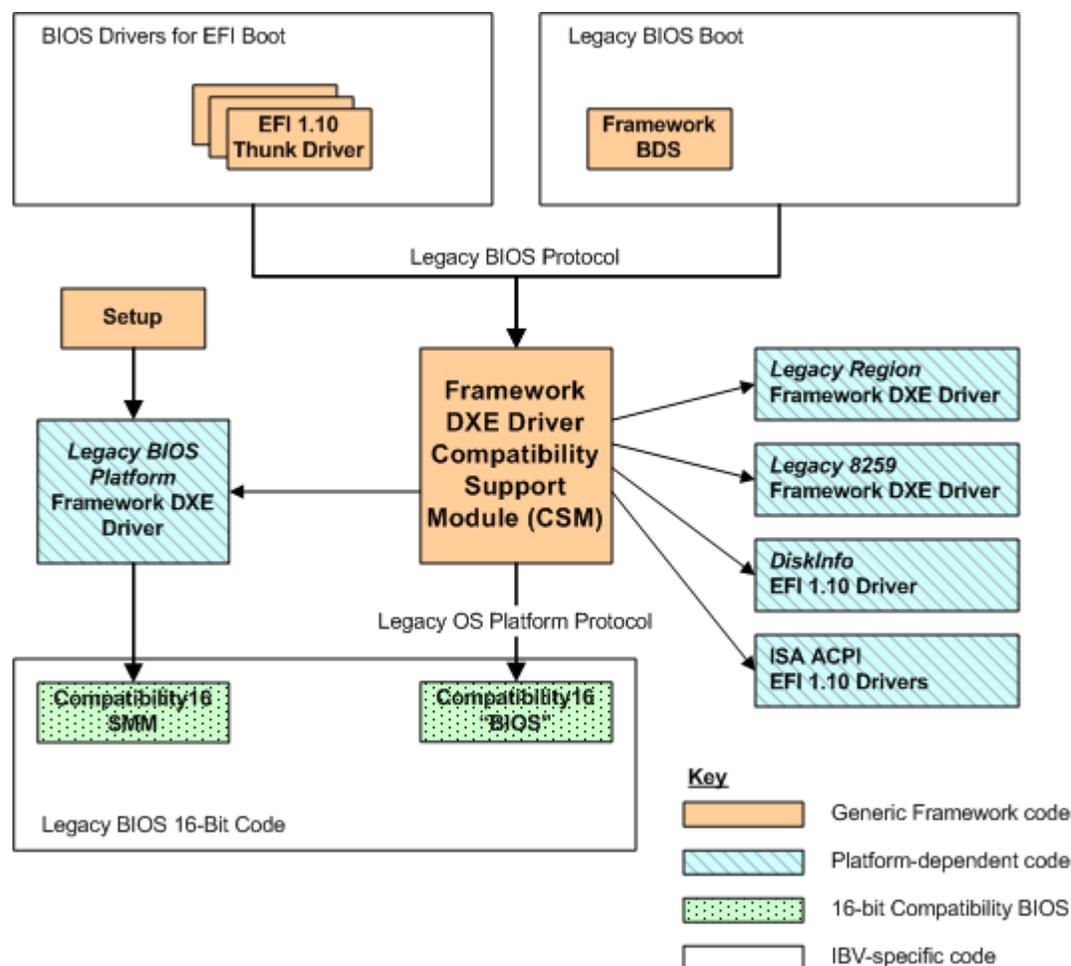


Figure 1 Compatibility Overview

## 2.3.2 Differences between Traditional BIOS and EFI

An EFI system differs from the traditional BIOS POST in that only minimal system configuration takes place until the Boot Device Selection (BDS) phase (equivalent to traditional POST INT19). Video is not required until the BDS phase, nor are other OpROMs dispatched until the BDS phase. Likewise, BIOS Setup is entered from the BDS phase. These differences place the policy to invoke (or not invoke) the CSM in BDS and make this policy an integral part of BDS.

The policy is predominately set by the following three classes of information: OS being booted, boot drive selection, and Device OpROM selection.

### 2.3.2.1 OS Being Booted

The selection of booting a traditional (non-EFI-aware) OS dictates that any OpROM being dispatched must be a traditional OpROM rather than an EFI OpROM. This requirement means that the CSM code must be activated and invoked.

### 2.3.2.2 Boot Device Selection

A boot device that has only a traditional OpROM associated with it requires the CSM code to be activated and invoked.

### 2.3.2.3 Device OpROM Selection

A BDS policy to initialize all devices might require the CSM code to be activated and invoked when a non-boot device has only a traditional OpROM associated with it.

### 2.3.3 BDS Legacy Flow

The figure below is a flowchart showing the decisions and operations that take place during BDS in a legacy environment.

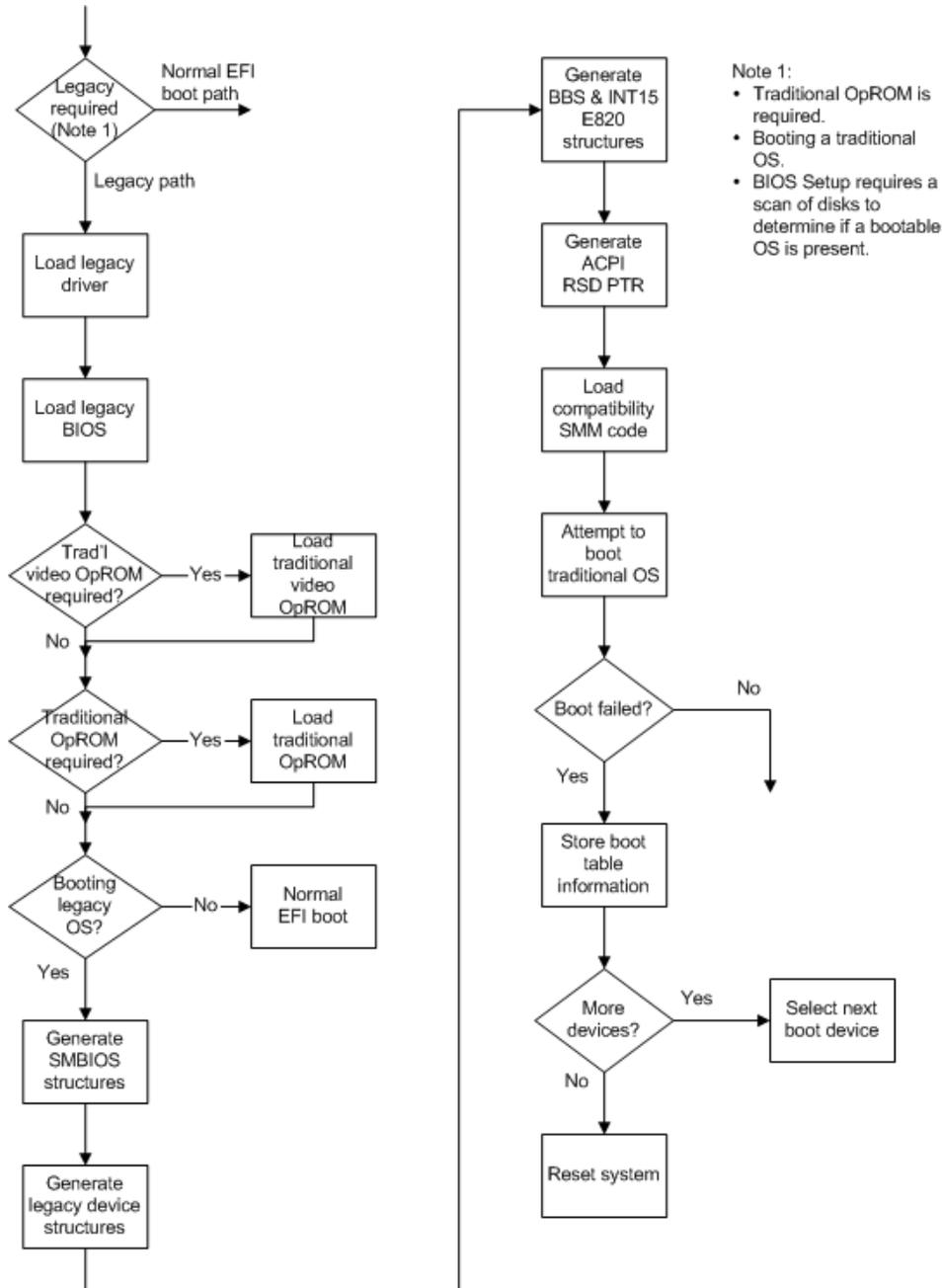


Figure 2 BDS Legacy Flow

## 2.3.4 Components of CSM

The CSM code consists of the following six main components or functional areas:

- **EFI Compatibility Support Module initialization code:** A set of modules to initialize the CSM data structures and the traditional Post Memory Manager (PMM).
- **Dispatching traditional OpROMs:** A set of EfiCompatibility drivers to simulate traditional INTs, and code to place traditional OpROMs within the traditional OpROM memory region and invoke the OpROMs.
- **Translating traditional devices into CSM structures and updating traditional tables:** A set of Compatibility16 functions to extract data from EFI and then convert the extracted data into standard Compatibility16 data structures.
- **Booting the OS:** A set of EfiCompatibility procedures to boot a traditional OS or boot an EFI-aware OS off a device controller by using a traditional OpROM.
- **Thunk and reverse thunk code:** There are two flavors of the thunk code; Far call and Interrupt (INT). Both of these internally are assembly-based calls rather than C-based calls but externally are C-based. The *thunk* provides a mechanism to transfer control from EFI to 16-bit traditional code and return to EFI after completion. The *reverse thunk* provides a mechanism to transfer from 16-bit traditional code to 32-bit EFI code and return after completion. It is expected that the reverse thunk will be invoked only in exceptional conditions.
- **Runtime traditional code provided by an IBV:** Consists of the following:
  - The Compatibility16 runtime code
  - Traditional SMM code residing with EFI SMM code
  - EfiCompatibility platform protocol internals

## 2.4 CSM Architecture

### 2.4.1 Overview

The CSM provides additional functionality to EFI. This additional functionality permits the loading of a traditional OS or the use of a traditional OpROM. This new functionality requires the following:

- New 32-bit code that operates in the EFI environment (EfiCompatibility)
- A stripped-down traditional 16-bit real-mode BIOS (Compatibility16)
- Code to transition between the 32-bit and 16-bit code (thunk and reverse thunk)
- Optionally code in SMM (CompatibilitySmm) to perform traditional functions not taken over by EFI SMM

Outside this additional functionality are the traditional OpROMs, regardless if they reside onboard or offboard.

Several pieces of code make up the CSM, as listed in the table below.

**Table 1 Components of CSM**

| Component                      | Description   |
|--------------------------------|---|
| <u>EfiCompatibility</u>        | <p>32-bit code that interfaces with EFI. EfiCompatibility is comprised of several EFI drivers. These drivers fall into the following four categories:</p> <ul style="list-style-type: none"> <li>• Drivers that are platform and hardware neutral. They provide the foundation of the CSM and do not change from platform to platform.</li> <li>• Drivers that are platform and chipset neutral. They control traditional hardware such as the 8259 PIC.</li> <li>• Drivers that are chipset dependant. They control chipset hardware that changes from platform to platform. An example is the code to perform PCI IRQ steering.</li> <li>• Drivers that are platform specific.</li> </ul> |
| <u>Compatibility16</u>         | Stripped-down, traditional IBV, 16-bit real-mode code consisting mainly of the traditional software INT runtime support.  |
| <u>CompatibilitySmm</u>        | Optional code in SMM to perform traditional functions that are not taken over by the EFI SMM.   |
| <u>Thunk and Reverse Thunk</u> | Thunk code is used to switch from EfiCompatibility (32-bit) to Compatibility16 or traditional OpROMs (16-bit). Reverse thunk code is used to switch from Compatibility16 code or traditional OpROMs (16-bit) to EfiCompatibility (32-bit).  |

Outside the CSM, but still part of a traditional system, are the traditional 16-bit real-mode OpROMs. The CSM operates in two distinct environments:

- Booting a traditional or non-EFI-aware OS.
- Loading an EFI-aware OS a device that is controlled by a traditional OpROM.

The first operation, booting a traditional or non-EFI-aware OS, is the traditional environment.

It is expected that traditional OpROMs will be around long after traditional OSs have been replaced by EFI-aware OSs. The code that is required to load an EFI-aware OS is a subset of the code that is required to boot a traditional (non-EFI-aware) OS. The Framework architecture reflects this split to allow removing unneeded code in the future.

See Steps in CSM Driver Interactions for additional details on how the various CSM components interconnect with each other and how external drivers interconnect with the CSM.

## 2.4.2 EfiCompatibility

The EfiCompatibility consists of the protocols listed in the table below. This EfiCompatibility code is written in C and exists in the EFI environment.

**Table 2 EfiCompatibility Protocols**

| Protocol                                      | Description   |
|---|---|
| <a href="#">Legacy BIOS Protocol</a>          | The primary protocol of the CSM. This protocol is platform and hardware neutral.  |
| <a href="#">Legacy BIOS Platform Protocol</a> | Provides the information that makes this platform unique compared to another platform using the same chipset. This protocol is platform specific.   |
| <a href="#">Legacy Region Protocol</a>        | Manages the hardware that allows the region from physical address 0xC0000 to 0xFFFFF to be made read only or read-write. It can optionally manage the hardware that prevents a write in the above region propagating to any aliased memory regions This protocol is chipset specific. |
| <a href="#">Legacy 8259 Protocol</a>          | Manages the hardware controlling the 8259 PIC in 32-bit protected mode and in 16-bit real mode. It keeps track of the interrupt masks and edge/level programming for both modes. This protocol is platform and chipset neutral.   |
| <a href="#">Legacy Interrupt Protocol</a>     | Manages the hardware for assigning IRQs to PCI. EFI is polled rather than interrupt driven. This protocol is chipset specific.  |

Each of the above protocols is described in more detail in the following sections. See [EfiCompatibility Code](#) in [Code Definitions](#) for the definitions of these protocols.

## 2.4.2.1 Legacy BIOS Protocol

### 2.4.2.1.1 LegacyBios Module

The LegacyBios module constitutes the CSM skeleton. The other CSM modules are support modules. The LegacyBios initialization code consists of the following elements:

- Code to initialize itself and to load the Compatibility16 code
- Code to determine the boot device
- Code to load other EfiCompatibility drivers
- Code to load the thunk and reverse thunk code
- Code to interface with Compatibility16 functions
- Code to load and invoke traditional OpROMs, including code to find baseboard traditional OpROMs and to load them
- Code to load a traditional OS

The BDS code, as part of its normal functions, binds a device with a traditional OpROM, but it uses the LegacyBios code to dispatch and initialize the traditional OpROM. The BDS code also generates the various boot device paths, but it uses the LegacyBios code to boot to a traditional OS. The LegacyBios code that is used to boot a traditional OS performs the following actions:

- Extracts EFI data into standard EfiCompatibility structures
- Updates standard BDS, EBDA, and CMOS locations
- Updates hardware with traditional resources (IRQs)

The LegacyBios code parses the data hub or invokes EFI APIs to gather data that is required by Compatibility16 and translates it into a series of standard Compatibility16 data structures. That data is used to update standard traditional data values in the BDA, EBDA, and CMOS. The data is also used by Legacy BIOS Protocol APIs to reprogram traditional devices to traditional resources.

Compatibility16 does not configure low-level device hardware and instead leaves that operation to EFI. EFI does not assign IRQs to devices such as serial ports, but Compatibility16 requires them to be configured with the appropriate IRQs. The LegacyBios code must reconfigure any traditional devices that were configured by EFI into a valid Compatibility16 configuration.

It is expected that there will be a light and full version of the Legacy BIOS Protocol. The light version is for environments where the OS is always an EFI-aware OS that might have traditional OpROMS. The full version is for environments where a traditional OS might be invoked.

#### 2.4.2.1.2 Legacy BIOS Protocol

The [Legacy BIOS Protocol](#), along with the initialization of the LegacyBios driver, provides the foundation of the CSM code. The table below lists the functions that are included in the Legacy BIOS Protocol. See **EFI\_LEGACY\_BIOS\_PROTOCOL** in [Code Definitions](#) for the definitions of these functions.

**Table 3 Functions in Legacy BIOS Protocol**

| Functions                                  | Description   |
|--|---|
| <a href="#">BootUnconventionalDevice()</a> | Allows the user to boot off of an unconventional device such as a PARTIES partition.  |
| <a href="#">CheckPciRom()</a>              | Checks if a device has a traditional OpROM associated with it. It is used to determine valid traditional OS boot devices, or if a traditional OpROM exists for a device that has no EFI OpROM support.  |
| <a href="#">CopyLegacyRegion()</a>         | Allows EFI to copy data to the area specified by <b>GetLegacyRegion()</b> . It may be invoked multiple times. This function performs boundary checking via information passed into <b>GetLegacyRegion()</b> .   |
| <a href="#">FarCall86()</a>                | Allows the 32-bit protected-mode code to perform a far call to 16-bit real-mode code. It is analogous to the <b>Int86()</b> function, but a far call is patched instead.  |
| <a href="#">GetBbsInfo()</a>               | Allows external drivers to access the internal EfiCompatibility BBS data structures. This function is normally used by BIOS Setup.  |
| <a href="#">GetLegacyRegion()</a>          | Allows EFI to reserve an area in the 0xE0000 or 0xF0000 block. This function may be invoked only once.  |
| <a href="#">Int86()</a>                    | Allows the 32-bit protected-mode code to perform a traditional 16-bit real-mode software interrupt. The function invokes the thunk code to switch to 16-bit real mode, patches an INT instruction with the required software interrupt, loads the IA-32 registers from data in the passed-in register file, and issues the software interrupt. Upon completion of the interrupt, it updates the register file and switches back to 32-bit protected mode. |
| <a href="#">InstallPciRom()</a>            | Installs a traditional OpROM in the 0xC0000 to 0xFFFFF region.  |

|                                  |   |
|----------------------------------|---|
| <u>LegacyBoot()</u>              | Initiates booting from a traditional OS. The majority of the CSM work is done within this function, because the final commitment to boot from a traditional OS has been made and the boot process will destroy EFI code. This function returns to the caller only in the exceptional condition in which a traditional INT19 failed but control was never passed to an OS first-stage loader. If control was ever passed to an OS first-stage loader, then the Compatibility16 code must issue a reset, because memory may have been written over and EFI corrupted. |
| <u>PrepareToBootEfi()</u>        | Allows an external agent to prepare for booting to an EFI-aware OS. It is a subset of actions taken by <b>LegacyBoot()</b> . It causes legacy drive numbers to be assigned.   |
| <u>ShadowAllLegacyOproms()</u>   | Allows an external agent to force the loading of legacy OpROMs. A side effect of this function is that all EFI drivers are disconnected and must be reconnected for proper EFI functioning.   |
| <u>UpdateKeyboardLedStatus()</u> | Allows the EfiCompatibility code to synchronize the traditional BIOS BDA with the state that EFI has programmed the keyboard LEDs. This function does not touch hardware. The Compatibility16 code is invoked with the state of the LEDs in case any proprietary information needs to be updated.   |

### 2.4.2.1.3 GetBbsInfo(), LegacyBoot(), ShadowAllLegacyOproms(), and PrepareToBootEfi()

BDS and BIOS Setup require certain information to intelligently determine boot devices and require different actions to occur depending upon the type of OS being booted.

- Determining what boot devices are available:** Both BDS and BIOS Setup need to know the complete list of boot devices to present a comprehensive list to the user. It is possible that a device controller by both an EFI and legacy OpROM may report different results. EFI drivers generate a list of boot devices and then the **EFI\_LEGACY\_BIOS\_PROTOCOL.ShadowAllLegacyOproms()** call is issued. The internal CSM BBS table information is updated during the OpROM initializations. The **EFI\_LEGACY\_BIOS\_PROTOCOL.ShadowAllLegacyOproms()** function will disconnect all EFI devices so a reconnect must be performed after the invocation. **EFI\_LEGACY\_BIOS\_PROTOCOL.GetBbsInfo()** returns the list of legacy boot devices that were discovered. Note that at this time no legacy drive numbers 0x8y have been assigned because the Compatibility16 code has not been issued the **EFI\_LEGACY\_BIOS\_PROTOCOL.PrepareToBootEfi()** function.
- Determining the boot OS type:** Once the list of boot devices is available, the user selects the boot device. If booting to a traditional OS, BDS issues the **EFI\_LEGACY\_BIOS\_PROTOCOL.LegacyBoot()** function. If booting to an EFI-aware OS and any legacy OpROMs have been initialized, then **EFI\_LEGACY\_BIOS\_PROTOCOL.PrepareToBootEfi()** is issued.

### 2.4.2.2 Legacy BIOS Platform Protocol

The Legacy BIOS Platform Protocol provides the customization of CSM for both platform configuration and for OEM differentiation. The table below lists the functions that are included in the

Legacy BIOS Platform Protocol. See [EFI\\_LEGACY\\_BIOS\\_PLATFORM\\_PROTOCOL](#) in [Code Definitions](#) for the definitions of these functions.

**Table 4 Functions in the Legacy BIOS Platform Protocol**

| Function                            | Description  |
|-------------------------------------|--|
| <a href="#">GetPlatformHandle()</a> | Finds all handles for the requested entity and returns them sorted by priority. Handle[0] is highest priority.   |
| <a href="#">GetPlatformInfo()</a>   | Used to return binary objects or various pieces of data..  |
| <a href="#">GetRoutingTable()</a>   | Serves two purposes; it is used for PCI PIRQ routing and for \$PIR table information.  |
| <a href="#">PlatformHooks()</a>     | Any required hook after a CSM operation.   |
| <a href="#">PrepareToBoot()</a>     | Allows any final processing to take place before booting a traditional OS.   |
| <a href="#">SmmInit()</a>           | Finds any CompatibilitySmm modules that exist in EFI firmware volumes and registers them with the EFI SMM driver. The number of CompatibilitySmm modules can be zero or greater. There is no maximum number. |
| <a href="#">TranslatePirq()</a>     | Translates the PIRQ reported by the PCI device back through the bridges into the equivalent root PIRQ.   |

### 2.4.2.3 Legacy Region Protocol

The [Legacy Region Protocol](#) controls the read-write attributes for the region 0xC0000 to 0xFFFFF. The table below lists the functions that are included in the Legacy Region Protocol. See [EFI\\_LEGACY\\_REGION\\_PROTOCOL](#) in [Code Definitions](#) for the definitions of these functions.

**Table 5 Functions in Legacy Region Protocol**

| Function                   | Description   |
|----------------------------|---|
| <a href="#">Decode()</a>   | Programs the chipset to decode or not decode regions in the 0xC0000 to 0xFFFFF range. The default is to decode entire range.  |
| <a href="#">Lock()</a>     | Programs the chipset to lock (write protect) regions in the 0xC0000 to 0xFFFFF range.   |
| <a href="#">BootLock()</a> | Programs the chipset to lock (write protect) regions in the 0xC0000 to 0xFFFFF range and is invoked just prior to booting a traditional OS. In addition, it ensures that a write to the region does not cause a write at any aliased addresses. |
| <a href="#">Unlock()</a>   | Programs the chipset to unlock (read-write) regions in the 0xC0000 to 0xFFFFF range. In addition, it ensures that a write to the region does not cause a write at any aliased addresses.  |

## 2.4.2.4 Legacy 8259 Protocol

The Legacy 8259 Protocol controls the programming of the 8259 PIC in both the EFI (32-bit protected) environment and legacy (16-bit real-mode) environment. The table below lists the functions that are included in the Legacy 8259 Protocol. See **EFI\_LEGACY\_8259\_PROTOCOL** in Code Definitions for the definitions of these functions.

**Table 6 Functions in Legacy 8259 Protocol**

| Functions                 | Description   |
|---------------------------|---|
| <u>SetVectorBase()</u>    | Sets the vector base for the 8259 PIC. In the EFI environment, the base is set to 0x1A0 (INT68) for master and 0x1C0 (INT70) for slave PIC. In the legacy environment, the base is set to 0x20 (INT08) for master and 0x1C0 (INT70) for slave PIC. The different master PIC address for EFI prevents the overlaying of interrupts and processor exceptions. |
| <u>GetMask()</u>          | Gets the current settings of the master and slave interrupt mask and/or the edge/level register programming. The caller can specify EFI and/or legacy environment.  |
| <u>SetMask()</u>          | Sets the current settings of the master and slave interrupt mask and/or the edge/level register programming. The caller can specify EFI and/or legacy environment.  |
| <u>SetMode()</u>          | Sets the current mode (EFI or legacy) and settings of the master and slave interrupt mask and/or the edge/level register programming. This function should not be invoked multiple times in the same mode. Use the <b>SetMask( )</b> function instead.  |
| <u>GetVector()</u>        | Translates an IRQ into an INT. For example, IRQ0 is INT68 for the EFI environment and INT08 for the legacy environment.   |
| <u>EnableIrq()</u>        | Enables an interrupt in the EFI environment. Non-CSM drivers normally use this function.  |
| <u>DisableIrq()</u>       | Disables an interrupt in the EFI environment. Non-CSM drivers normally use this function.   |
| <u>GetInterruptLine()</u> | Returns the IRQ assigned to the specified PCI device.   |
| <u>EndOfInterrupt()</u>   | Generates an End of Interrupt (EOI) command for the specified IRQ.  |

### 2.4.2.5 Legacy Interrupt Protocol

The [Legacy Interrupt Protocol](#) manages the programming of PCI interrupts. The table below lists the functions that are included in the Legacy Interrupt Protocol. See [EFI\\_LEGACY\\_INTERRUPT\\_PROTOCOL](#) in [Code Definitions](#) for the definitions of these functions.

**Table 7 Functions in Legacy Interrupt Protocol**

| Functions                        | Description   |
|----------------------------------|---|
| <a href="#">GetNumberPirqs()</a> | Returns the number of PIRQs that the chipset supports.                                  |
| <a href="#">GetLocation()</a>    | Returns the PCI bus location of the chipset. The \$PIR table requires this information. |
| <a href="#">ReadPirq()</a>       | Reads the current PIRQ contents for the indicated PIRQ.                                 |
| <a href="#">WritePirq()</a>      | Writes the current PIRQ contents for the indicated PIRQ.                                |

### 2.4.3 Compatibility16

The Compatibility16 code is a stripped-down version of a traditional BIOS that removes the POST and BIOS Setup code. This stripped-down BIOS consists of the following:

- Runtime code
- INT18 code
- INT19 code
- A small piece of new code to handle the interface between EfiCompatibility code and Compatibility16 code

The design goal is to have the Compatibility16 code be universal for each class of platforms. Examples are desktop, server, and mobile platforms. This goal implies that the Compatibility16 code is chipset and platform neutral. It controls hardware through traditional hardware interfaces and leaves the chipset programming to EFI and/or EfiCompatibility. This design goal maximizes reusability and minimizes code bugs.

#### 2.4.3.1 Communication between EfiCompatibility and Compatibility16

The communication between EfiCompatibility modules and Compatibility16 occurs using the following three mechanisms:

- Compatibility16 Table
- Compatibility16 Functions
- Compatibility16 Function Data Structures

The following sections discuss these mechanisms in more detail. See [Compatibility16 Code](#) in [Code Definitions](#) for definitions of these functions and structures.

### 2.4.3.1.1 Compatibility16 Table

There is a new table, **EFI\_COMPATIBILITY16\_TABLE**, introduced to the traditional legacy runtime BIOS for CSM support. This table is on a 16-byte boundary and has a signature of “\$EFI” when read as a DWORD. The Compatibility16 code has a default table generated at build time. The most important fields are the *Compatibility16CallSegment:Offset*. EfiCompatibility uses this address to issue Compatibility16 Functions. The appropriate side fills in the other fields during normal CSM operation.

### 2.4.3.1.2 Compatibility16 Functions

These functions allow the EfiCompatibility code to communicate with the Compatibility16 code and are an addition to the traditional BIOS runtime code.

These functions provide the platform-specific information that is required by the generic EfiCompatibility code. The functions are invoked via thunking by using **EFI\_LEGACY\_BIOS\_PROTOCOL.FarCall186()** with the 32-bit physical entry point **EFI\_COMPATIBILITY16\_TABLE**.

The table below lists the Compatibility16 functions that are available.

**Table 8 Compatibility16 Functions**

| Functions                                      | Description   |
|--|---|
| <u>Compatibility16InitializeYourself()</u>     | The first function that is invoked and allows the Compatibility16 code to do any initialization. Because EFI performs the equivalent of POST, this invocation is the first time the Compatibility16 code gets control. The region from 0xE0000 to 0xFFFFF is read/write.  |
| <u>Compatibility16UpdateBbs()</u>              | Allows the Compatibility16 code to update the CSM's BBS data structures for any OpROM that hooked INT13, INT18, or INT19. The region from 0xE0000 to 0xFFFFF is read-write.   |
| <u>Compatibility16PrepareToBoot()</u>          | Allows the Compatibility16 code to do any last minute cleanup or bookkeeping prior to booting a traditional OS. The region from 0xE0000 to 0xFFFFF is read-write.   |
| <u>Compatibility16Boot()</u>                   | The last function invoked prior to booting a traditional OS. The region from 0xE0000 to 0xFFFFF is write protected.   |
| <u>Compatibility16RetrieveLastBootDevice()</u> | Retrieves the last boot device priority number. This number allows the CSM to determine the boot device when multiple boot devices exist. The region from 0xE0000 to 0xFFFFF is write protected.  |
| <u>Compatibility16DispatchOprom()</u>          | Passes control to the OpROM initialization address under Compatibility16 control. This address allows the Compatibility16 code to re-hook INT13, INT18, and/or INT19 for non-BBS-compliant OpROMs. The region from 0xE0000 to 0xFFFFF is write protected.<br><br><b>Note:</b> If the platform allows OpROMs to be placed in the 0xExxxx region, then that region is read/write. |

|   |  |
|---|--|
| <u>Compatibility16GetTableAddress()</u>   | Asks the Compatibility16 to allocate an area of the indicated size in the 0xE0000–0xFFFFF region. The EfiCompatibility code then copies data into that region. The region from 0xE0000 to 0xFFFFF is read-write. |
| <u>Compatibility16SetKeyboardLeds()</u>   | Allows the Compatibility16 code to update any nonstandard data structures with the keyboard LED state. The region from 0xE0000 to 0xFFFFF is read-write.   |
| <u>Compatibility16InstallPciHandler()</u> | Allows the Compatibility16 code to install an IRQ handler for mass storage devices that do not have an OpROM associated with them. An example is Serial ATA (SATA).  |

### 2.4.3.1.3 Compatibility16 Function Data Structures

There are two major structures passed from EfiCompatibility to Compatibility16:

- **EFI\_TO\_COMPATIBILITY16\_INIT\_TABLE**
- **EFI\_TO\_COMPATIBILITY16\_BOOT\_TABLE**

These tables describe the state of the machine at the time the function is issued.

**EFI\_TO\_COMPATIBILITY16\_INIT\_TABLE** is passed in during the **Compatibility16InitializeYourself()** function.

**EFI\_TO\_COMPATIBILITY16\_BOOT\_TABLE** is passed in during the **Compatibility16PrepareToBoot()** function.

### 2.4.3.2 Compatibility16 Support

The Compatibility16 support includes all runtime support and all software interrupts, other than OpROMs and traditional hardware interrupt service routines.

### 2.4.4 CompatibilitySmm

The CompatibilitySmm code is optional. User requirements or traditional features may force it to become a required piece of code. CompatibilitySmm is expected to be chipset and/or platform specific. The following are possible examples:

- System configuration data for INT15 D042 support
- USB legacy support provided for keyboard and mouse
- Update BBS with USB boot devices information

### 2.4.5 Thunk and Reverse Thunk Overview

*Thunk* is the code that switches from 32-bit protected environment into the 16-bit real-mode environment. *Reverse thunk* is the code that does the opposite. The code ensures that the 8259 PIC is correct for the environment. This piece of code is arcane.

The transition from EfiCompatibility to Compatibility16 code or to OpROM code requires a “thunk.”. This code does the following:

- Handles any APIC and PIC reprogramming and loading of new GDT and IDT tables.
- Performs the requested action.
- Saves the 16-bit code interrupt state.
- Restores the 32-bit interrupt environment and returns to EFI.

EFI can use either of the following functions to accomplish the thunk:

- `EFI_LEGACY_BIOS_PROTOCOL.Int86()`
- `EFI_LEGACY_BIOS_PROTOCOL.FarCall86()`

The 16-bit code returns to the EFI environment by performing an IRET or FAR RET.

The reverse thunk is similar to a thunk but is used on the 16-bit to 32-bit to 16-bit transitions. There are no defined reverse thunks at this time. Its code is added for completeness.

The figure below shows how the thunk and reverse thunk operate between the 16-bit and 32-bit environments.

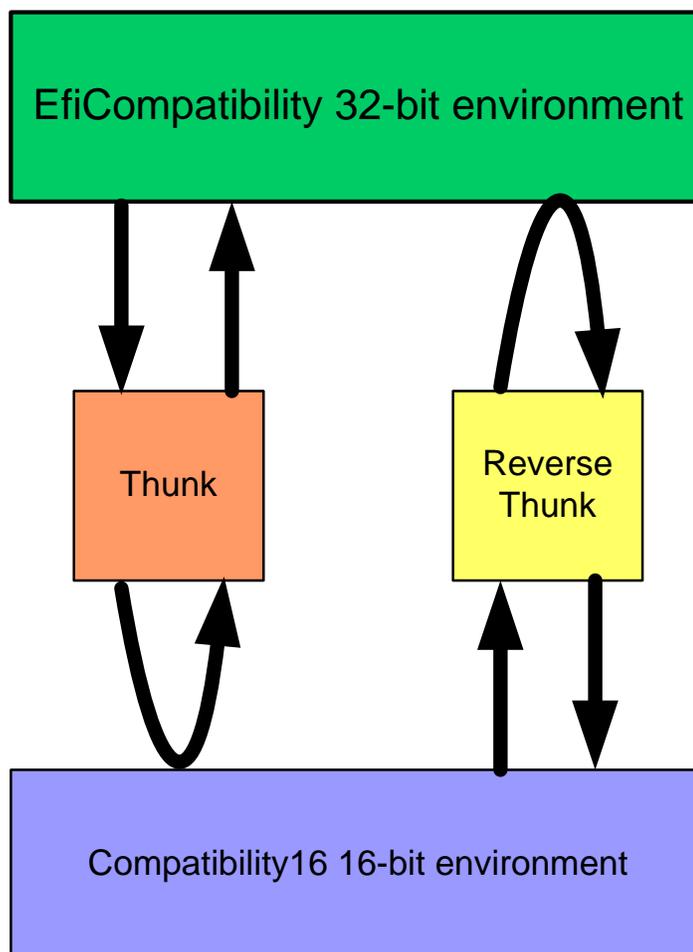


Figure 3 Thunk and Reverse Thunk in a Traditional Code Environment

## 2.5 Interactions between CSM and Legacy BIOS

### 2.5.1 BDS and Legacy Drivers

BDS must invoke the CSM by dispatching the Legacy BIOS Protocol if either of the following is true:

- A traditional OpROM is required.
- A traditional boot option is found in the boot sequence

#### 2.5.1.1 Traditional OpROMs

There are two cases where traditional OpROMs are required in an EFI environment, as follows:

- **No EFI driver exists**

There are cases where a required device has no EFI driver but only a traditional OpROM. The normal binding of a device and driver fails and an attempt is made to do the binding via the EfiCompatibility code. This binding is done in the Legacy BIOS Protocol. The thunk driver is bound by the BDS (due to its priority) and the thunk driver calls back into the Legacy BIOS Protocol to load the ROM.

- **Bootting a traditional OS**

All devices requiring an OpROM in a traditional BIOS boot will require traditional OpROMs when booting a traditional OS in an EFI environment. This requirement means that there may be an EFI driver and a traditional OpROM for the same device. This transition from EFI to traditional BIOS code is done in **EFI\_LEGACY\_BIOS\_PROTOCOL.LegacyBoot ( )**. This code disconnects all EFI drivers for traditional devices.

#### 2.5.1.2 Determining if Traditional OS Is Present on a Boot Device

The EFI Device Path distinguishes between booting to the following:

- An EFI-aware OS (regardless if the device is EFI or traditional)
- A traditional OS

**EFI\_LEGACY\_BIOS\_PROTOCOL.LegacyBoot ( )** is used in the latter case. It is recommended that potential removable media boot devices are checked to see if any media are present prior to setting boot devices. This check speeds up the boot time and may prevent a possible system reset. A failed traditional boot will cause a system reset any time control is passed to an OS boot loader and the loader returns back to the BIOS. This reset occurs because EFI might have been corrupted.

#### 2.5.1.3 Determining the Boot Sequence When Traditional OSs Are Involved

The EFI device path determines which of the following is used:

- The normal EFI boot sequence
- The **EFI\_LEGACY\_BIOS\_PROTOCOL.LegacyBoot ( )** sequence

Once it is determined that the **EFI\_LEGACY\_BIOS\_PROTOCOL.LegacyBoot ( )** is used, then the **EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL.PrepareToBoot ( )** function is used to order the device boot sequence.

### 2.5.1.4 Traditional Installation

The traditional BIOS driver is used to abstract the traditional BIOS for EFI. BDS installing the traditional code causes the Legacy BIOS Protocol initialization code to do the following actions:

- Find the Legacy Region Protocol.
- Find the Legacy Interrupt Protocol.
- Find the Legacy BIOS Platform Protocol.
- Find the Legacy 8259 Protocol.
- Allocate the first 4 KB for interrupt vectors and BDA from traditional memory.
- Allocate 0x80000–0x9FFFF for EfiCompatibility usage and for the EBDA.
- Allocate memory for thunk and reverse thunk code.
- Initialize thunk code.
- Initialize the traditional memory map.
- Allocate PMM memory between 1 MB and 16 MB.
- Initialize the BDA and EBDA.
- Locate the firmware volume from which this code was loaded and searches that firmware volume for the Compatibility16 code.
- Determine the size of the Compatibility16 code and from the size calculates the starting address of the Compatibility16 code.
- Make the final destination of the Compatibility16 code read-write and then shadows the Compatibility16 code to the final destination.
- Search for and validate the **EFI\_COMPATIBILITY16\_TABLE**, saves the Compatibility16 entry point, and updates internal data structures.
- Using the Compatibility16 table function entry point, thunk into the Compatibility16 bit code and request it to perform the function **Compatibility16InitializeYourself()**. The traditional memory map is passed in as a parameter.
- **EFI\_COMPATIBILITY16\_TABLE** is read to get the Plug and Play installation check address. The internal data structures are updated.
- The Compatibility16 code is then set to read only.
- Install the Legacy BIOS Protocol.
- The Legacy BIOS Protocol returns back to BDS.

### 2.5.2 16-Bit Traditional Code

The 16-bit traditional code consists of traditional OpROMs and Compatibility16 code. The Compatibility16 code roughly consists of traditional BIOS minus POST and BIOS Setup. It is assembled separately from the EFI code and is linked as a binary module just like an EFI OpROM would be.

See Compatibility16 in CSM Architecture for details on the new Compatibility16 code that is used to interface between the EfiCompatibility portion and the Compatibility16 portion of the traditional BIOS.

### 2.5.2.1 Legacy BIOS Interface and Functions

There is a table located within the traditional BIOS in either the 0xF000:xxxx or 0xE000:xxxx physical address range. The table is located on a 16-byte boundary and provides the physical address of the entry point for the [Compatibility16 Functions](#).

The Compatibility16 functions provide the platform-specific information that is required by the generic EfiCompatibility code. The functions are invoked via thunking by using `EFI_LEGACY_BIOS_PROTOCOL.FarCall186()` with the 32-bit physical entry point `EFI_COMPATIBILITY16_TABLE`.

See [Compatibility16 Code](#) in [Code Definitions](#) for definitions of the Compatibility16 functions and the 32-bit physical entry point.

### 2.5.2.2 EfiCompatibility to 16-Bit Legacy Transitions

There are the following two cases of transitions:

- Thunk
- Reverse thunk

A *thunk* is the transition from EfiCompatibility to 16-bit traditional code and back. A *reverse thunk* is the transition from 16-bit traditional code to EfiCompatibility and back.

See [Thunk](#) in [CSM Architecture](#) for additional details.

### 2.5.2.3 EfiCompatibility Drivers

Three drivers are needed to emulate various traditional software INTs, as follows:

- UGA emulation of INT10
- Keyboard emulation of INT16
- Block I/O emulation

The following sections provide more information on these INTs.

#### 2.5.2.4 UGA Emulation of INT10

This situation occurs when traditional OpROMs are to be invoked. The UGA controller is to be placed in VGA emulation mode and a VGA OpROM invoked. This driver must translate EFI console-out data and requests into their VGA equivalent. The following assumptions are used in this document:

- All INT10 functions, both character and dot must be supported.
- The OpROMs may access direct both VGA registers and video memory buffers.
- UGA hardware supports a VGA mode and can be switched between UGA/VGA modes multiple times.

#### 2.5.2.5 Keyboard Emulation of INT16

The Compatibility16 BIOS does not take over USB emulation until the final states of traditional boot. Until that time, INT16 requests must be converted into EFI requests, data received and converted back into INT16 format.

#### 2.5.2.6 Block I/O Emulation

This driver is used when EFI needs to access a traditional floppy or hard disk. It translates EFI block I/O requests into the equivalent INT13 requests.

## 2.6 Assumptions

### 2.6.1 External Assumptions

The CSM code makes the following external assumptions:

- When unloaded, EFI device drivers that have EFI OpROMs leave the hardware in a neutral state that allows an equivalent traditional OpROM to be invoked without any adverse device interaction.
- Traditional OpROMs cannot be unloaded and thus leave the hardware in a non-neutral state.
- The UGA hardware is bi-modal, which also supports a VGA emulation mode.
- The UGA OpROM also carries a traditional VGA OpROM.
- Only traditional ACPI-aware OSs are supported.
- Traditional device programming is done either by EFI, EfiCompatibility, or ACPI.
- MS-DOS\* boots but there is no guarantee that all DOS programs will work.
- The Legacy BIOS Platform Protocol code, Compatibility16 code, and CompatibilitySmm code (if it exists) are all provided by the same IBV. Using a single IBV ensures consistency and coherency.

### 2.6.2 Internal Assumptions

The CSM code makes the following internal assumptions:

- The Compatibility16 bit code consists of a traditional runtime BIOS, INT18, and INT19. Compatibility16 does not include 16-bit OpROMs.
- The POST code is removed. The EFI code functions as the traditional BIOS POST equivalent. This assumption presents the minimal space footprint.
- The following assumptions pertain to the Compatibility16 bit code except where indicated.
- Runtime text messages are kept to a minimum and are simple ASCII or numerical data. It is considered too expensive, space wise, to carry a display engine for a couple of messages. There is also the coherency of localization between EFI and Compatibility16.
- There is no need for cache control. It is assumed that cache is always enabled or controlled by the OS.
- There are no flash or NVRAM updates, or all updates are done via CompatibilitySmm that is cognizant of EFI firmware volumes and EFI update protocols. There are several reasons for this assumption. Compatibility16 code knows nothing of EFI firmware volumes. Having multiple independent entities trying to maintain flash or NVRAM is guaranteed to introduce system instability. There are security problems in having multiple entities maintaining flash or NVRAM. Having no updates has several ramifications to the Compatibility16 code, as follows:
  - No ESCD
  - No processor patches
  - No update of SMBIOS structures
  - No CMOS save to flash
- There is no APM support. Only ACPI-aware OSs are supported.
- There is no BIOS Setup. EFI provides this functionality.
- There is no POST. EFI provides this functionality.
- SMBIOS version 2.3 is supported in a limited manner, as follows:
  - Table entry only.
  - No Plug and Play interface.

- Static information only, no flash updates.
  - All SMBIOS functions are read only, and both OEMs and manufacturing must use EFI utilities to write asset tags.
- The boot HDD needs to be INT13 drive 0x80. Other drives can be assigned numbers in any order.
- USB legacy is supported from INT19 on. Pre-INT19 is EFI via any required drivers or via CompatibilitySmm and is CSM implementation specific. This requirement includes keyboard and mouse.
- EFI is sufficient for S3. No legacy code is required.
- EFI drivers, EfiCompatibility drivers, or ACPI ASL are used to program traditional devices. There are no Plug and Play device nodes.
- EFI provides the ASL code.
- Compatibility16 code is chipset hardware neutral. CompatibilitySmm code is not chipset hardware neutral.

### 2.6.3 Design Assumptions

The CSM design assumes the following:

- The major assumption is that large sections of the BIOS IBV's current runtime assembly code will be ported directly to the Compatibility16. EFI interfaces extract information from the EFI modules and translate it into Compatibility16 equivalents.
- The traditional BIOS (Compatibility16) consists of a single module.
- The traditional BIOS is a compiled feature. It is not dynamically controlled via Setup or any other mechanism.
- Compatibility16 does not need to configure motherboard devices. The EFI PEI and DXE phases configure the devices during POST and the ACPI ASL configures devices at runtime. Plug and Play device nodes are not supported. This assumption implies that the ACPI device configuration selections include entries with and without IRQs.
- Because the Compatibility16 contains traditional devices that use interrupts, it requires an interrupt vector table and interrupts located at the traditional locations. The EFI Interrupt Descriptor Table (IDT) resides at a different address.
- EFI selects the boot ordering, not EfiCompatibility or Compatibility16. EfiCompatibility can change the boot priority.
- Compatibility16 owns resources below 1 MB in memory. An area needs to be reserved for EFI double buffering usage and 0:7C00 needs to be reserved for the boot loader.
- The CSM is invoked in BDS and dispatches the Compatibility16 code.
- If a traditional OS is booted, then all OpROMs must be traditional.
- If an EFI OS is booted, then OpROMs can be either EFI (preferred) or traditional.

## 2.7 Valid EFI and Legacy Combinations

The table below lists the valid EFI and legacy code combinations.

**Table 9 Valid EFI and Legacy Combinations**

| Video OpROM | Other OpROM | Boot Device OpROM | OS          | Valid?                          |
|-------------|-------------|-------------------|-------------|---------------------------------|
| EFI         | EFI         | EFI               | EFI         | Compatibility mode not required |
| EFI         | EFI         | EFI               | Traditional | No                              |
| EFI Note1   | EFI         | Traditional       | EFI         | Yes                             |
| EFI         | EFI         | Traditional       | Traditional | No                              |
| EFI Note 1  | Traditional | EFI               | EFI         | Yes                             |
| EFI         | Traditional | EFI               | Traditional | No                              |
| EFI Note1   | Traditional | Traditional       | EFI         | Yes                             |
| EFI Note1   | Traditional | Traditional       | Traditional | Yes                             |
| Traditional | EFI         | EFI               | EFI         | Yes                             |
| Traditional | EFI         | EFI               | Traditional | No                              |
| Traditional | EFI         | Traditional       | EFI         | Yes                             |
| Traditional | EFI         | Traditional       | Traditional | No                              |
| Traditional | Traditional | EFI               | EFI         | Yes                             |
| Traditional | Traditional | EFI               | Traditional | No                              |
| Traditional | Traditional | Traditional       | EFI         | Yes                             |
| Traditional | Traditional | Traditional       | Traditional | Yes                             |

Note 1: The EFI UGA video driver must be unloaded and re-invoked in VGA mode with a VGA OpROM.



### 3.1 Introduction

This section contains definitions of the following protocols, functions, or data types.

**Table 10 EfiCompatability Code and Compatabiloity16 code**

| <b>EfiCompatability Code:</b>  |  |
|--|--|
| <b>EFI_LEGACY_BIOS_PROTOCOL</b>                                      | Used to abstract the traditional BIOS for EFI.   |
| <b>EFI_LEGACY_BIOS_PLATFORM_PROTOCOL</b>                             | Used to abstract the platform-specific traditional hardware and or policy decisions from the generic EfiCompatability code.  |
| <b>EFI_LEGACY_REGION_PROTOCOL</b>                                    | Used to abstract the hardware control of the OpROM and Compatibility16 region shadowing.   |
| <b>EFI_LEGACY_8259_PROTOCOL</b>                                      | Used to abstract the 8259 PIC.   |
| <b>EFI_LEGACY_INTERRUPT_PROTOCOL</b>                                 | Used to abstract the PIRQ programming from the generic code.   |
| <b>Compatibility16 Code:</b>   |  |
| <b>EFI_COMPATIBILITY16_TABLE</b>                                     | A new table introduced to the traditional legacy runtime BIOS for CSM support. Provides the physical address of the entry point for the Compatibility16 functions. |
| <b>EFI_COMPATIBILITY_FUNCTIONS</b> and the Compatibility16 functions | Allows the EfiCompatability code to communicate with the Compatibility16 code and are an addition to the traditional BIOS runtime code.                            |

## 3.2 EfiCompatibility Code

### 3.2.1 Legacy BIOS Protocol

#### EFI\_LEGACY\_BIOS\_PROTOCOL

##### Summary

Abstracts the traditional BIOS from the rest of EFI. The **LegacyBoot()** member function allows the BDS to support booting a traditional OS. EFI thinks drivers that make EFI bindings for BIOS INT services use all the other member functions.

##### GUID

```
// { DB9A1E3D-45CB-4ABB-853B-E5387FDB2E2D}
#define EFI_LEGACY_BIOS_PROTOCOL_GUID \
    { 0xdb9a1e3d, 0x45cb, 0x4abb, 0x85, 0x3b, 0xe5, 0x38, 0x7f, 0xdb, 0x2e, \
    0x2d }
```

##### Protocol Interface Structure

```
typedef struct _EFI_LEGACY_BIOS_PROTOCOL {
    EFI_LEGACY_BIOS_INT86                Int86;
    EFI_LEGACY_BIOS_FARCALL86            FarCall86;
    EFI_LEGACY_BIOS_CHECK_ROM            CheckPciRom;
    EFI_LEGACY_BIOS_INSTALL_ROM          InstallPciRom;
    EFI_LEGACY_BIOS_BOOT                  LegacyBoot;
    EFI_LEGACY_BIOS_UPDATE_KEYBOARD_LED_STATUS UpdateKeyboardLedStatus;
    EFI_LEGACY_BIOS_GET_BBS_INFO          GetBbsInfo;
    EFI_LEGACY_BIOS_SHADOW_ALL_LEGACY_OPROMS ShadowAllLegacyOproms;
    EFI_LEGACY_BIOS_PREPARE_TO_BOOT_EFI  PrepareToBootEFI;
    EFI_LEGACY_BIOS_GET_LEGACY_REGION     GetLegacyRegion;
    EFI_LEGACY_BIOS_COPY_LEGACY_REGION    CopyLegacyRegion;
    EFI_LEGACY_BIOS_BOOT_UNCONVENTIONAL_DEVICE BootUnconventionalDevice;
} EFI_LEGACY_BIOS_PROTOCOL;
```

## Parameters

### *Int86*

Performs traditional software INT. See the **Int86()** function description.

### *FarCall86*

Performs a far call into Compatibility16 or traditional OpROM code. See the **FarCall86()** function description.

### *CheckPciRom*

Checks if a traditional OpROM exists for this device. See the **CheckPciRom()** function description.

### *InstallPciRom*

Loads a traditional OpROM in traditional OpROM address space. See the **InstallPciRom()** function description.

### *LegacyBoot*

Boots a traditional OS. See the **LegacyBoot()** function description. See the **PrepareToBootEfi()** function for booting an EFI-aware OS.

### *UpdateKeyboardLedStatus*

Updates BDA to reflect the current EFI keyboard LED status. See the **UpdateKeyboardLedStatus()** function description.

### *GetBbsInfo*

Allows an external agent, such as BIOS Setup, to get the BBS data. See the **GetBbsInfo()** function description.

### *ShadowAllLegacyOproms*

Causes all legacy OpROMs to be shadowed. See the **ShadowAllLegacyOproms()** function description.

### *PrepareToBootEfi*

Performs all actions prior to boot. Used when booting an EFI-aware OS rather than a legacy OS. See the **PrepareToBootEfi()** function description. See the **LegacyBoot()** function for booting a legacy OS.

### *GetLegacyRegion*

Allows EFI to reserve an area in the 0xE0000 or 0xF0000 block. See the **GetLegacyRegion()** function description.

### *CopyLegacyRegion*

Allows EFI to copy data to the area specified by *GetLegacyRegion*. See the **CopyLegacyRegion()** function description.

### *BootUnconventionalDevice*

Allows the user to boot off an unconventional device such as a PARTIES partition. See the **BootUnconventionalDevice()** function description.

## Description

The **EFI\_LEGACY\_BIOS\_PROTOCOL** is used to abstract the traditional BIOS for EFI.

## EFI\_LEGACY\_BIOS\_PROTOCOL.Int86()

### Summary

Issues a traditional software INT.

### Prototype

```
typedef
BOOLEAN
(EFI_API *EFI_LEGACY_BIOS_INT86) (
    IN  EFI_LEGACY_BIOS_PROTOCOL_  *This,
    IN  UINT8                      BiosInt,
    IN OUT EFI_IA32_REGISTER_SET  *Regs
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_BIOS\_PROTOCOL** instance.

#### *BiosInt*

The software INT requested.

#### *Regs*

The IA-32 registers. Type **EFI\_IA32\_REGISTER\_SET** is defined in “Related Definitions” below.

### Description

This function issues a software INT and gets the results.

### Related Definitions

```
/**
//*****
//  EFI_IA32_REGISTER_SET
//*****
typedef union {
    EFI_DWORD_REGS  E;
    EFI_WORD_REGS   X;
    EFI_BYTE_REGS   H;
} EFI_IA32_REGISTER_SET;
```

#### *E*

Dword registers. Type **EFI\_DWORD\_REGS** is defined below.

#### *X*

Word registers. Type **EFI\_WORD\_REGS** is defined below.

*H*

Byte registers. Type **EFI\_BYTE\_REGS** is defined below.

```

//*****
// EFI_DWORD_REGS
//*****

```

```

typedef struct {
    UINT32      EAX;
    UINT32      EBX;
    UINT32      ECX;
    UINT32      EDX;
    UINT32      ESI;
    UINT32      EDI;
    EFI_EFLAGS_REG  EFlags;
    UINT16      ES;
    UINT16      CS;
    UINT16      SS;
    UINT16      DS;
    UINT16      FS;
    UINT16      GS;
    UINT32      EBP;
    UINT32      ESP;
} EFI_DWORD_REGS;

```

```

//*****
// EFI_EFLAGS_REG
//*****

```

```

typedef struct {
    UINT32 CF:1;
    UINT32 Reserved1:1;
    UINT32 PF:1;
    UINT32 Reserved2:1;
    UINT32 AF:1;
    UINT32 Reserved3:1;
    UINT32 ZF:1;
    UINT32 SF:1;

```

## Intel Platform Innovation Framework for EFI Compatibility Support Module Specification

```
    UINT32 TF:1;
    UINT32 IF:1;
    UINT32 DF:1;
    UINT32 OF:1;
    UINT32 IOPL:2;
    UINT32 NT:1;
    UINT32 Reserved4:2;
    UINT32 VM:1;
    UINT32 Reserved5:14;
} EFI_EFLAGS_REG;

//*****
// EFI_WORD_REGS
//*****

typedef struct {
    UINT16      AX;
    UINT16      ReservedAX;
    UINT16      BX;
    UINT16      ReservedBX;
    UINT16      CX;
    UINT16      ReservedCX;
    UINT16      DX;
    UINT16      ReservedDX;
    UINT16      SI;
    UINT16      ReservedSI;
    UINT16      DI;
    UINT16      ReservedDI;
    EFI_FLAGS_REG  Flags;
    UINT16      ReservedFlags;
    UINT16      ES;
    UINT16      CS;
    UINT16      SS;
    UINT16      DS;
    UINT16      FS;
    UINT16      GS;
    UINT16      BP;
```

```

        UINT16          ReservedBP;

        UINT16          SP;
        UINT16          ReservedSP;
    } EFI_WORD_REGS;

//*****
// EFI_FLAGS_REG
//*****
typedef struct {
    UINT16      CF:1;
    UINT16      Reserved1:1;
    UINT16      PF:1;
    UINT16      Reserved2:1;
    UINT16      AF:1;
    UINT16      Reserved3:1;
    UINT16      ZF:1;
    UINT16      SF:1;
    UINT16      TF:1;
    UINT16      IF:1;
    UINT16      DF:1;
    UINT16      OF:1;
    UINT16      IOPL:2;
    UINT16      NT:1;
    UINT16      Reserved4:1;
} EFI_FLAGS_REG;

//*****
// EFI_BYTE_REGS
//*****

typedef struct {
    UINT8      AL, AH;
    UINT16     ReservedAX;
    UINT8      BL, BH;
    UINT16     ReservedBX;

```

```
    UINT8      CL, CH;  
    UINT16     ReservedCX;  
    UINT8      DL, DH;  
    UINT16     ReservedDX;  
} EFI_BYTE_REGS;
```

```
#define CARRY_FLAG 0x01
```

### Status Codes Returned

|       |  |
|-------|--|
| FALSE | INT completed. See <i>Regs</i> for status. |
| TRUE  | INT was not completed.                     |

## EFI\_LEGACY\_BIOS\_PROTOCOL.FarCall86()

### Summary

Performs a far call into Compatibility16 or traditional OpROM code.

### Prototype

```
typedef
BOOLEAN
(EFIAPI *EFI_LEGACY_BIOS_FARCALL86) (
    IN  EFI_LEGACY_BIOS_PROTOCOL    *This,
    IN  UINT16                      Segment,
    IN  UINT16                      Offset,
    IN  EFI_IA32_REGISTER_SET       *Regs,
    IN  VOID                        *Stack,
    IN  UINTN                       StackSize
)
```

### Parameters

#### *This*

Indicates the `EFI_LEGACY_BIOS_PROTOCOL` instance.

#### *Segment*

Segment of 16-bit mode call.

#### *Offset*

Offset of 16-bit mode call.

#### *Regs*

The IA-32 registers. Type `EFI_IA32_REGISTER_SET` is defined in `EFI_LEGACY_BIOS_PROTOCOL.Int86()`.

#### *Stack*

Caller-allocated stack that is used to pass arguments.

#### *StackSize*

Size of *Stack* in bytes.

### Description

This function performs a far call into Compatibility16 or traditional OpROM code at the specified *Segment:Offset*.

### Status Codes Returned

|       |   |
|-------|---|
| FALSE | <code>FarCall()</code> completed. See <i>Regs</i> for status. |
| TRUE  | <code>FarCall()</code> was not completed.                     |

## EFI\_LEGACY\_BIOS\_PROTOCOL.CheckPciRom()

### Summary

Tests to see if a traditional PCI ROM exists for this device..

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_BIOS_CHECK_ROM) (
    IN  EFI_LEGACY_BIOS_PROTOCOL_   *This,
    IN  EFI_HANDLE                  PciHandle
    OUT VOID                        **RomImage, OPTIONAL
    OUT UINTN                       *RomSize,  OPTIONAL
    OUT UINTN                       *Flags
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_BIOS\_PROTOCOL** instance.

#### *PciHandle*

The handle for this device. Type **EFI\_HANDLE** is defined in **InstallProtocolInterface()** in the *EFI 1.10 Specification*.

#### *RomImage*

Pointer to the ROM image.

#### *RomSize*

The size of the ROM image.

#### *Flags*

The type of ROM discovered. Multiple bits can be set, as follows:

00 = No ROM

01 = ROM Found

02 = ROM is a valid legacy ROM

### Description

This function tests to see if a traditional PCI ROM exists for this device..

### Status Codes Returned

|                 |   |
|-----------------|---|
| EFI_SUCCESS     | A traditional OpROM is available for this device. |
| EFI_UNSUPPORTED | A traditional OpROM is not supported.             |

## EFI\_LEGACY\_BIOS\_PROTOCOL.InstallPciRom()

### Summary

Shadows an OpROM.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_BIOS_INSTALL_ROM) (
    IN  EFI_LEGACY_BIOS_PROTOCOL    *This,
    IN  EFI_HANDLE                  PciHandle,
    IN  VOID                        **RomImage,
    OUT UINTN                       *Flags
    OUT UINT8                       *DiskStart, OPTIONAL
    OUT UINT8                       *DiskEnd,   OPTIONAL
    OUT VOID                        **RomShadowAddress, OPTIONAL
    OUT UINT32                      *ShadowedRomSize OPTIONAL
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_BIOS\_PROTOCOL** instance.

#### *PciHandle*

The PCI PC-AT\* OpROM from this device's ROM BAR will be loaded. Type **EFI\_HANDLE** is defined in **InstallProtocolInterface()** in the *EFI 1.10 Specification*.

#### *RomImage*

A PCI PC-AT ROM image. This argument is non-**NULL** if there is no hardware associated with the ROM and thus no *PciHandle*; otherwise it must be **NULL**. An example is the PXE base code.

#### *Flags*

The type of ROM discovered. Multiple bits can be set, as follows:

- 00 = No ROM.
- 01 = ROM found.
- 02 = ROM is a valid legacy ROM.

#### *DiskStart*

Disk number of the first device hooked by the ROM. If *DiskStart* is the same as *DiskEnd*, no disks were hooked.

#### *DiskEnd*

Disk number of the last device hooked by the ROM.

*RomShadowAddress*

Shadow address of PC-AT ROM.

*ShadowedRomSize*

Size in bytes of *RomShadowAddress*.

## Description

This function loads a traditional PC-AT OpROM on the *PciHandle* device and returns information about how many disks were added by the OpROM and the shadow address and size. *DiskStart* and *DiskEnd* are INT13h drive letters. Thus 0x80 is C:.

## Status Codes Returned

|                 |                                    |
|-----------------|------------------------------------|
| EFI_SUCCESS     | The OpROM was shadowed             |
| EFI_UNSUPPORTED | The <i>PciHandle</i> was not found |

## EFI\_LEGACY\_BIOS\_PROTOCOL.LegacyBoot()

### Summary

Boots a traditional OS.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_BIOS_BOOT) (
    IN  EFI_LEGACY_BIOS_PROTOCOL_ *This,
    IN  BBS_BBS_DEVICE_PATH       *BootOption,
    IN  UINT32                    LoadOptionsSize,
    IN  VOID                      *LoadOptions
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_BIOS\_PROTOCOL** instance.

#### *BootOption*

The EFI device path from BootXXXX variable. Type **BBS\_BBS\_DEVICE\_PATH** is defined in "Related Definitions" below.

#### *LoadOptionSize*

Size of *LoadOption*.

#### *LoadOption*

The load option from BootXXXX variable.

### Description

This function attempts to traditionally boot the specified *BootOption*. If the EFI context has been compromised, this function will not return. This procedure is not used for loading an EFI-aware OS off a traditional device. The following actions occur:

- Get EFI SMBIOS data structures, convert them to a traditional format, and copy to Compatibility16.
- Get a pointer to ACPI data structures and copy the Compatibility16 RSD PTR to F0000 block.
- Find the traditional SMI handler from a firmware volume and register the traditional SMI handler with the EFI SMI handler.
- Build onboard IDE information and pass this information to the Compatibility16 code.
- Make sure all PCI Interrupt Line registers are programmed to match 8259.
- Reconfigure SIO devices from EFI mode (polled) into traditional mode (interrupt driven).
- Shadow all PCI ROMs.
- Set up BDA and EBDA standard areas before the legacy boot.
- Construct the Compatibility16 boot memory map and pass it to the Compatibility16 code.

- Invoke the Compatibility16 table function `Compatibility16PrepareToBoot()`. This invocation causes a thunk into the Compatibility16 code, which sets all appropriate internal data structures. The boot device list is a parameter.
- Invoke the Compatibility16 Table function `Compatibility16Boot()`. This invocation causes a thunk into the Compatibility16 code, which does an INT19.
- If the `Compatibility16Boot()` function returns, then the boot failed in a graceful manner—i.e., EFI code is still valid. An ungraceful boot failure causes a reset because the state of EFI code is unknown.

## Related Definitions

```

//*****
// BBS_BBS_DEVICE_PATH
//*****
#define BBS_DEVICE_PATH          0x05
#define BBS_BBS_DP              0x01

typedef struct _BBS_BBS_DEVICE_PATH {
    EFI_DEVICE_PATH_PROTOCOL      Header;
    UINT16                       DeviceType;
    UINT16                       StatusFlag;
    CHAR8                        String[1];
} BBS_BBS_DEVICE_PATH;
    
```

### *Header*

The device path header. Type `EFI_DEVICE_PATH` is defined in `LocateDevicePath()` in the *EFI 1.10 Specification*.

### *DeviceType*

Device type as defined by the BBS Specification. Defined device types are listed in "Related Definitions" in `Compatibility16PrepareToBoot()`.

### *StatusFlag*

Status flags as defined by the BBS Specification. Type `BBS_STATUS_FLAGS` is defined in `Compatibility16PrepareToBoot()`.

### *String*

ASCIIZ string that describes the boot device to a user. The length of this string *n* can be determined by subtracting 8 from the `Header.Length` entry.

## Status Codes Returned

|                                      |   |
|--------------------------------------|---|
| <p><code>EFI_DEVICE_ERROR</code></p> | <p>Failed to boot from any boot device and memory is uncorrupted.</p> <p><b>Note:</b> This function normally never returns. It will either boot the OS or reset the system if memory has been "corrupted" by loading a boot sector and passing control to it.</p> |
|--------------------------------------|---|

## EFI\_LEGACY\_BIOS\_PROTOCOL.UpdateKeyboardLedStatus()

### Summary

Updates the BDA to reflect status of the Scroll Lock, Num Lock, and Caps Lock keys and LEDs.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_BIOS_UPDATE_KEYBOARD_LED_STATUS) (
    IN EFI_LEGACY_BIOS_PROTOCOL  *This,
    IN UINT8                      Leds
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_BIOS\_PROTOCOL** instance.

#### *Leds*

Current LED status, as follows:

Bit 0 – Scroll Lock      0 = Off

Bit 1 – Num Lock

Bit 2 – Caps Lock

### Description

This function takes the *Leds* input parameter and sets/resets the BDA accordingly. *Leds* is also passed to Compatibility16 code, in case any special processing is required. This function is normally called from EFI Setup drivers that handle user-selectable keyboard options such as boot with NUM LOCK on/off. This function does not touch the keyboard or keyboard LEDs but only the BDA.

### Status Codes Returned

|             |                                   |
|-------------|-----------------------------------|
| EFI_SUCCESS | The BDA was updated successfully. |
|-------------|-----------------------------------|

## EFI\_LEGACY\_BIOS\_PROTOCOL.GetBbsInfo()

### Summary

Presents BBS information to external agents.

### Prototype

**typedef**

**EFI\_STATUS**

```
(EFIAPI *EFI_LEGACY_BIOS_GET_BBS_INFO) (
    IN    EFI_LEGACY_BIOS_PROTOCOL    *This,
    OUT   UINT16                      *HddCount,
    OUT   HDD_INFO                    **HddInfo,
    OUT   UINT16                      *BbsCount,
    IN OUT BBS_TABLE                  **BbsTable
)
```

### Parameters

*This*

Indicates the **EFI\_LEGACY\_BIOS\_PROTOCOL** instance.

*HddCount*

Number of **HDD\_INFO** structures. Type **HDD\_INFO** is defined in "Related Definitions" in **Compatibility16PrepareToBoot()**.

*HddInfo*

Onboard IDE controller information.

*BbsCount*

Number of **BBS\_TABLE** structures.

*BbsTable*

BBS entry. Type **BBS\_TABLE** is defined in "Related Definitions" in **Compatibility16PrepareToBoot()**.

### Description

This function presents the internal BBS data structures to external agents such as BIOS Setup and allows them to assign boot priorities.

### Status Codes Returned

|             |                               |
|-------------|-------------------------------|
| EFI_SUCCESS | Tables returned successfully. |
|-------------|-------------------------------|

## EFI\_LEGACY\_BIOS\_PROTOCOL.ShadowAllLegacyOproms()

### Summary

Allows external agents to force loading of all legacy OpROMs. This function can be invoked before [GetBbsInfo\(\)](#) to ensure all devices are counted.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_BIOS_SHADOW_ALL_LEGACY_OPROMS) (
    IN EFI_LEGACY_BIOS_PROTOCOL *This
)
```

### Parameters

*This*

Indicates the `EFI_LEGACY_BIOS_PROTOCOL` instance.

### Description

This function forces loading and invocation of the legacy OpROMs, which causes the BBS table to be updated.

### Status Codes Returned

|             |                               |
|-------------|-------------------------------|
| EFI_SUCCESS | Tables returned successfully. |
|-------------|-------------------------------|

## EFI\_LEGACY\_BIOS\_PROTOCOL.PrepareToBootEfi()

### Summary

This function is called when booting an EFI-aware OS with legacy hard disks. The legacy hard disks may or may not be the boot device but will be accessed by the EFI-aware OS.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_BIOS_PREPARE_TO_BOOT) (
    IN    EFI_LEGACY_BIOS_PROTOCOL    *This
    OUT   UINT16                      *BbsCount,
    OUT   BBS_TABLE                   **BbsTable

)
```

### Parameters

#### *This*

Indicates the `_EFI_LEGACY_BIOS_PROTOCOL` instance.

#### *BbsCount*

Number of `BBS_TABLE` structures.

#### *BbsTable*

BBS entry. Type `BBS_TABLE` is defined in "Related Definitions" in `Compatibility16PrepareToBoot()`.

### Description

This function is called when booting an EFI-aware OS with legacy hard disks. The `Compatibility16` code needs to assign drive numbers for BBS entries. The `AssignedDriveNumber` field in the BBS Table reports back the drive number assigned by the 16-bit CSM. Use

`EFI_LEGACY_BIOS_PROTOCOL.LegacyBoot()` for booting a legacy OS.

### Status Codes Returned

|             |                               |
|-------------|-------------------------------|
| EFI_SUCCESS | Tables returned successfully. |
|-------------|-------------------------------|

## EFI\_LEGACY\_BIOS\_PROTOCOL.GetLegacyRegion()

### Summary

This function is called when EFI needs to reserve an area in the 0xE0000 or 0xF0000 64 KB blocks.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_BIOS_GET_LEGACY_REGION) (
    IN EFI_LEGACY_BIOS_PROTOCOL      *This,
    IN UINTN                         LegacyMemorySize,
    IN UINTN                         Region,
    IN UINTN                         Alignment,
    OUT VOID                         **LegacyMemoryAddress
)
```

### Parameters

#### *This*

Indicates the `_EFI_LEGACY_BIOS_PROTOCOL` instance.

#### *LegacyMemorySize*

Requested size in bytes of the region.

#### *Region*

Requested region.

00 = Either 0xE0000 or 0xF0000 blocks.

Bit0 = 1 Specify 0xF0000 block

Bit1 = 1 Specify 0xE0000 block

#### *Alignment*

Bit-mapped value specifying the address alignment of the requested region. The first nonzero value from the right is alignment.

#### *LegacyMemoryAddress*

Address assigned.

### Description

This function is called when EFI needs to reserve an area in the 0xE0000 or 0xF0000 64 KB blocks. This function may be invoked only once. Use

`EFI_LEGACY_BIOS_PROTOCOL.CopyLegacyRegion()` to move data to the returned region.

### Status Codes Returned

|                   |  |
|-------------------|--|
| EFI_SUCCESS       | The requested region was assigned.     |
| EFI_ACCESS_DENIED | The function was previously invoked.   |
| Other             | The requested region was not assigned. |

## EFI\_LEGACY\_BIOS\_PROTOCOL.CopyLegacyRegion()

### Summary

This function is called when copying data to the region assigned by `EFI_LEGACY_BIOS_PROTOCOL.GetLegacyRegion()`.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_BIOS_COPY_LEGACY_REGION) (
    IN EFI_LEGACY_BIOS_PROTOCOL    *This,
    IN UINTN                        LegacyMemorySize,
    IN VOID                         *LegacyMemoryAddress,
    IN VOID                         *LegacyMemorySourceAddress
)
```

### Parameters

#### *This*

Indicates the `_EFI_LEGACY_BIOS_PROTOCOL` instance.

#### *LegacyMemorySize*

Size in bytes of the memory to copy.

#### *LegacyMemoryAddress*

The location within the region returned by `EFI_LEGACY_BIOS_PROTOCOL.GetLegacyRegion()`.

#### *LegacyMemorySourceAddress*

Source of the data to copy.

### Description

This function is called when copying data to the region that was assigned by `GetLegacyRegion()`. It may be invoked multiple times. This function performs boundary checking via information passed into the `EFI_LEGACY_BIOS_PROTOCOL.GetLegacyRegion()`. The user is responsible for any internal checking, if this function is invoked multiple times.

### Status Codes Returned

|                   |   |
|-------------------|---|
| EFI_SUCCESS       | The data was copied successfully.                       |
| EFI_ACCESS_DENIED | Either the starting or ending address is out of bounds. |

## EFI\_LEGACY\_BIOS\_PROTOCOL.BootUnconventionalDevice()

### Summary

This function is called when either booting to an unconventional device such as a PARTIES partition and/or executing hard disk diagnostics.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_BIOS_BOOT_UNCONVENTIONAL_DEVICE) (
    IN EFI_LEGACY_BIOS_PROTOCOL      *This,
    IN UDC_ATTRIBUTES                Attributes,
    IN UINTN                          BbsEntry,
    IN VOID                           *BeerData,
    IN VOID                           *ServiceAreaData
)
```

### Parameters

#### *This*

Indicates the `EFI_LEGACY_BIOS_PROTOCOL` instance.

#### *Attributes*

Flags used to interpret the rest of the input parameters. Type `UDC_ATTRIBUTES` is defined in `Compatibility16PrepareToBoot()`.

#### *BbsEntry*

The zero-based index into the `BbsTable` for the parent device. Type `BBS_TABLE` is defined in `Compatibility16PrepareToBoot()`.

#### *BeerData*

Pointer to the 128 bytes of raw Beer data.

#### *ServiceAreaData*

Pointer to the 64 bytes of raw service area data. It is up to the caller to select the appropriate service area and point to it.

## Description

This function is called when booting from an unconventional device such as a PARTIES partition and/or executing hard disk diagnostics. All other *BbsTable* entries are set to ignore and, depending upon *Attributes*, one or two entries are created. If executing hard disk diagnostics, a *BbsEntry* is created and given the highest priority. If booting from an unconventional device, a *BbsEntry* is created and given the highest priority after the diagnostic entry. It is the caller's responsibility to lock all other drives with hidden partitions, if they exist. If an unconventional boot fails, the system is reset to preserve device partition security.

## Status Codes Returned

|                       |   |
|-----------------------|---|
| EFI_INVALID_PARAMETER | Either the <i>Attribute</i> and/or pointers do not match. |
|-----------------------|---|

## 3.2.2 Legacy BIOS Platform Protocol

### EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL

#### NOTE

The architecture assumes that the creator of this protocol is also the creator of the Compatibility16 code. Having a single creator ensures that IBV-specific code is coherent.

#### Summary

Abstracts the platform portion of the traditional BIOS. The Legacy BIOS Platform Protocol will match the IBV's traditional BIOS code.

#### GUID

```
// { 783658A3-4172-4421-A299-E009079C0CB4}
#define EFI_LEGACY_BIOS_PLATFORM_PROTOCOL_GUID \
    { 0x783658a3, 0x4172, 0x4421, 0xa2, 0x99, 0xe0, 0x9, 0x7, 0x9c, 0xc, \
      0xb4 }
```

#### Protocol Interface Structure

```
typedef struct _EFI_LEGACY_BIOS_PLATFORM_PROTOCOL {
    EFI_LEGACY_BIOS_PLATFORM_GET_PLATFORM_INFO    GetPlatformInfo;
    EFI_LEGACY_BIOS_PLATFORM_GET_PLATFORM_HANDLE GetPlatformHandle;
    EFI_LEGACY_BIOS_PLATFORM_SMM_INIT            SmmInit;
    EFI_LEGACY_BIOS_PLATFORM_HOOKS               PlatformHooks;
    EFI_LEGACY_BIOS_PLATFORM_GET_ROUTING_TABLE   GetRoutingTable;
    EFI_LEGACY_BIOS_PLATFORM_TRANSLATE_PIRQ      TranslatePirq;
    EFI_LEGACY_BIOS_PLATFORM_PREPARE_TO_BOOT     PrepareToBoot;
} EFI_LEGACY_BIOS_PLATFORM_PROTOCOL;
```

#### Parameters

##### *GetPlatformInfo*

Gets binary data or other platform information. See the **GetPlatformInfo()** function description. There are several subfunctions.

##### *GetPlatformHandle*

Returns a buffer of all handles matching the requested subfunction. See the **GetPlatformHandle()** function description. There are several subfunctions.

##### *SmmInit*

Loads and initializes the traditional BIOS SMM handler. See the **SmmInit()** function description.

##### *PlatformHooks*

Allows platform to perform any required actions after a LegacyBios operation..

*GetRoutingTable*

Gets \$PIR table. See the **`_GetRoutingTable()`** function description.

*TranslatePirq*

Translates the given PIRQ to the final value after traversing any PCI bridges. See the **`TranslatePirq()`** function description.

*PrepareToBoot*

Final platform function before the system attempts to boot to a traditional OS. See the **`PrepareToBoot()`** function description.

**Description**

The **`EFI_LEGACY_BIOS_PLATFORM_PROTOCOL`** is used to abstract the platform-specific traditional hardware and or policy decisions from the generic EfiCompatibility code.

## EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL.GetPlatformInfo()

### Summary

Finds the binary data or other platform information. Refer to the sub-functions for additional information.

### Prototype

**typedef**

**EFI\_STATUS**

```
(EFIAPI *EFI_LEGACY_BIOS_PLATFORM_GET_PLATFORM_INFO) (
    IN  EFI_LEGACY_BIOS_PLATFORM_PROTOCOL  *This,
    IN  EFI_GET_PLATFORM_INFO_MODE        Mode,
    IN OUT VOID                            **Table,
    IN OUT UINTN                           *TableSize,
    IN OUT UINTN                           *Location,
    OUT  UINTN                             *Alignment,
    IN  UINT16                             LegacySegment,
    IN  UINT16                             LegacyOffset
);
```

### Parameters

*This*

Indicates the **EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL** instance.

*Mode*

Specifies what data to return.

- GetMpTable
- GetOemIntData
- GetOem16Data
- GetOem32Data
- GetTpmBinary
- GetSystemRom
- GetPciExpressBase
- GetPlatformPmmSize
- GetPlatformEndOpromShadowAddr

*Table*

Pointer to OEM legacy 16-bit code or data.

*TableSize*

Size of data.

*Location*

Location to place table. 0x00 – Either 0xE0000 or 0xF0000 64 KB blocks.

Bit 0 = 1 0xF0000 64 KB block.

Bit 1 = 1 0xE0000 64 KB block.

Multiple bits can be set.

*Alignment*

Bit-mapped address alignment granularity. The first nonzero bit from the right is the address granularity.

*LegacySegment*

Segment where EfiCompatibility code will place the table or data.

*LegacyOffset*

Offset where EfiCompatibility code will place the table or data.

**Related Definitions**

```
//*****
// EFI_GET_PLATFORM_INFO_MODE
//*****
typedef enum {
    EfiGetPlatformBinaryMpTable           = 0,
    EfiGetPlatformBinaryOemIntData       = 1,
    EfiGetPlatformBinaryOem16Data        = 2,
    EfiGetPlatformBinaryOem32Data        = 3,
    EfiGetPlatformBinaryTpmBinary        = 4,
    EfiGetPlatformBinarySystemRom        = 5,
    EfiGetPlatformPciExpressBase         = 6,
    EfiGetPlatformPmmSize                 = 7,
    EfiGetPlatformEndOpromShadowAddr     = 8,
} EFI_GET_PLATFORM_INFO_MODE;
```

**Description**

Refer to the section for each **EFI\_GET\_PLATFORM\_INFO\_MODE** description.

### Status Codes Returned

|                 |   |
|-----------------|---|
| EFI_SUCCESS     | The data was returned successfully.     |
| EFI_UNSUPPORTED | Mode is not supported on this platform. |
| EFI_NOT_FOUND   | Binary image not found.                 |

### 3.2.2.1 Mode Values for GetPlatformInfo()

#### EfiGetPlatformBinaryMpTable

##### Summary

Returns the multiprocessor (MP) table information

##### Parameters

###### *This*

Indicates the **EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL** instance.

###### *Mode*

EfiGetPlatformBinaryMpTable

###### *Table*

Pointer to the MP table.

###### *TableSize*

Size in bytes of the MP table.

###### *Location*

Location to place table. 0x00 – Either 0xE0000 or 0xF0000 64 KB blocks.

Bit 0 = 1 0xF0000 64 KB block.

Bit 1 = 1 0xE0000 64 KB block.

Multiple bits can be set.

###### *Alignment*

Bit-mapped address alignment granularity. The first nonzero bit from the right is the address granularity.

###### *LegacySegment*

Segment where EfiCompatibility code will place the MP table.

###### *LegacyOffset*

Offset where EfiCompatibility code will place the MP table.

##### Description

This mode is invoked twice. The first invocation has *LegacySegment* and *LegacyOffset* set to 0. The mode returns the MP table address in EFI memory and its size.

The second invocation has *LegacySegment* and *LegacyOffset* set to the location in the 0xF0000 or 0xE0000 block to which the MP table is to be copied. The second invocation allows any MP table address fix-ups to occur in the EFI memory copy of the MP table. The caller, not **EfiGetPlatformBinaryMpTable**, copies the modified MP table to the allocated region in 0xF0000 or 0xE0000 block after the second invocation..

### Status Codes Returned

|                 |   |
|-----------------|---|
| EFI_SUCCESS     | The MP table was returned.                      |
| EFI_UNSUPPORTED | The MP table is not supported on this platform. |

## EfiGetPlatformBinaryOemIntData

### Summary

Returns any OEM-specific code and/or data.

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL** instance.

#### *Mode*

EfiGetPlatformBinaryOemIntData

#### *Table*

Pointer to OEM legacy 16-bit code or data.

#### *TableSize*

Size of data.

#### *Location*

Location to place table. 0x00 – Either 0xE0000 or 0xF0000 64 KB blocks.

Bit 0 = 1 0xF0000 64 KB block.

Bit 1 = 1 0xE0000 64 KB block.

Multiple bits can be set.

#### *Alignment*

Bit-mapped address alignment granularity. The first nonzero bit from the right is the address granularity.

#### *LegacySegment*

Segment where EfiCompatibility code will place the table or data.

#### *LegacyOffset*

Offset where EfiCompatibility code will place the table or data.

### Description

This function returns a block of data. The contents and usage is IBV or OEM defined. OEMs or IBVs normally use this function for nonstandard Compatibility16 runtime soft INTs. It is the responsibility of this routine to coalesce multiple OEM 16-bit functions, if they exist, into one coherent package that is understandable by the Compatibility16 code.

This function is invoked twice. The first invocation has *LegacySegment* and *LegacyOffset* set to 0. The function returns the table address in EFI memory and its size.

The second invocation has *LegacySegment* and *LegacyOffset* set to the location in the 0xF0000 or 0xE0000 block to which the data (table) is to be copied. The second invocation allows any data (table) address fix-ups to occur in the EFI memory copy of the table. The caller, not **GetOemIntData()**, copies the modified data (table) to the allocated region in 0xF0000 or 0xE0000 block after the second invocation.

### Status Codes Returned

|                 |  |
|-----------------|--|
| EFI_SUCCESS     | The data was returned successfully.        |
| EFI_UNSUPPORTED | Oem INT is not supported on this platform. |

Returns any OEM INT-specific code and/or data.

## EfiGetPlatformBinaryOem16Data

### Summary

Returns any 16-bit OEM-specific code and/or data.

### Parameters

#### *This*

Indicates the EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL instance.

#### *Mode*

EfiGetPlatformBinaryOem16Data

#### *Table*

Pointer to OEM legacy 16-bit code or data.

#### *TableSize*

Size of data.

#### *Location*

Location to place the table. 0x00 – Either 0xE0000 or 0xF0000 64 KB blocks.

Bit 0 = 1 0xF0000 64 KB block.

Bit 1 = 1 0xE0000 64 KB block.

Multiple bits can be set.

#### *Alignment*

Bit-mapped address alignment granularity. The first nonzero bit from the right is the address granularity.

#### *LegacySegment*

Segment where EfiCompatibility code will place the table or data.

#### *LegacyOffset*

Offset where EfiCompatibility code will place the table or data.

### Description

This mode returns a block of data. The contents and usage is IBV defined. OEMs or IBVs normally use this mode for nonstandard Compatibility16 runtime 16-bit routines. It is the responsibility of this routine to coalesce multiple OEM 16-bit functions, if they exist, into one coherent package that is understandable by the Compatibility16 code.

An example usage might be a legacy mobile BIOS that has a pre-existing runtime interface to return the battery status to calling applications.

This mode is invoked twice. The first invocation has *LegacySegment* and *LegacyOffset* set to 0. The mode returns the table address in EFI memory and its size.

The second invocation has *LegacySegment* and *LegacyOffset* set to the location in the 0xF0000 or 0xE0000 block to which the table is to be copied. The second invocation allows any table address fix-ups to occur in the EFI memory copy of the table. The caller, not

**EfiGetPlatformBinaryOem16Data**, copies the modified table to the allocated region in 0xF0000 or 0xE0000 block after the second invocation..

### Status Codes Returned

|                 |  |
|-----------------|--|
| EFI_SUCCESS     | The data was returned successfully.      |
| EFI_UNSUPPORTED | Oem16 is not supported on this platform. |

## EfiGetPlatformBinaryOem32Data

### Summary

Returns any 32-bit OEM-specific code and/or data.

### Parameters

#### *This*

Indicates the EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL instance.

#### *Mode*

EfiGetPlatformBinaryOem32Data

#### *Table*

Pointer to OEM legacy 32-bit code or data.

#### *TableSize*

Size of data.

#### *Location*

Location to place the table. 0x00 – Either 0xE0000 or 0xF0000 64 KB blocks.

Bit 0 = 1 0xF0000 64 KB block.

Bit 1 = 1 0xE0000 64 KB block.

Multiple bits can be set.

#### *Alignment*

Bit-mapped address alignment granularity. The first nonzero bit from the right is the address granularity.

#### *LegacySegment*

Segment where EfiCompatibility code will place the table or data.

#### *LegacyOffset*

Offset where EfiCompatibility code will place the table or data.

### Description

This mode returns a block of data. The contents and usage is IBV defined. OEMs or IBVs normally use this mode for nonstandard Compatibility16 runtime 32-bit routines. It is the responsibility of this routine to coalesce multiple OEM 32-bit functions, if they exist, into one coherent package that is understandable by the Compatibility16 code.

An example usage might be a legacy mobile BIOS that has a pre-existing runtime interface to return the battery status to calling applications.

This mode is invoked twice. The first invocation has *LegacySegment* and *LegacyOffset* set to 0. The mode returns the table address in EFI memory and its size.

The second invocation has *LegacySegment* and *LegacyOffset* set to the location in the 0xF0000 or 0xE0000 block to which the table is to be copied. The second invocation allows any table address fix-ups to occur in the EFI memory copy of the table. The caller, not **EfiGetPlatformBinaryOem32Data**, copies the modified table to the allocated region in 0xF0000 or 0xE0000 block after the second invocation..

 **NOTE**

*There are two generic mechanisms by which this mode can be used.*

*Mechanism 1: This mode returns the data and the Legacy BIOS Protocol copies the data into the F0000 or E0000 block in the Compatibility16 code. The **EFI\_COMPATIBILITY16\_TABLE** entries *Oem32Segment* and *Oem32Offset* can be viewed as two UINT16 entries.*

*Mechanism 2: This mode directly fills in the **EFI\_COMPATIBILITY16\_TABLE** with a pointer to the INT15 E820 region containing the 32-bit code. It returns **EFI\_UNSUPPORTED**. The **EFI\_COMPATIBILITY16\_TABLE** entries, *Oem32Segment* and *Oem32Offset*, can be viewed as two UINT16 entries or as a single UINT32 entry as determined by the IBV.*

**Status Codes Returned**

|                 |  |
|-----------------|--|
| EFI_SUCCESS     | The data was returned successfully.      |
| EFI_UNSUPPORTED | Oem32 is not supported on this platform. |

## EfiGetPlatformBinaryTpmBinary

### Summary

Gets the TPM (Trusted Platform Module) binary image associated with the onboard TPM device.

### Parameters

#### *This*

Indicates the `EFI_LEGACY_BIOS_PLATFORM_PROTOCOL` instance.

#### *Mode*

EfiGetPlatformBinaryTpmBinary

#### *Table*

TPM binary image for the onboard TPM device.

#### *TableSize*

Size of *BinaryImage* in bytes

#### *Location*

Location to place the table. 0x00 – Either 0xE0000 or 0xF0000 64 KB blocks.

Bit 0 = 1 0xF0000 64 KB block.

Bit 1 = 1 0xE0000 64 KB block.

Multiple bits can be set.

#### *Alignment*

Bit-mapped address alignment granularity. The first nonzero bit from the right is the address granularity.

#### *LegacySegment*

Segment where EfiCompatibility code will place the table or data.

#### *LegacyOffset*

Offset where EfiCompatibility code will place the table or data.

### Description

This mode returns a TPM binary image for the onboard TPM device.

### Status Codes Returned

|                 |   |
|-----------------|---|
| EFI_SUCCESS     | <i>BinaryImage</i> is valid.            |
| EFI_UNSUPPORTED | Mode is not supported on this platform. |
| EFI_NOT_FOUND   | No <i>BinaryImage</i> was found.        |

## EfiGetPlatformBinarySystemRom

### Summary

Finds the Compatibility16 “ROM”.

### Parameters

*This*

Indicates the `EFI_LEGACY_BIOS_PLATFORM_PROTOCOL` instance.

*Mode*

EfiGetPlatformBinarySystemRom

*Table*

System ROM image for the platform

*TableSize*

Size of *Table* in bytes

*Location*

Ignored

*Alignment*

Ignored

*LegacySegment*

Ignored

*LegacyOffset*

Ignored

### Description

The mode finds the Compatibility16 “ROM” image.

### Status Codes Returned

|               |                  |
|---------------|------------------|
| EFI_SUCCESS   | ROM image found. |
| EFI_NOT_FOUND | ROM not found.   |

## EfiGetPlatformPciExpressBase

### Summary

Gets the PciExpress base address

### Parameters

#### *This*

Indicates the `EFI_LEGACY_BIOS_PLATFORM_PROTOCOL` instance.

#### *Mode*

EfiGetPlatformPciExpressBase

#### *Table*

Ignored

#### *TableSize*

Ignored

#### *Location*

Base address of PciExpress memory mapped configuration address space.

#### *Alignment*

Ignored

#### *LegacySegment*

Ignored

#### *LegacyOffset*

Ignored

### Description

This mode returns the Base address of PciExpress memory mapped configuration address space

### Status Codes Returned

|                 |                             |
|-----------------|-----------------------------|
| EFI_SUCCESS     | Address is valid.           |
| EFI_UNSUPPORTED | System does not PciExpress. |

## EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL.GetPlatformHandle()

### Summary

Returns a buffer of handles for the requested sub-function.

### Prototype

```

typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_BIOS_PLATFORM_GET_PLATFORM_HANDLE) (
    IN  EFI_LEGACY_BIOS_PLATFORM_PROTOCOL  *This,
    IN  EFI_GET_PLATFORM_HANDLE_MODE      Mode,
    IN  UINT16                             Type,
    OUT EFI_HANDLE                         **HandleBuffer,
    OUT UINTN                              *HandleCount,
    OUT VOID OPTIONAL                      **AdditionalData
)

```

### Parameters

#### *This*

Indicates the EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL instance.

#### *Mode*

Specifies what handle to return.

GetVgaHandle

GetIdeHandle

GetIsaBusHandle

GetUsbHandle

#### *Type*

Handle Modifier – Mode specific

#### *HandleBuffer*

Pointer to buffer containing all Handles matching the specified criteria. Handles are sorted in priority order. Type EFI\_HANDLE is defined in **InstallProtocolInterface()** in the *EFI 1.10 Specification*.

### NOTE

It is the callers responsibility to save the HandleBuffer if they want to preserve it for future use as any subsequent invocation of this function will destroy the buffer contents.

#### *HandleCount*

Number of handles in HandleBuffer.

#### *AdditionalData*

Pointer to additional data returned – mode specific.

## Related Definitions

```
//*****
// EFI_GET_PLATFORM_HANDLE_MODE
//*****
typedef enum {
    EfiGetPlatformVgaHandle           = 0,
    EfiGetPlatformIdeHandle           = 1,
    EfiGetPlatformIsaBusHandle        = 2,
    EfiGetPlatformUsbHandle           = 3
} EFI_GET_PLATFORM_HANDLE_MODE;
```

## Description

This function returns handles for the specific sub-function specified by Mode.

## Status Codes Returned

|                 |   |
|-----------------|---|
| EFI_SUCCESS     | The handle is valid.                    |
| EFI_UNSUPPORTED | Mode is not supported on this platform. |
| EFI_NOT_FOUND   | The handle is not known.                |

### 3.2.2.2 Mode Values for GetPlatformHandle()

#### EfiGetPlatformVgaHandle

##### Summary

Returns the handle for the VGA device that should be used during a Compatibility16 boot.

##### Parameters

*This*

Indicates the EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL instance.

*Mode*

EfiGetPlatformVgaHandle

*Type*

0x00

*HandleBuffer*

Buffer of all VGA handles found.

*HandleCount*

Number of VGA handles found.

*AdditionalData*

**NULL**

##### Description

This mode returns the Compatibility16 policy for the device that should be the VGA controller used during a Compatibility16 boot.

##### Status Codes Returned

|                 |   |
|-----------------|---|
| EFI_SUCCESS     | The handle is valid.                    |
| EFI_UNSUPPORTED | Mode is not supported on this platform. |
| EFI_NOT_FOUND   | The VGA handle is not known.            |

## EfiGetPlatformIdeHandle

### Summary

Returns the handle for the IDE controller that should be used during a Compatibility16 boot.

### Parameters

#### *This*

Indicates the [EFI\\_LEGACY\\_BIOS\\_PLATFORM\\_PROTOCOL](#) instance.

#### *Mode*

EfiGetPlatformIdeHandle

#### *Type*

0x00

#### *HandleBuffer*

Buffer of all IDE handles found.

#### *HandleCount*

Number of IDE handles found.

#### *AdditionalData*

Pointer to HddInfo

Information about all onboard IDE controllers. Type **HDD\_INFO** is defined in “Related Definitions” in **Compatibility16PrepareToBoot()**.

### Description

This mode returns the Compatibility16 policy for the device that should be the IDE controller used during a Compatibility16 boot.

### Status Codes Returned

|                 |   |
|-----------------|---|
| EFI_SUCCESS     | The handle is valid.                    |
| EFI_UNSUPPORTED | Mode is not supported on this platform. |
| EFI_NOT_FOUND   | The IDE handle is not known.            |

## EfiGetPlatformIsaBusHandle

### Summary

Returns the handle for the ISA bus controller that should be used during a Compatibility16 boot.

### Parameters

#### *This*

Indicates the EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL instance.

#### *Mode*

EfiGetPlatformIsaBusHandle

#### *Type*

0x00

#### *HandleBuffer*

Buffer of all ISA bus handles found.

#### *HandleCount*

Number of ISA bus handles found.

#### *AdditionalData*

**NULL**

### Description

This mode returns the Compatibility16 policy for the device that should be the ISA bus controller used during a Compatibility16 boot.

### Status Codes Returned

|                 |   |
|-----------------|---|
| EFI_SUCCESS     | The handle is valid.                    |
| EFI_UNSUPPORTED | Mode is not supported on this platform. |
| EFI_NOT_FOUND   | ISA bus handle is not known.            |

## EfiGetPlatformUsbHandle

### Summary

Returns the handle for the USB device that should be used during a Compatibility16 boot.

### Parameters

#### *This*

Indicates the EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL instance.

#### *Mode*

EfiGetPlatformIsaBusHandle

#### *Type*

0x00

#### *HandleBuffer*

Buffer of all USB handles found.

#### *HandleCount*

Number of USB bus handles found.

#### *AdditionalData*

**NULL**

### Description

This mode returns the Compatibility16 policy for the device that should be the USB device used during a Compatibility16 boot.

### Status Codes Returned

|                 |   |
|-----------------|---|
| EFI_SUCCESS     | The handle is valid.                    |
| EFI_UNSUPPORTED | Mode is not supported on this platform. |
| EFI_NOT_FOUND   | USB bus handle is not known.            |

## EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL.SmmInit()

### Summary

Loads and registers the Compatibility16 handler with the EFI SMM code.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_BIOS_PLATFORM_SMM_INIT) (
    IN EFI_LEGACY_BIOS_PLATFORM_PROTOCOL    *This,
    IN VOID                                  *EfiToCompatibility16BootTable
);
```

### Parameters

*This*

Indicates the EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL instance.

*EfiToCompatibility16BootTable*

The boot table passed to the Compatibility16. Allows the `SmmInit()` function to update `EFI_TO_COMPATIBILITY16_BOOT_TABLE.SmmTable`.

### Description

This function loads and initializes the traditional BIOS SMM handler.

### Status Codes Returned

|                  |                              |
|------------------|------------------------------|
| EFI_SUCCESS      | The SMM code loaded.         |
| EFI_DEVICE_ERROR | The SMM code failed to load. |

## EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL.PlatformHooks()

### Summary

Allows platform to perform any required action after a LegacyBios operation.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_BIOS_PLATFORM_HOOKS) (
    IN  EFI_LEGACY_BIOS_PLATFORM_PROTOCOL  *This,
    IN  EFI_GET_PLATFORM_HOOK_MODE        Mode,
    IN  UINT16                             Type,
    IN  EFI_HANDLE                         DeviceHandle,  OPTIONAL
    IN  OUT  UINTN                          *ShadowAddress,  OPTIONAL
    IN  EFI_COMPATIBILITY16_TABLE          Compatibility16Table,  OPTIONAL
    OUT  VOID                               **AdditionalData  OPTIONAL
)

```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL** instance.

#### *Mode*

Specifies what handle to return.

- PrepareToScanRom
- ShadowServiceRoms
- AfterRomInit

#### *Type*

Mode specific.

#### *DeviceHandle*

List of PCI devices in the system. Type **EFI\_HANDLE** is defined in **InstallProtocolInterface()** in the *EFI 1.10 Specification*.

#### *Shadowaddress*

First free OpROM area, after other OpROMs have been dispatched..

#### *Compatibility16Table*

Pointer to the Compatibility16 Table.

#### *AdditionalData*

Pointer to additional data returned – mode specific..

## Related Definitions

```
//*****
// EFI_GET_PLATFORM_HOOK_MODE
//*****
typedef enum {
    EfiPlatformHookPrepareToScanRom = 0,
    EfiPlatformHookShadowServiceRoms = 1,
    EfiPlatformHookAfterRomInit = 2
} EFI_GET_PLATFORM_HOOK_MODE;
```

 **NOTE**

*Any OEM defined hooks start with 0x8000*

## Description

This function invokes the specific sub-function specified by Mode.

## Status Codes Returned

|                 |   |
|-----------------|---|
| EFI_SUCCESS     | The operation performed successfully.   |
| EFI_UNSUPPORTED | Mode is not supported on this platform. |
| EFI_SUCCESS     | Mode specific.                          |

### 3.2.2.3 Mode Values for PlatformHooks()

#### EfiPrepareToScanRom

##### Summary

Allows any preprocessing before scanning OpROMs.

##### Parameters

###### *This*

Indicates the **EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL** instance.

###### *Mode*

EfiPlatformHookPrepareToScanRom

###### *Type*

0

###### *DeviceHandle*

Handle of device OpROM is associated with. Type **EFI\_HANDLE** is defined in **InstallProtocolInterface()** in the *EFI 1.10 Specification*.

###### *ShadowAddress*

Address where OpROM is shadowed.

###### *Compatibility16Table*

**NULL**

###### *AdditionalData*

**NULL**

##### Description

This mode allows any preprocessing before scanning OpROMs.

##### Status Codes Returned

|                 |   |
|-----------------|---|
| EFI_SUCCESS     | All pre-ROM scan operations completed successfully. |
| EFI_UNSUPPORTED | Do not install OpROM.                               |

## EfiShadowServiceRoms

### Summary

Shadows legacy OpROMS that may not have a physical device associated with them. Examples are PXE base code and BIS.

### Parameters

*This*

Indicates the EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL instance.

*Mode*

EfiPlatformHookShadowServiceRoms

*Type*

0

*DeviceHandle*

0

*ShadowAddress*

First free OpROM area, after other OpROMs have been dispatched..

*Compatibility16Table*

Pointer to the Compatability16 Table.

*AdditionalData*

**NULL**

### Description

This mode shadows legacy OpROMS that may not have a physical device associated with them. It returns **EFI\_SUCCESS** if the ROM was shadowed.

### Status Codes Returned

|                 |   |
|-----------------|---|
| EFI_SUCCESS     | The traditional ROM was loaded for this device. |
| EFI_UNSUPPORTED | Mode is not supported on this platform.         |

## EfiAfterRomInit

### Summary

Allows platform to perform any required operation after an OpROM has completed its initialization..

### Parameters

#### *This*

Indicates the [EFI\\_LEGACY\\_BIOS\\_PLATFORM\\_PROTOCOL](#) instance.

#### *Mode*

EfiPlatformHookAfterRomInit

#### *Type*

0

#### *DeviceHandle*

Handle of device OpROM is associated with. Type **EFI\_HANDLE** is defined in **InstallProtocolInterface()** in the EFI 1.10 Specification.

#### *ShadowAddress*

Address where OpROM is shadowed.

#### *Compatibility16Table*

NULL

#### *AdditionalData*

NULL

### Description

This mode allows platform to perform any required operation after an OpROM has completed its initialization.

### Status Codes Returned

|                 |   |
|-----------------|---|
| EFI_SUCCESS     | The traditional ROM was loaded for this device. |
| EFI_UNSUPPORTED | Mode is not supported on this platform.         |

## EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL.GetRoutingTable()

### Summary

Returns information associated with PCI IRQ routing.

### Prototype

```
typedef
EFI_STATUS
(EFI_API *EFI_LEGACY_BIOS_PLATFORM_GET_ROUTING_TABLE) (
    IN EFI_LEGACY_BIOS_PLATFORM_PROTOCOL *This,
    OUT VOID **RoutingTable,
    OUT UINTN *RoutingTableEntries,
    OUT VOID **LocalPirqTable, OPTIONAL
    OUT UINTN *PirqTableSize, OPTIONAL
    OUT VOID **LocalIrqPriorityTable, OPTIONAL
    OUT UINTN *IrqPriorityTableEntries OPTIONAL
)
```

### Parameters

#### *This*

Indicates the EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL instance.

#### *RoutingTable*

Pointer to the PCI IRQ routing table. This location is the \$PIR table minus the header. The contents are described by the PCI IRQ Routing Table Specification and consist of *RoutingTableEntries* of EFI\_LEGACY\_IRQ\_ROUTING\_ENTRY. Type EFI\_LEGACY\_IRQ\_ROUTING\_ENTRY is defined in "Related Definitions" below.

#### *RoutingTableEntries*

Number of entries in the PCI IRQ routing table.

#### *LocalPirqTable*

\$PIR table. It consists of EFI\_LEGACY\_PIRQ\_TABLE\_HEADER, immediately followed by *RoutingTable*. Type EFI\_LEGACY\_PIRQ\_TABLE\_HEADER is defined in "Related Definitions" below.

#### *PirqTableSize*

Size of \$PIR table.

#### *LocalIrqPriorityTable*

A priority table of IRQs to assign to PCI. This table consists of *IrqPriorityTableEntries* of EFI\_LEGACY\_IRQ\_PRIORITY\_TABLE\_ENTRY and is used to prioritize the allocation of IRQs to PCI. Type EFI\_LEGACY\_IRQ\_PRIORITY\_TABLE\_ENTRY is defined in "Related Definitions" below.

#### *IrqPriorityTableEntries*

Number of entries in the priority table.

## Description

This function returns the following information associated with PCI IRQ routing:

- An IRQ routing table and number of entries in the table
- The \$PIR table and its size
- A list of PCI IRQs and the priority order to assign them

## Related Definitions

```
//*****
// EFI_LEGACY_IRQ_ROUTING_ENTRY
//*****

typedef struct {
    UINT8          Bus;
    UINT8          Device;
    EFI_LEGACY_PIRQ_ENTRY PirqEntry[4];
    UINT8          Slot;
    UINT8          Reserved;
} EFI_LEGACY_IRQ_ROUTING_ENTRY;
```

### *Bus*

PCI bus of the entry.

### *Device*

PCI device of this entry.

### *PirqEntry*

An IBV value and IRQ mask for PIRQ pins A through D. Type **EFI\_LEGACY\_PIRQ\_ENTRY** is defined below.

### *Slot*

If nonzero, the slot number assigned by the board manufacturer.

### *Reserved*

Reserved for future use.

```

//*****
// EFI_LEGACY_PIRQ_ENTRY
//*****

```

```

typedef struct {
    UINT8          Pirq;
    UINT16         IrqMask;
} EFI_LEGACY_PIRQ_ENTRY;

```

*Pirq*

If nonzero, a value assigned by the IBV.

*IrqMask*

If nonzero, the IRQs that can be assigned to this device.

```

//*****
// EFI_LEGACY_PIRQ_TABLE_HEADER
//*****

```

```

typedef struct {
    UINT32          Signature;
    UINT8           MinorVersion;
    UINT8           MajorVersion;
    UINT16          TableSize;
    UINT8           Bus;
    UINT8           DevFun;
    UINT16          PciOnlyIrq;
    UINT16          CompatibleVid;
    UINT16          CompatibleDid;
    UINT32          Miniport;
    UINT8           Reserved[11];
    UINT8           Checksum;
} EFI_LEGACY_PIRQ_TABLE_HEADER;

```

*Signature*

“\$PIR”.

*MinorVersion*

0x00.

*MajorVersion*

0x01 for table version 1.0.

*TableSize*

0x20 + *RoutingTableEntries* \* 0x10.

*Bus*

PCI interrupt router bus.

*DevFunc*

PCI interrupt router device/function.

*PciOnlyIrq*

If nonzero, bit map of IRQs reserved for PCI.

*CompatibleVid*

Vendor ID of a compatible PCI interrupt router.

*CompatibleDid*

Device ID of a compatible PCI interrupt router.

*Minport*

If nonzero, a value passed directly to the IRQ miniport's Initialize function.

*Reserved*

Reserved for future usage.

*Checksum*

This byte plus the sum of all other bytes in the *LocalPirqTable* equal 0x00.

```

//*****
// EFI_LEGACY_IRQ_PRIORITY_TABLE_ENTRY
//*****

typedef struct {
    UINT8          Irq;
    UINT8          Used;
} EFI_LEGACY_IRQ_PRIORITY_TABLE_ENTRY;

```

*Irq*

IRQ for this entry.

*Used*

Status of this IRQ.

- PCI\_UNUSED            0x00 – This IRQ has not been assigned to PCI.
- PCI\_USED              0xFF – This IRQ has been assigned to PCI.
- LEGACY\_USED         0xFE – This IRQ has been used by an SIO legacy device and cannot be used by PCI.

**Status Codes Returned**

|             |                                 |
|-------------|---------------------------------|
| EFI_SUCCESS | Data was returned successfully. |
|-------------|---------------------------------|

## EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL.TranslatePirq()

### Summary

Translates the given PIRQ accounting for bridges.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_BIOS_PLATFORM_TRANSLATE_PIRQ) (
    IN  EFI_LEGACY_BIOS_PLATFORM_PROTOCOL  *This,
    IN  UINTN                               PciBus,
    IN  UINTN                               PciDevice,
    IN  UINTN                               PciFunction,
    IN  OUT UINT8                           *Pirq,
    OUT UINT8                               *PciIrq
)
```

### Parameters

#### *This*

Indicates the EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL instance.

#### *PciBus*

PCI bus number for this device.

#### *PciDevice*

PCI device number for this device.

#### *PciFunction*

PCI function number for this device.

#### *Pirq*

The PIRQ. PIRQ A = 0, PIRQ B = 1, and so on.

#### *PirqIrq*

IRQ assigned to the indicated PIRQ.

### Description

This function translates the given PIRQ back through all buses, if required, and returns the true PIRQ and associated IRQ.

### Status Codes Returned

|             |                          |
|-------------|--------------------------|
| EFI_SUCCESS | The PIRQ was translated. |
|-------------|--------------------------|

## EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL.PrepareToBoot()

### Summary

Attempts to boot a traditional OS.

### Prototype

```
typedef
EFI_STATUS
(EFI_API *EFI_LEGACY_BIOS_PLATFORM_PREPARE_TO_BOOT) (
    IN  EFI_LEGACY_BIOS_PLATFORM_PROTOCOL  *This,
    IN  BBS_BBS_DEVICE_PATH                *BbsDevicePath,
    IN  VOID                               *BbsTable,
    IN  UINT32                             LoadOptionsSize,
    IN  VOID                               *LoadOptions,
    IN  VOID                               *EfiToLegacyBootTable
)
```

### Parameters

#### *This*

Indicates the EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL instance.

#### *BbsDevicePath*

EFI Device Path from BootXXXX variable. Type **BBS\_BBS\_DEVICE\_PATH** is defined in **EFI\_LEGACY\_BIOS\_PROTOCOL.LegacyBoot()**.

#### *BbsTable*

A list of BBS entries of type **BBS\_TABLE**. Type **BBS\_TABLE** is defined in **Compatibility16PrepareToBoot()**.

#### *LoadOptionsSize*

Size of *LoadOption* in bytes.

#### *LoadOptions*

*LoadOption* from BootXXXX variable.

#### *EfiToLegacyBootTable*

Pointer to **EFI\_TO\_COMPATIBILITY16\_BOOT\_TABLE**. Type **EFI\_TO\_COMPATIBILITY16\_BOOT\_TABLE** is defined in **Compatibility16PrepareToBoot()**.

## Description

This function assigns priorities to BBS table entries.

## Status Codes Returned

|             |                |
|-------------|----------------|
| EFI_SUCCESS | Ready to boot. |
|-------------|----------------|

### 3.2.3 Legacy Region Protocol

## EFI\_LEGACY\_REGION\_PROTOCOL

### Summary

Abstracts the hardware control of the physical address region 0xC0000–0xFFFFF for the traditional BIOS.

### GUID

```
// { 0FC9013A-0568-4BA9-9B7E-C9C390A6609B }
#define EFI_LEGACY_REGION_PROTOCOL_GUID \
    { 0xfc9013a, 0x568, 0x4ba9, 0x9b, 0x7e, 0xc9, 0xc3, 0x90, 0xa6, 0x60, \
    0x9b }
```

### Protocol Interface Structure

```
typedef struct _EFI_LEGACY_REGION_PROTOCOL {
    EFI_LEGACY_REGION_DECODE           Decode;
    EFI_LEGACY_REGION_LOCK              Lock;
    EFI_LEGACY_REGION_BOOT_LOCK         BootLock;
    EFI_LEGACY_REGION_UNLOCK           UnLock;
} EFI_LEGACY_REGION_PROTOCOL;
```

### Parameters

#### *Decode*

Specifies a region for the chipset to decode. See the **Decode()** function description.

#### *Lock*

Makes the specified OpROM region read only or locked. See the **Lock()** function description.

#### *BootLock*

Sets a region to read only and ensures that flash is locked from inadvertent modification. See the **BootLock()** function description.

#### *Unlock*

Makes the specified OpROM region read-write or unlocked. See the **Unlock()** function description.

### Description

The **EFI\_LEGACY\_REGION\_PROTOCOL** is used to abstract the hardware control of the OpROM and Compatibility16 region shadowing.

## EFI\_LEGACY\_REGION\_PROTOCOL.Decode()

### Summary

Sets hardware to decode or not decode a region.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_REGION_DECODE) (
    IN  EFI_LEGACY_REGION_PROTOCOL  *This,
    IN  UINT32                       Start,
    IN  UINT32                       Length,
    IN  BOOLEAN                      *On
);
```

### Parameters

#### *This*

Indicates the `EFI_LEGACY_REGION_PROTOCOL` instance

#### *Start*

Start of region to decode.

#### *Length*

Size in bytes of the region.

#### *On*

Decode/nondecode flag.

### Description

This function sets the hardware to either decode or not decode a region within 0xC0000 to 0xFFFFF.

### Status Codes Returned

|             |                                    |
|-------------|------------------------------------|
| EFI_SUCCESS | Decode range successfully changed. |
|-------------|------------------------------------|

## EFI\_LEGACY\_REGION\_PROTOCOL.Lock()

### Summary

Sets a region to read only.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_REGION_LOCK) (
    IN EFI_LEGACY_REGION_PROTOCOL  *This,
    IN  UINT32                      Start,
    IN  UINT32                      Length,
    OUT UINT32                      *Granularity OPTIONAL
);
```

### Parameters

*This*

Indicates the `EFI_LEGACY_REGION_PROTOCOL` instance

*Start*

Start of the region to lock.

*Length*

Length of the region.

*Granularity*

Lock attribute affects this granularity in bytes.

### Description

This function makes a region from 0xC0000 to 0xFFFFF read only.

### Status Codes Returned

|             |                                |
|-------------|--------------------------------|
| EFI_SUCCESS | The region was made read only. |
|-------------|--------------------------------|

## EFI\_LEGACY\_REGION\_PROTOCOL.BootLock()

### Summary

Sets a region to read only and ensures that flash is locked from being inadvertently modified.

### Prototype

**typedef**

**EFI\_STATUS**

```
(EFIAPI *EFI_LEGACY_REGION_BOOT_LOCK) (
    IN  EFI_LEGACY_REGION_PROTOCOL  *This,
    IN  UINT32                      Start,
    IN  UINT32                      Length,
    OUT UINT32                      *Granularity  OPTIONAL
);
```

### Parameters

*This*

Indicates the **EFI\_LEGACY\_REGION\_PROTOCOL** instance

*Start*

Start of the region to lock.

*Length*

Length of the region

*Granularity*

Lock attribute affects this granularity in bytes.

### Description

This function makes a region from 0xC0000 to 0xFFFFF read only and prevents writes to any alias regions.

### Status Codes Returned

|             |  |
|-------------|--|
| EFI_SUCCESS | The region was made read only and flash is locked. |
|-------------|--|

## EFI\_LEGACY\_REGION\_PROTOCOL.Unlock()

### Summary

Sets a region to read-write.

### Prototype

**typedef**

**EFI\_STATUS**

```
(EFI_API *EFI_LEGACY_REGION_UNLOCK) (
    IN  EFI_LEGACY_REGION_PROTOCOL  *This,
    IN  UINT32                       Start,
    IN  UINT32                       Length,
    OUT UINT32                       *Granularity  OPTIONAL
);
```

### Parameters

*This*

Indicates the **EFI\_LEGACY\_REGION\_PROTOCOL** instance

*Start*

Start of the region to lock.

*Length*

Length of the region

*Granularity*

Lock attribute affects this granularity in bytes.

### Description

This function makes a region from 0xC0000 to 0xFFFFF read/write.

### NOTE

*This function might have to prevent writes to RAM in the region from propagating to the NVRAM, if other drivers do not. An IA-32 example is where a write to 0xFxxx can also propagate to 0xFFFFxxx and an innocent data pattern can mimic a NVRAM write or erase sequence.*

### Status Codes Returned

|                    |  |
|--------------------|--|
| <b>EFI_SUCCESS</b> | The region was successfully made read-write. |
|--------------------|--|

## 3.2.4 Legacy 8259 Protocol

### EFI\_LEGACY\_8259\_PROTOCOL

#### Summary

Abstracts the 8259 and APIC hardware control between EFI usage and Compatibility16 usage.

#### GUID

```
// { 38321DBA-4FE0-4E17-8AEC-413055EAEDC1 }
#define EFI_LEGACY_8259_PROTOCOL_GUID \
    { 0x38321dba, 0x4fe0, 0x4e17, 0x8a, 0xec, 0x41, 0x30, 0x55, \
      0xea, 0xed, 0xc1 }
```

#### Protocol Interface Structure

```
typedef struct _EFI_LEGACY_8259_PROTOCOL {
    EFI_LEGACY_8259_SET_VECTOR_BASE      SetVectorBase;
    EFI_LEGACY_8259_GET_MASK             GetMask;
    EFI_LEGACY_8259_SET_MASK             SetMask;
    EFI_LEGACY_8259_SET_MODE              SetMode;
    EFI_LEGACY_8259_GET_VECTOR            GetVector;
    EFI_LEGACY_8259_ENABLE_IRQ            EnableIrq;
    EFI_LEGACY_8259_DISABLE_IRQ           DisableIrq;
    EFI_LEGACY_8259_GET_INTERRUPT_LINE    GetInterruptLine;
    EFI_LEGACY_8259_END_OF_INTERRUPT      EndOfInterrupt
} EFI_LEGACY_8259_PROTOCOL;
```

#### Parameters

*SetVectorBase*

Sets the vector bases for master and slave PICs. See the **SetVectorBase()** function description.

*GetMask*

Gets IRQ and edge/level masks for 16-bit real mode and 32-bit protected mode. See the **GetMask()** function description.

*SetMask*

Sets the IRQ and edge/level masks for 16-bit real mode and 32-bit protected mode. See the **Setmask()** function description.

*SetMode*

Sets PIC mode to 16-bit real mode or 32-bit protected mode. See the **SetMode()** function description.

*GetVector*

Gets the base vector assigned to an IRQ. See the **GetVector()** function description.

*EnableIrq*

Enables an IRQ. See the **EnableIrq()** function description.

*DisableIrq*

Disables an IRQ. See the **DisableIrq()** function description.

*GetInterruptLine*

Gets an IRQ that is assigned to a PCI device. See the **GetInterruptLine()** function description.

*EndOfInterrupt*

Issues the end of interrupt command. See the **EndOfInterrupt()** function description.

## Description

The **EFI\_LEGACY\_8259\_PROTOCOL** is used to abstract the 8259 PIC.

## EFI\_LEGACY\_8259\_PROTOCOL.SetVectorBase()

### Summary

Sets the base address for the 8259 master and slave PICs.

### Prototype

```
typedef
EFI_STATUS
(EFI_API *EFI_LEGACY_8259_SET_VECTOR_BASE) (
    IN EFI_LEGACY_8259_PROTOCOL    *This,
    IN UINT8                       MasterBase,
    IN UINT8                       SlaveBase
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_8259\_PROTOCOL** instance.

#### *MasterBase*

Interrupt vectors for IRQ0–IRQ7.

#### *SlaveBase*

Interrupt vectors for IRQ8–IRQ15.

### Description

This function sets the 8259 master and slave address that maps the IRQ to the processor interrupt vector number.

### Status Codes Returned

|                  |   |
|------------------|---|
| EFI_SUCCESS      | The 8259 PIC was programmed successfully.         |
| EFI_DEVICE_ERROR | There was an error while writing to the 8259 PIC. |

## EFI\_LEGACY\_8259\_PROTOCOL.GetMask()

### Summary

Gets the current 16-bit real mode and 32-bit protected-mode IRQ masks.

### Prototype

```
typedef
EFI_STATUS
(EFI_API *EFI_LEGACY_8259_GET_MASK) (
    IN EFI_LEGACY_8259_PROTOCOL *This,
    OUT UINT16                    *LegacyMask, OPTIONAL
    OUT UINT16                    *LegacyEdgeLevel, OPTIONAL
    OUT UINT16                    *ProtectedMask, OPTIONAL
    OUT UINT16                    *ProtectedEdgeLevel OPTIONAL
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_8259\_PROTOCOL** instance.

#### *LegacyMask*

16-bit mode interrupt mask for IRQ0–IRQ15.

#### *LegacyEdgeLevel*

16-bit mode edge/level mask for IRQ0–IRQ15.

#### *ProtectedMask*

32-bit mode interrupt mask for IRQ0–IRQ15.

#### *ProtectedEdgeLevel*

32-bit mode edge/level mask for IRQ0–IRQ15.

### Description

This function gets the current settings of the interrupt mask and edge/level mask for the 16-bit real-mode operation and 32-bit protected-mode operation.

### Status Codes Returned

|                  |  |
|------------------|--|
| EFI_SUCCESS      | The 8259 PIC was programmed successfully.      |
| EFI_DEVICE_ERROR | There was an error while reading the 8259 PIC. |

## EFI\_LEGACY\_8259\_PROTOCOL.SetMask()

### Summary

Sets the current 16-bit real mode and 32-bit protected-mode IRQ masks.

### Prototype

```
typedef
EFI_STATUS
(EFI_API *EFI_LEGACY_8259_SET_MASK) (
    IN EFI_LEGACY_8259_PROTOCOL *This,
    IN UINT16                    *LegacyMask, OPTIONAL
    IN UINT16                    *LegacyEdgeLevel, OPTIONAL
    IN UINT16                    *ProtectedMask, OPTIONAL
    IN UINT16                    *ProtectedEdgeLevel OPTIONAL
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_8259\_PROTOCOL** instance.

#### *LegacyMask*

16-bit mode interrupt mask for IRQ0–IRQ15.

#### *LegacyEdgeLevel*

16-bit mode edge/level mask for IRQ0–IRQ15.

#### *ProtectedMask*

32-bit mode interrupt mask for IRQ0–IRQ15.

#### *ProtectedEdgeLevel*

32-bit mode edge/level mask for IRQ0–IRQ15.

### Description

This function sets the current settings of the interrupt mask and edge/level mask for the 16-bit real-mode operation and 32-bit protected-mode operation.

### Status Codes Returned

|                  |  |
|------------------|--|
| EFI_SUCCESS      | The 8259 PIC was programmed successfully.      |
| EFI_DEVICE_ERROR | There was an error while reading the 8259 PIC. |

## EFI\_LEGACY\_8259\_PROTOCOL.SetMode()

### Summary

Sets the mode of the PICs.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_8259_SET_MODE) (
    IN  EFI_LEGACY_8259_PROTOCOL  *This,
    IN  EFI_8259_MODE             Mode,
    IN  UINT16                    *Mask, OPTIONAL
    IN  UINT16                    *EdgeLevel OPTIONAL
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_8259\_PROTOCOL** instance.

#### *Mode*

16-bit real or 32-bit protected mode. Type **EFI\_8259\_MODE** is defined in "Related Definitions" below.

#### *Mask*

The value with which to set the interrupt mask.

#### *EdgeLevel*

The value with which to set the edge/level mask.

### Description

This function switches from one mode to the other mode. This procedure is not to be invoked multiple times for changing masks in the same mode but changing masks. Use the **EFI\_LEGACY\_8259\_PROTOCOL.SetMask()** function instead.

### Related Definitions

```

//*****
//  EFI_8259_MODE
//*****
typedef enum {
    Efi8259LegacyMode,
    Efi8259ProtectedMode,
    Efi8259MaxMode
} EFI_8259_MODE;
```

**Status Codes Returned**

|                       |                                |
|-----------------------|--------------------------------|
| EFI_SUCCESS           | The mode was set successfully. |
| EFI_INVALID_PARAMETER | The mode was not set.          |

## EFI\_LEGACY\_8259\_PROTOCOL.GetVector()

### Summary

Translates the IRQ into a vector.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_8259_GET_VECTOR) (
    IN EFI_LEGACY_8259_PROTOCOL    *This,
    IN EFI_8259_IRQ                Irq
    OUT UINT8                      *Vector
)
```

### Parameters

#### *This*

Indicates the EFI\_LEGACY\_8259\_PROTOCOL instance.

#### *Irq*

IRQ0–IRQ15. Type EFI\_8259\_IRQ is defined in "Related Definitions" below.

#### *Vector*

The vector that is assigned to the IRQ.

### Description

This function retrieves the vector that is assigned to the IRQ.

### Related Definitions

```

/*****
// EFI_8259_IRQ
*****/
typedef enum {
    Efi8259Irq0,
    Efi8259Irq1,
    Efi8259Irq2,
    Efi8259Irq3,
    Efi8259Irq4,
    Efi8259Irq5,
    Efi8259Irq6,
    Efi8259Irq7,
    Efi8259Irq8,

```

```
Efi8259Irq9,  
Efi8259Irq10,  
Efi8259Irq11,  
Efi8259Irq12,  
Efi8259Irq13,  
Efi8259Irq14,  
Efi8259Irq15,  
Efi8259IrqMax  
} EFI_8259_IRQ;
```

### Status Codes Returned

|                       |   |
|-----------------------|---|
| EFI_SUCCESS           | The <i>Vector</i> that matches <i>Irq</i> was returned. |
| EFI_INVALID_PARAMETER | <i>Irq</i> is not valid.                                |

## EFI\_LEGACY\_8259\_PROTOCOL.EnableIrq()

### Summary

Enables the specified IRQ.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_8259_ENABLE_IRQ) (
    IN  EFI_LEGACY_8259_PROTOCOL  *This,
    IN  EFI_8259_IRQ              Irq,
    IN  BOOLEAN                   LevelTriggered
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_8259\_PROTOCOL** instance.

#### *Irq*

8259 IRQ0–IRQ15. Type **EFI\_8259\_IRQ** is defined in **EFI\_LEGACY\_8259\_PROTOCOL.GetVector()**.

#### *LevelTriggered*

0 = Edge triggered; 1 = Level triggered.

### Description

This function enables the specified *Irq* by unmasking the interrupt in the 32-bit mode environment's 8259 PIC.

### Status Codes Returned

|                       |   |
|-----------------------|---|
| EFI_SUCCESS           | The <i>Irq</i> was enabled on the 8259 PIC. |
| EFI_INVALID_PARAMETER | The <i>Irq</i> is not valid.                |

## EFI\_LEGACY\_8259\_PROTOCOL.DisableIrq()

### Summary

Disables the specified IRQ.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_8259_DISABLE_IRQ) (
    IN  EFI_LEGACY_8259_PROTOCOL  *This,
    IN  EFI_8259_IRQ              Irq
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_8259\_PROTOCOL** instance.

#### *Irq*

8259 IRQ0–IRQ15. Type **EFI\_8259\_IRQ** is defined in **EFI\_LEGACY\_8259\_PROTOCOL.GetVector()**.

### Description

This function disables the specified *Irq* by masking the interrupt in the 32-bit mode environment's 8259 PIC.

### Status Codes Returned

|                       |  |
|-----------------------|--|
| EFI_SUCCESS           | The <i>Irq</i> was disabled on the 8259 PIC. |
| EFI_INVALID_PARAMETER | The <i>Irq</i> is not valid.                 |

## EFI\_LEGACY\_8259\_PROTOCOL.GetInterruptLine()

### Summary

Reads the PCI configuration space to get the interrupt number that is assigned to the card.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_8259_GET_INTERRUPT_LINE) (
    IN  EFI_LEGACY_8259_PROTOCOL  *This,
    IN  EFI_HANDLE                PciHandle,
    OUT UINT8                     *Vector
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_8259\_PROTOCOL** instance.

#### *PciHandle*

PCI function for which to return the vector. Type **EFI\_HANDLE** is defined in **InstallProtocolInterface()** in the *EFI 1.10 Specification*.

#### *Vector*

IRQ number that corresponds to the interrupt line.

### Description

This function reads the PCI configuration space to get the interrupt number that is assigned to the card. *PciHandle* represents a PCI configuration space of a PCI function. *Vector* represents the interrupt pin (from the PCI configuration space) and it is the data that is programmed into the interrupt line (from the PCI configuration space) register.

### Status Codes Returned

|             |   |
|-------------|---|
| EFI_SUCCESS | The interrupt line value was read successfully. |
|-------------|---|

## EFI\_LEGACY\_8259\_PROTOCOL.EndOfInterrupt()

### Summary

Issues the End of Interrupt (EOI) commands to PICs.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_8259_END_OF_INTERRUPT) (
    IN EFI_LEGACY_8259_PROTOCOL  *This,
    IN EFI_8259_IRQ              Irq
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_8259\_PROTOCOL** instance.

#### *Irq*

The interrupt for which to issue the EOI command. Type **EFI\_8259\_IRQ** is defined in **EFI\_LEGACY\_8259\_PROTOCOL.GetVector()**.

### Description

This function issues the end of interrupt commands to PICs.

### Status Codes Returned

|                       |                              |
|-----------------------|------------------------------|
| EFI_SUCCESS           | The EOI command was issued.  |
| EFI_INVALID_PARAMETER | The <i>Irq</i> is not valid. |

## 3.2.5 Legacy Interrupt Protocol

### EFI\_LEGACY\_INTERRUPT\_PROTOCOL

#### Summary

Abstracts the PIRQ programming from the generic EFI Compatibility Support Modules (CSMs).

#### GUID

```
// { 31CE593D-108A-485D-ADB2-78F21F2966BE }
#define EFI_LEGACY_INTERRUPT_PROTOCOL_GUID \
    { 0x31ce593d, 0x108a, 0x485d, 0xad, 0xb2, 0x78, 0xf2, 0x1f, 0x29, 0x66, \
    0xbe }
```

#### Protocol Interface Structure

```
typedef struct _EFI_LEGACY_INTERRUPT_PROTOCOL {
    EFI_LEGACY_INTERRUPT_GET_NUMBER_PIRQS    GetNumberPirqs;
    EFI_LEGACY_INTERRUPT_GET_LOCATION        GetLocation;
    EFI_LEGACY_INTERRUPT_READ_PIRQ          ReadPirq;
    EFI_LEGACY_INTERRUPT_WRITE_PIRQ        WritePirq;
} EFI_LEGACY_INTERRUPT_PROTOCOL;
```

#### Parameters

##### *GetNumberPirqs*

Gets the number of PIRQs supported. See the **GetNumberPirqs()** function description.

##### *GetLocation*

Gets the PCI bus, device, and function that associated with this protocol. See the **GetLocation()** function description.

##### *ReadPirq*

Reads the indicated PIRQ register. See the **ReadPirq()** function description.

##### *WritePirq*

Writes to the indicated PIRQ register. See the **WritePirq()** function description.

#### Description

The **EFI\_LEGACY\_INTERRUPT\_PROTOCOL** is used to abstract the PIRQ programming from the generic code.

## EFI\_LEGACY\_INTERRUPT\_PROTOCOL.GetNumberPirqs()

### Summary

Gets the number of PIRQs that this hardware supports.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_INTERRUPT_GET_NUMBER_PIRQS) (
    IN  EFI_LEGACY_INTERRUPT_PROTOCOL  *This,
    OUT UINT8                          *NumberPirqs
)
```

### Parameters

*This*

Indicates the **EFI\_LEGACY\_INTERRUPT\_PROTOCOL** instance.

*NumberPirqs*

Number of PIRQs that are supported.

### Description

This function gets the number of PIRQs that are supported by the hardware.

### Status Codes Returned

|             |  |
|-------------|--|
| EFI_SUCCESS | The number of PIRQs was returned successfully. |
|-------------|--|

## EFI\_LEGACY\_INTERRUPT\_PROTOCOL.GetLocation()

### Summary

Gets the PCI location associated with this protocol.

### Prototype

```
typedef
EFI_STATUS
(EFIAPI *EFI_LEGACY_INTERRUPT_GET_LOCATION) (
    IN  EFI_LEGACY_INTERRUPT_PROTOCOL  *This,
    OUT UINT8                          *Bus,
    OUT UINT8                          *Device,
    OUT UINT8                          *Function
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_INTERRUPT\_PROTOCOL** instance.

#### *Bus*

PCI bus number of this device.

#### *Device*

PCI device number of this device.

#### *Function*

PCI function number of this device.

### Description

This function gets the PCI location of the device supporting this protocol.

### Status Codes Returned

|             |   |
|-------------|---|
| EFI_SUCCESS | The PCI bus number was returned successfully. |
|-------------|---|

## EFI\_LEGACY\_INTERRUPT\_PROTOCOL.ReadPirq()

### Summary

Reads the given PIRQ register and returns the IRQ that is assigned to it.

### Prototype

```
typedef
EFI_STATUS
(EFI_API *EFI_LEGACY_INTERRUPT_READ_PIRQ) (
    IN  EFI_LEGACY_INTERRUPT_PROTOCOL  *This,
    IN  UINT8                          PirqNumber,
    OUT UINT8                          *PirqData
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_INTERRUPT\_PROTOCOL** instance.

#### *PirqNumber*

PIRQ A = 0, PIRQ B = 1, and so on.

#### *PirqData*

IRQ assigned to this PIRQ

### Description

This function reads the indicated PIRQ register and returns the IRQ that is assigned to it.

### Status Codes Returned

|                       |                                     |
|-----------------------|-------------------------------------|
| EFI_SUCCESS           | The data was returned successfully. |
| EFI_INVALID_PARAMETER | The PIRQ number invalid.            |

## EFI\_LEGACY\_INTERRUPT\_PROTOCOL.WritePirq()

### Summary

Writes data to the specified PIRQ register.

### Prototype

```
typedef
EFI_STATUS
(EFI_API *EFI_LEGACY_INTERRUPT_WRITE_PIRQ) (
    IN  EFI_LEGACY_INTERRUPT_PROTOCOL  *This,
    IN  UINT8                          PirqNumber,
    IN  UINT8                          PirqData
)
```

### Parameters

#### *This*

Indicates the **EFI\_LEGACY\_INTERRUPT\_PROTOCOL** instance.

#### *PirqNumber*

PIRQ A = 0, PIRQB = 1, and so on.

#### *PirqData*

IRQ assigned to this PIRQ

### Description

This function writes the indicated PIRQ register with the requested data.

### Status Codes Returned

|                       |                          |
|-----------------------|--------------------------|
| EFI_SUCCESS           | The PIRQ was programmed. |
| EFI_INVALID_PARAMETER | The PIRQ is not valid.   |

## 3.3 Compatibility16 Code

### 3.3.1 Compatibility16 Code

The runtime Compatibility16 code (traditional 16-bit runtime code) is loaded as a binary file during the installation of **EFI\_LEGACY\_BIOS\_PROTOCOL**.

**EFI\_LEGACY\_BIOS\_PLATFORM\_PROTOCOL.GetSystemRom()** is invoked, which finds the appropriate binary file. The GUID referring to this binary is IBV specific and may be specific for an OEM supported by the IBV.

#### GUID

**IBV or OEM specific**

### 3.3.2 Legacy BIOS Interface

#### 3.3.2.1 Compatibility16 Table

#### EFI\_COMPATIBILITY16\_TABLE

##### Summary

There is a table located within the traditional BIOS in either the 0xF000:xxxx or 0xE000:xxxx physical address range. It is located on a 16-byte boundary and provides the physical address of the entry point for the Compatibility16 functions. These functions provide the platform-specific information that is required by the generic EfiCompatibility code. The functions are invoked via thunking by using **EFI\_LEGACY\_BIOS\_PROTOCOL.FarCall186()** with the 32-bit physical entry point defined below.

##### Prototype

```
typedef struct {
    UINT32          Signature;
    UINT8           TableChecksum;
    UINT8           TableLength;
    UINT8           EfiMajorRevision;
    UINT8           EfiMinorRevision;
    UINT8           TableMajorRevision;
    UINT8           TableMinorRevision;
    UINT16          Reserved;
    UINT16          Compatibility16CallSegment;
    UINT16          Compatibility16CallOffset;
    UINT16          PnPInstallationCheckSegment;
    UINT16          PnPInstallationCheckOffset;
    UINT32          EfiSystemTable;
    UINT32          OemIdStringPointer;
}
```

```

    UINT32          AcpiRsdPtrPointer;
    UINT16          OemRevision;
    UINT32          E820Pointer;
    UINT32          E820Length;
    UINT32          IrqRoutingTablePointer;
    UINT32          IrqRoutingTableLength;
    UINT32          MpTablePtr;
    UINT32          MpTableLength;
    UINT16          OemIntSegment;
    UINT16          OemIntOffset;
    UINT16          Oem32Segment;
    UINT16          Oem32Offset;
    UINT16          Oem16Segment;
    UINT16          Oem16Offset;
    UINT16          TpmSegment;
    UINT16          TpmOffset;
    UINT32          IbvPointer;
    UINT32          PciExpressBase;
    UINT8           LastPciBus;
} EFI_COMPATIBILITY16_TABLE;

```

## Parameters

### *Signature*

The string “\$EFI” denotes the start of the EfiCompatibility table. Byte 0 is “I,” byte 1 is “F,” byte 2 is “E,” and byte 3 is “\$” and is normally accessed as a DWORD or UINT32.

### *TableChecksum*

The value required such that byte checksum of *TableLength* equals zero.

### *TableLength*

The length of this table.

### *EfiMajorRevision*

The major EFI revision for which this table was generated.

### *EfiMinorRevision*

The minor EFI revision for which this table was generated.

### *TableMajorRevision*

The major revision of this table.

### *TableMinorRevision*

The minor revision of this table.

### *Reserved*

Reserved for future usage.

#### *Compatibility16CallSegment*

The segment of the entry point within the traditional BIOS for Compatibility16 functions.

#### *Compatibility16CallOffset*

The offset of the entry point within the traditional BIOS for Compatibility16 functions.

#### *PnPInstallationCheckSegment*

The segment of the entry point within the traditional BIOS for EfiCompatibility to invoke the PnP installation check.

#### *PnPInstallationCheckOffset*

The Offset of the entry point within the traditional BIOS for EfiCompatibility to invoke the PnP installation check.

#### *EfiSystemTable*

Pointer to EFI system resources table. EFI system resources table is of the type **EFI\_SYSTEM\_TABLE** defined in the *Intel® Platform Innovation Framework for EFI Driver Execution Environment Core Interface Specification (DXE CIS)*.

#### *OemIdStringPointer*

The address of an OEM-provided identifier string. The string is null terminated.

#### *AcpiRsdPtrPointer*

The 32-bit physical address where ACPI RSD PTR is stored within the traditional BIOS. The remained of the ACPI tables are located at their EFI addresses. The size reserved is the maximum for ACPI 2.0. The EfiCompatibility will fill in the ACPI RSD PTR with either the ACPI 1.0b or 2.0 values.

#### *OemRevision*

The OEM revision number. Usage is undefined but provided for OEM module usage.

#### *E820Pointer*

The 32-bit physical address where INT15 E820 data is stored within the traditional BIOS. The EfiCompatibility code will fill in the E820Pointer value and copy the data to the indicated area.

#### *E820Length*

The length of the E820 data and is filled in by the EfiCompatibility code.

#### *IrqRoutingTablePointer*

The 32-bit physical address where the **\$PIR** table is stored in the traditional BIOS. The EfiCompatibility code will fill in the *IrqRoutingTablePointer* value and copy the data to the indicated area.

#### *IrqRoutingTableLength*

The length of the **\$PIR** table and is filled in by the EfiCompatibility code.

#### *MpTablePtr*

The 32-bit physical address where the MP table is stored in the traditional BIOS. The EfiCompatibility code will fill in the *MpTablePtr* value and copy the data to the indicated area.

*MpTableLength*

The length of the MP table and is filled in by the EfiCompatibility code.

*Oemint15Segment*

The segment of the OEM-specific INT table/code.

*OemInt15Offset*

The offset of the OEM-specific INT table/code.

*Oem32Segment*

The segment of the OEM-specific 32-bit table/code.

*Oem32Offset*

The offset of the OEM-specific 32-bit table/code.

*Oem16Segment*

The segment of the OEM-specific 16-bit table/code.

*Oem16Offset*

The offset of the OEM-specific 16-bit table/code.

*TpmSegment*

The segment of the TPM binary passed to 16-bit CSM.

*TpmOffset*

The offset of the TPM binary passed to 16-bit CSM.

*IbvPointer*

A pointer to a string identifying the independent BIOS vendor.

*PciExpressBase*

This field is **NULL** for all systems not supporting PCI Express. This field is the base value of the start of the PCI Express memory-mapped configuration registers and must be filled in prior to EfiCompatibility code issuing the Compatibility16 function **Compatibility16InitializeYourself()**. **Compatibility16InitializeYourself()** is defined in Compatibility16 Functions.

*LastpciBus*

Maximum PCI bus number assigned.

 **NOTE**

The *E820Pointer*, *IrqRoutingTablePointer*, and *MpTablePtr* values are generated by calling the **Compatibility16GetTableAddress()** function and converted to 32-bit physical pointers.

### 3.3.3 Compatibility16 Functions

These functions are accessed by the EfiCompatibility code using the `EFI_LEGACY_BIOS_PROTOCOL.FarCall186()` call with the segment:offset equivalent of the 32-bit physical entry point for legacy EFI services.

Note that the `EFI_COMPATIBILITY_FUNCTIONS` are for IA-32. Unused registers on input and on output are undefined and not guaranteed to be preserved. Equivalents for the Itanium® processor family are not defined at this time.

#### NOTE

*Register AX denotes the function that is requested and the rest of the registers are function dependant.*

*Functions 0x0000–0x7FFF are standard Compatibility16 functions.*

*Functions 0x8000–0xFFFF are OEM-defined Compatibility16 functions and outside the scope of this document.*

#### 3.3.3.1 EFI Compatibility Functions

### EFI\_COMPATIBILITY\_FUNCTIONS

#### Summary

Functions to communicate between the EfiCompatibility and Compatibility16 code.

#### Prototype

```
typedef enum {
    Compatibility16InitializeYourself    0000,
    Compatibility16UpdateBbs            0001,
    Compatibility16PrepareToBoot        0002,
    Compatibility16Boot                  0003,
    Compatibility16RetrieveLastBootDevice 0004,
    Compatibility16DispatchOprom         0005,
    Compatibility16GetTableAddress       0006,
    Compatibility16SetKeyboardLeds       0007,
    Compatibility16InstallPciHandler     0008,
} EFI_COMPATIBILITY_FUNCTIONS;
```

## Parameters

### **Compatibility16InitializeYourself**

Causes the Compatibility16 code to do any internal initialization required. See the **Compatibility16InitializeYourself()** function description.

### **Compatibility16UpdateBbs**

Causes the Compatibility16 BIOS to perform any drive number translations to match the boot sequence. See the **Compatibility16UpdateBbs()** function description.

### **Compatibility16PrepareToBoot**

Allows the Compatibility16 code to perform any final actions before booting. See the **Compatibility16PrepareToBoot()** function description.

### **Compatibility16Boot**

Causes the Compatibility16 BIOS to boot. See the **Compatibility16Boot()** function description.

### **Compatibility16RetrieveLastBootDevice**

Allows the Compatibility16 code to get the last device from which a boot was attempted. See the **Compatibility16RetrieveLastBootDevice()** function description.

### **Compatibility16DispatchOprom**

Allows the Compatibility16 code rehook INT13, INT18, and/or INT19 after dispatching a legacy OpROM. See the **Compatibility16DispatchOprom()** function description.

### **Compatibility16GetTableAddress**

Finds a free area in the 0xFxxxx or 0xExxxx region of the specified length and returns the address of that region. See the **Compatibility16GetTableAddress()** function description.

### **Compatibility16SetKeyboardLeds**

Enables the EfiCompatibility module to do any nonstandard processing of keyboard LEDs or state. See the **Compatibility16SetKeyboardLeds()** function description.

### **Compatibility16InstallPciHandler**

Enables the EfiCompatibility module to install an interrupt handler for PCI mass media devices that do not have an OpROM associated with them. See the **Compatibility16InstallPciHandler()** function description.

## Compatibility16InitializeYourself()

### Summary

Causes the Compatibility16 code to do any internal initialization required. The `EFI_TO_COMPATIBILITY16_INIT_TABLE` pointer is passed into this function.

### Input Registers

AX = `Compatibility16InitializeYourself`

ES:BX = Pointer to `EFI_TO_COMPATIBILITY16_INIT_TABLE`

### Output Registers

AX = Return Status codes

### Related Definitions

```

//*****
// EFI_TO_COMPATIBILITY16_INIT_TABLE
//*****
typedef struct {
    UINT32      BiosLessThan1MB;
    UINT32      HiPmmMemory;
    UINT32      HiPmmMemorySizeInBytes;
    UINT16      ReverseThunkCallSegment;
    UINT16      ReverseThunkCallOffset;
    UINT32      NumberE820Entries;
    UINT32      OsMemorybove1Mb;
    UINT32      ThunkStart;
    UINT32      ThunkSizeInBytes;
    UINT32      LowPmmMemory;
    UINT32      LowPmmMemorySizeInBytes;
} EFI_TO_COMPATIBILITY16_INIT_TABLE;

```

#### *BiosLessThan1MB*

Starting address of low memory block (below 1MB) that can be used for PMM. The end address is assumed to be 0x9FFFF. This field is maintained for compatibility with previous versions of the specification and the CSM16 should not use this field. The CSM16 should use *LowPmmMemory* and *LowPmmMemorySizeInBytes* fields for the low memory that can be used for PMM.

#### *HiPmmMemory*

Starting address of the high memory block.

*HiPmmMemorySizeInBytes*

Length of high memory block.

*ReverseThunkCallSegment*

The segment of the reverse thunk call code.

*ReverseThunkCallOffset*

The offset of the reverse thunk call code.

*Number820Entries*

The number of E820 entries copied to the Compatibility16 BIOS.

*OsMemoryAbove1Mb*

The amount of usable memory above 1 MB, e.g., E820 type 1 memory.

*ThunkStart*

The start of thunk code in main memory. Memory cannot be used by BIOS or PMM.

*ThunkSizeInBytes*

The size of the thunk code.

*LowPmmMemory*

Starting address of memory under 1 MB.

*LowPmmMemorySizeInBytes*

Length of low Memory block.

 **NOTE**

The address of the *ReverseThunkCall* code is provided in case the Compatibility16 code needs to invoke a Compatibility16 function. It is **not** used to return from this function or any other traditional BIOS interface function. These functions simply do a far return.

 **NOTE**

CSM16 must handle cases where the PMM pointers are NULL. That indicates that PMM is not supported for that range. If both pointers are NULL then PMM is not supported. This covers cases where no add-in cards are supported and/or memory given to EFI.

CSM16 must initialize the PMM regions to zero prior to usage by OPROMS. CSM16 should not assume the CSM32 has zeroed out the regions.

CSM16 must monitor for EBDA size increase after OPROM is initialized and adjust PMM below 1MB, if required.

### Status Codes Returned

|             |        |
|-------------|--------|
| EFI_SUCCESS | 0x0000 |
|-------------|--------|

## Compatibility16UpdateBbs()

### Summary

Causes the Compatibility16 BIOS to perform any drive number translations to match the boot sequence.

### Input Registers

AX = **Compatibility16UpdateBbs**

ES:BX = Pointer to **EFI\_TO\_COMPATIBILITY16\_BOOT\_TABLE**

### Output Registers

AX = Returned status codes

### Status Codes Returned

|             |        |
|-------------|--------|
| EFI_SUCCESS | 0x0000 |
|-------------|--------|

## Compatibility16PrepareToBoot()

### Summary

Allows the Compatibility16 code to perform any final actions before booting. The Compatibility16 code is read/write.

### Input Registers

AX = **Compatibility16PrepareToBoot**

ES:BX = Pointer to **EFI\_TO\_COMPATIBILITY16\_BOOT\_TABLE** structure

### Output Registers

AX = Returned status codes

### Related Definitions

The following data types and structures are defined in this section. These definitions in turn may contain other data type and structure definitions that are not included in this list.

- **EFI\_TO\_COMPATIBILITY16\_BOOT\_TABLE**
- **DEVICE\_PRODUCER\_DATA\_HEADER**
- **HDD\_INFO**
- **BBS\_TABLE**
- **BBS\_STATUS\_FLAGS**
- **SMM\_TABLE**
- **UD\_TABLE**
- **UDC\_ATTRIBUTES**

```

//*****
// EFI_TO_COMPATIBILITY16_BOOT_TABLE
//*****
typedef struct {
    UINT16          MajorVersion;
    UINT16          MinorVersion;
    UINT32          AcpiTable;           // 4 GB range
    UINT32          SmbiosTable;        // 4 GB range
    UINT32          SmbiosTableLength;

    //
    // Legacy SIO state
    //

```

```

DEVICE_PRODUCER_DATA_HEADER    SioData;
UINT16                          DevicePathType;
UINT16                          PciIrqMask;
UINT32                          NumberE820Entries;

//
// Controller & Drive Identify[2] per controller information
//

HDD_INFO                        HddInfo[MAX_IDE_CONTROLLER];
UINT32                          NumberBbsEntries;
UINT32                          BbsTable;
UINT32                          SmmTable;
UINT32                          OsMemoryAbove1Mb;
UINT32                          UnconventionalDeviceTable;
} EFI_TO_COMPATIBILITY16_BOOT_TABLE;

```

*MajorVersion*

The EfiCompatibility major version number.

*MinorVersion*

The EfiCompatibility minor version number.

*AcpiTable*

Location of the RSDT ACPI table.

*SmbiosTable*

Location of the SMBIOS table in EFI memory.

*SioData*

Standard traditional device information. Type **DEVICE\_PRODUCER\_DATA\_HEADER** is defined below.

*DevicePathType*

The default boot type. Following are the defined values:

1. FD = Floppy
2. HD = Hard Disk
3. CDROM = CD-ROM
4. PCMCIA = PCMCIA
5. USB = USB
6. NET = Networks
7. BEV = BBS BEV devices

*PciIrqMask*

Mask of which IRQs have been assigned to PCI.

*NumberE820Entries*

Number of E820 entries. The number can change from the **Compatibility16InitializeYourself()** function.

*HddInfo*

Hard disk drive information, including raw Identify Drive data. Type **HDD\_INFO** is defined below.

*NumberBbsEntries*

Number of entries in the BBS table

*BbsTable*

Pointer to the BBS table. Type **BBS\_TABLE** is defined below.

*SmmTable*

Pointer to the SMM table. Type **SMM\_TABLE** is defined below.

*OsMemoryAbove1Mb*

The amount of usable memory above 1 MB, i.e. E820 type 1 memory. This value can differ from the value in **EFI\_TO\_COMPATIBILITY16\_INIT\_TABLE** as more memory may have been discovered.

*UnconventionalDeviceTable*

Information to boot off an unconventional device like a PARTIES partition. Type **UD\_TABLE** is defined below.

```
//*****
// DEVICE_PRODUCER_DATA_HEADER
//*****
typedef struct {
    DEVICE_PRODUCER_SERIAL    Serial[4];
    DEVICE_PRODUCER_PARALLEL  Parallel[3];
    DEVICE_PRODUCER_FLOPPY    Floppy;
    UINT8                     MousePresent;
    LEGACY_DEVICE_FLAGS       Flags;
} DEVICE_PRODUCER_DATA_HEADER;
```

*Serial*

Data for serial port x. Type **DEVICE\_PRODUCER\_SERIAL** is defined below.

*Parallel*

Data for parallel port x. Type **DEVICE\_PRODUCER\_PARALLEL** is defined below.

*Floppy*

Data for floppy. Type **DEVICE\_PRODUCER\_FLOPPY** is defined below.

*MousePresent*

Flag to indicate if mouse is present.

*Flags*

Miscellaneous Boolean state information passed to CSM. Type **LEGACY\_DEVICE\_FLAGS** is defined below.

```

/*****
// DEVICE_PRODUCER_SERIAL
/*****
typedef struct {
    UINT16      Address;
    UINT8       Irq;
    SERIAL_MODE Mode;
} DEVICE_PRODUCER_SERIAL;

```

*Address*

I/O address assigned to the serial port

*Irq*

IRQ assigned to the serial port.

*Mode*

Mode of serial port. Values are defined below.

```

/*****
// Serial Mode values
/*****
#define DEVICE_SERIAL_MODE_NORMAL      0x00
#define DEVICE_SERIAL_MODE_IRDA       0x01
#define DEVICE_SERIAL_MODE_ASK_IR     0x02
#define DEVICE_SERIAL_MODE_DUPLEX_HALF 0x00
#define DEVICE_SERIAL_MODE_DUPLEX_FULL 0x10

/*****
// DEVICE_PRODUCER_PARALLEL
/*****

typedef struct {

```

```

    UINT16      Address;
    UINT8       Irq;
    UINT8       Dma;
    PARALLEL_MODE Mode;
} DEVICE_PRODUCER_PARALLEL;

```

*Address*

I/O address assigned to the parallel port

*Irq*

IRQ assigned to the parallel port.

*Dma*

DMA assigned to the parallel port.

*Mode*

Mode of the parallel port. Values are defined below.

```

//*****
// Parallel Mode values
//*****
#define DEVICE_PARALLEL_MODE_MODE_OUTPUT_ONLY    0x00
#define DEVICE_PARALLEL_MODE_MODE_BIDIRECTIONAL  0x01
#define DEVICE_PARALLEL_MODE_MODE_EPP           0x02
#define DEVICE_PARALLEL_MODE_MODE_ECP           0x03

//*****
// DEVICE_PRODUCER_FLOPPY
//*****
typedef struct {
    UINT16      Address;
    UINT8       Irq;
    UINT8       Dma;
    UINT8       NumberOfFloppy;
} DEVICE_PRODUCER_FLOPPY;

```

*Address*

I/O address assigned to the floppy

*Irq*

IRQ assigned to the floppy.

*Dma*

DMA assigned to the floppy.

*NumberOfFloppy*

Number of floppies in the system.

```

//*****
// LEGACY_DEVICE_FLAGS
//*****

typedef struct {
    UINT32      A20Kybd:1;
    UINT32      A20Port92:1;
    UINT32      Reserved:30;
} LEGACY_DEVICE_FLAGS;

```

*A20Kybd*

A20 controller by keyboard controller.

*A20Port92*

A20 controlled by port 0x92.

*Reserved*

Reserved for future usage.

 **NOTE**

*A20Kybd* and *A20Port92* are **not** mutually exclusive.

```

//*****
// HDD_INFO
//*****

typedef struct {
    UINT16          Status;
    UINT32          Bus;
    UINT32          Device;
    UINT32          Function;
    UINT16          CommandBaseAddress;
    UINT16          ControlBaseAddress;
    UINT16          BusMasterAddress;
    UINT8           HddIrq;
    ATAPI_IDENTIFY IdentifyDrive[2];
} HDD_INFO;

```

*Status*

Status of IDE device. Values are defined below. There is one **HDD\_INFO** structure per IDE controller. The *IdentifyDrive* is per drive. Index 0 is master and index 1 is slave.

*Bus*

PCI bus of IDE controller.

*Device*

PCI device of IDE controller.

*Function*

PCI function of IDE controller.

*CommandBaseAddress*

Command ports base address.

*ControlBaseAddress*

Control ports base address.

*BusMasterAddress*

Bus master address

*IdentifyDrive*

Data that identifies the drive data, one per possible attached drive. Type **ATAPI\_IDENTIFY** is defined below.

```

//*****
// Status values
//*****

#define HDD_PRIMARY          0x01
#define HDD_SECONDARY       0x02
#define HDD_MASTER_ATAPI    0x04
#define HDD_SLAVE_ATAPI     0x08
#define HDD_MASTER_ATAPI_ZIPDISK 0x10
#define HDD_MASTER_IDE      0x20
#define HDD_SLAVE_IDE       0x40
#define HDD_SLAVE_ATAPI_ZIPDISK 0x80

//*****
// ATAPI_IDENTIFY
//*****

typedef struct {
    UINT16    Raw[256];
} ATAPI_IDENTIFY;

Raw
    Raw data from the IDE IdentifyDrive command.

//*****
// BBS_TABLE
//*****

typedef struct {
    UINT16    BootPriority;
    UINT32    Bus;
    UINT32    Device;
    UINT32    Function;
    UINT8     Class;
    UINT8     SubClass;
}

```

```

    UINT16           MfgStringOffset;
    UINT16           MfgStringSegment;
    UINT16           DeviceType;
    BBS_STATUS_FLAGS StatusFlags;
    UINT16           BootHandlerOffset;
    UINT16           BootHandlerSegment;
    UINT16           DescStringOffset;
    UINT16           DescStringSegment;
    UINT32           InitPerReserved;
    UINT32           AdditionalIrq13Handler;
    UINT32           AdditionalIrq18Handler;
    UINT32           AdditionalIrq19Handler;
    UINT32           AdditionalIrq40Handler;
    UINT8           AssignedDriveNumber;
    UINT32           AdditionalIrq41Handler;
    UINT32           AdditionalIrq46Handler;
    UINT32           IBV1;
    UINT32           IBV2;
} BBS_TABLE;

```

#### *BootPriority*

The boot priority for this boot device. Values are defined below.

#### *Bus*

The PCI bus for this boot device.

#### *Device*

The PCI device for this boot device.

#### *Function*

The PCI function for the boot device.

#### *Class*

The PCI class for this boot device..

#### *SubClass*

The PCI Subclass for this boot device.

#### *MfgString*

Segment:offset address of an ASCIIZ description string describing the manufacturer.

#### *DeviceType*

BBS device type. BBS device types are defined below.

*StatusFlags*

Status of this boot device. Type **BBS\_STATUS\_FLAGS** is defined below.

*BootHandler*

Segment:Offset address of boot loader for IPL devices or install INT13 handler for BCV devices.

*DescString*

Segment:offset address of an ASCIIZ description string describing this device.

*InitPerReserved*

Reserved.

*AdditionalIrq??Handler*

The use of these fields is IBV dependent. They can be used to flag that an OpROM has hooked the specified IRQ. The OpROM may be BBS compliant as some SCSI BBS-compliant OpROMs also hook IRQ vectors in order to run their BIOS Setup.

```

//*****
// BootPriority values
//*****
#define BBS_DO_NOT_BOOT_FROM          0xFFFC
#define BBS_LOWEST_PRIORITY           0xFFFD
#define BBS_UNPRIORITIZED_ENTRY      0xFFFE
#define BBS_IGNORE_ENTRY              0xFFFF

```

Table 11 gives a description of the above fields.

**Table 11 BBS Fields**

|                         |   |
|-------------------------|---|
| BBS_DO_NOT_BOOT_FROM    | Removes a device from the boot list but still allows it to be enumerated as a valid device under MS-DOS*.   |
| BBS_LOWEST_PRIORITY     | Forces the device to be the last boot device.   |
| BBS_UNPRIORITIZED_ENTRY | Value that is placed in the <b>BBS_TABLE.BootPriority</b> field before priority has been assigned but that indicates it is valid entry. Other values indicate the priority, with 0x0000 being the highest priority. |
| BBS_IGNORE_ENTRY        | When placed in the <b>BBS_TABLE.BootPriority</b> field, indicates that the entry is to be skipped.  |

```

//*****
// DeviceType values
//*****
#define     BBS_FLOPPY           0x01
#define     BBS_HARDDISK        0x02
#define     BBS_CDROM           0x03
#define     BBS_PCMCIA          0x04
#define     BBS_USB              0x05
#define     BBS_EMBED_NETWORK   0x06
#define     BBS_BEV_DEVICE      0x80
#define     BBS_UNKNOWN         0xff

//*****
// BBS_STATUS_FLAGS
//*****

typedef struct {
    UINT16      OldPosition      : 4;
    UINT16      Reserved1       : 4;
    UINT16      Enabled          : 1;
    UINT16      Failed           : 1;
    UINT16      MediaPresent     : 2;
    UINT16      Reserved2       : 4;
} BBS_STATUS_FLAGS ;

```

*OldPosition*

Prior priority.

*Reserved1*

Reserved for future use.

*Enabled*

If 0, ignore this entry.

*Failed*

0 = Not known if boot failure occurred.

1 = Boot attempted failed.

*MediaPresent*

State of media present.

00 = No bootable media is present in the device.

01 = Unknown if a bootable media present.

10 = Media is present and appears bootable.

11 = Reserved.

*Reserved2*

Reserved for future use.

```

//*****
// SMM_TABLE
//*****
//
// SMM Table definitions
// SMM table has a header that provides the number of entries.
// Following the header is a variable length amount of data.
//

typedef struct {
    UINT16          NumSmmEntries;
    SMM_ENTRY       SmmEntry;
} SMM_TABLE;

```

*NumSmmEntries*

Number of entries represented by *SmmEntry*.

*SmmEntry*

One entry per function. Type **SMM\_ENTRY** is defined below.

```

//*****
// SMM_ENTRY
//*****
typedef struct {
    SMM_ATTRIBUTES  SmmAttributes;
    SMM_FUNCTION     SmmFunction;
}

```

```

    UINTx          SmmPort;
    UINTx          SmmData;
} SMM_ENTRY;

```

*SmmAttributes*

Describes the access mechanism, *SmmPort*, and *SmmData* sizes. Type **SMM\_ATTRIBUTES** is defined below.

*SmmFunction*

Function Soft SMI is to perform. Type **SMM\_FUNCTION** is defined below.

*SmmPort*

*SmmPort* size depends upon *SmmAttributes* and ranges from 1 bytes to 8 bytes

*SmmData*

*SmmData* size depends upon *SmmAttributes* and ranges from 1 bytes to 8 bytes

 **NOTE**

The *SmmPort* and *SmmData* are packed in order to present the smallest footprint for the CSM16. Typically the user will set a pointer to the *SmmPort* and then use a structure like the one below to access the port and data.

```

typedef struct {
    UINT8          SmmPort;
    UINT8          SmmData;
} P8D8;

//*****
// SMM_ATTRIBUTES
//*****
typedef struct {
    UINT16        Type           : 3;
    UINT16        PortGranularity : 3;
    UINT16        DataGranularity : 3;
    UINT16        Reserved       : 7;
} SMM_ATTRIBUTES;

```

*Type*

Access mechanism used to generate the soft SMI. Defined types are below. The other values are reserved for future usage.

*PortGranularity*

Size of "port" in bits. Defined values are below.

*DataGranularity*

Size of data in bits. Defined values are below.

*Reserved*

Reserved for future use.

```

/*****
// Type values
/*****
#define STANDARD_IO      0x00
#define STANDARD_MEMORY  0x01

/*****
// PortGranularity values
/*****
#define PORT_SIZE_8      0x00
#define PORT_SIZE_16     0x01
#define PORT_SIZE_32     0x02
#define PORT_SIZE_64     0x03

/*****
// DataGranularity values
/*****
#define DATA_SIZE_8     0x00
#define DATA_SIZE_16    0x01
#define DATA_SIZE_32    0x02
#define DATA_SIZE_64    0x03

/*****
// SMM_FUNCTION
/*****
typedef struct {
    UINT16      Function      : 15;
    UINT16      Owner         : 1;
} SMM_FUNCTION;

```

*Function*

Function this Soft SMI is to initiate. Defined functions are below.

*Owner*

The definer of the function. Defined owners are below.

```

//*****
// Function values
//*****
#define INT15_D042          0x0000
#define GET_USB_BOOT_INFO  0x0001
#define DMI_PNP_50_57      0x0002
    
```

Table 12 gives a description of the fields in the above definition.

**Table 12 Function Value Descriptions**

|                   |   |
|-------------------|---|
| INT15_D042        | System Configuration Data functions accessed via INT15 AX=0xD042.   |
| GET_USB_BOOT_INFO | Retrieves USB boot device information for integration with BBS. The other values are reserved for future use. |
| DMI_PNP_50_57     | Process the DMI Plug and Play functions 0x50 through 0x57 via SMM code.                                       |

```

//*****
// Owner values
//*****
#define STANDARD_OWNER     0x0
#define OEM_OWNER          0x1
    
```

Table 13 gives a description of the fields in the above definition.

**Table 13 Owner Value Descriptions**

|                |   |
|----------------|---|
| STANDARD_OWNER | This document has defined the function.                       |
| OEM_OWNER      | An agent, other than this document, has defined the function. |

```

//*****
// UD_TABLE
//*****
typedef struct {
    UDC_ATTRIBUTES    Attributes;
    UINT8             DeviceNumber;
    UINT8             BbsTableEntryNumberForParentDevice;
    UINT8             BbsTableEntryNumberForBoot;
    UINT8             BbtTableEntryNumberForHddDiag;
    UINT8             BeerData[128];
    UINT8             ServiceAreaData[64];
} UD_TABLE;

```

#### *Attributes*

This field contains the bit-mapped attributes of the PARTIES information. Type **UDC\_ATTRIBUTES** is defined below.

#### *DeviceNumber*

This field contains the zero-based device on which the selected *ServiceDataArea* is present. It is 0 for master and 1 for the slave device.

#### *BbsTableEntryNumberForParentDevice*

This field contains the zero-based index into the *BbsTable* for the parent device. This index allows the user to reference the parent device information such as PCI bus, device function.

#### *BbsTableEntryNumberForBoot*

This field contains the zero-based index into the *BbsTable* for the boot entry.

#### *BbsTableEntryNumberForHddDiag*

This field contains the zero-based index into the *BbsTable* for the HDD diagnostics entry.

#### *BeerData*

The raw Beer data.

#### *ServiceAreaData*

The raw data of selected service area.

```

//*****
// UDC_ATTRIBUTES
//*****
typedef struct {
    UINT8      DirectoryServiceValidity      : 1;
    UINT8      RacbaUsedFlag                : 1;
    UINT8      ExecuteHddDiagnosticsFlag    : 1;
    UINT8      Reserved                     : 5;
} UDC_ATTRIBUTES;

```

*DirectoryServiceValidity*

This bit set indicates that the *ServiceAreaData* is valid.

*RacbaUsedFlag*

This bit set indicates to use the Reserve Area Boot Code Address (RACBA) only if *DirectoryServiceValidity* is 0.

*ExecuteHddDiagnosticsFlag*

This bit set indicates to execute hard disk diagnostics.

*Reserved*

Reserved for future use. Set to 0.

**Status Codes Returned**

|             |        |
|-------------|--------|
| EFI_SUCCESS | 0x0000 |
|-------------|--------|

## Compatibility16Boot()

### Summary

Causes the Compatibility16 BIOS to boot. The Compatibility16 code is Read/Only.

### Input Registers

AX = `Compatibility16Boot`

### Output Registers

AX = Returned status codes

### Related Definitions

```
typedef struct {  
} EFI_COMPATIBILITY16_BOOT;
```

### Status Codes Returned

|             |  |
|-------------|--|
| EFI_SUCCESS | 0x0000   |
| EFI_TBD     | 0x8000 – The master boot record is missing or corrupted. |

## Compatibility16RetrieveLastBootDevice()

### Summary

Allows the Compatibility16 code to get the last device from which a boot was attempted. This is stored in CMOS and is the priority number of the last attempted boot device.

### Input Registers

AX = **Compatibility16RetrieveLastBootDevice**

### Output Registers

AX = Returned status codes

BX = Priority number of the boot device.

### Status Codes Returned

|             |        |
|-------------|--------|
| EFI_SUCCESS | 0x0000 |
| EFI_ABORTED | 0x8015 |

## Compatibility16DispatchOprom()

### Summary

Allows the Compatibility16 code rehook INT13, INT18, and/or INT19 after dispatching a legacy OpROM.

### Input Registers

AX = `Compatibility16DispatchOprom`

ES:BX = Pointer to `EFI_DISPATCH_OPROM_TABLE`

### Output Registers

AX = Returned status codes

BX = Number of non-BBS-compliant devices found. Equals 0 if BBS compliant.

### Related Definitions

```

//*****
// EFI_DISPATCH_OPROM_TABLE
//*****
typedef struct {
    IN UINT16          PnpInstallationCheckSegment;
    IN UINT16          PnpInstallationCheckOffset;
    IN UINT16          OpromSegment;
    IN UINT8           PciBus;
    IN UINT8           PciDeviceFunction
    IN OUT UINT8       NumberBbbsEntries;
    VOID               *BbsTable;
} EFI_DISPATCH_OPROM_TABLE;

```

*PnpInstallationCheckSegment/Offset*

Pointer to the *PnpInstallationCheck* data structure.

*OpromSegment*

The segment where the OpROM was placed. Offset is assumed to be 3.

*PciBus*

The PCI bus.

*PciDeviceFunction*

The PCI device \* 0x08 | PCI function.

*NumberBbbsEntries*

The number of valid BBS table entries upon entry and exit. The IBV code may increase this number, if BBS-compliant devices also hook INTs in order to force the OpROM BIOS Setup to be executed.

*BbsTable*

Pointer to the BBS table.

**Status Codes Returned**

|             |        |
|-------------|--------|
| EFI_SUCCESS | 0x0000 |
|-------------|--------|

## Compatibility16GetTableAddress()

### Summary

Finds a free area in the 0xFxxxx or 0xExxxx region of the specified length and returns the address of that region.

### Input Registers

AX = **Compatibility16GetTableAddress**

BX = Allocation region

00 = Allocate from either 0xE0000 or 0xF0000 64 KB blocks.

Bit 0 = 1 Allocate from 0xF0000 64 KB block

Bit 1 = 1 Allocate from 0xE0000 64 KB block

CX = Requested length in bytes.

DX = Required address alignment. Bit mapped. First non-zero bit from the right is the alignment.

### Output Registers

AX = Returned status codes

DS:BX = Address of the region

### Status Codes Returned

|                      |        |
|----------------------|--------|
| EFI_SUCCESS          | 0x0000 |
| EFI_OUT_OF_RESOURCES | 0x8009 |

## Compatibility16SetKeyboardLeds()

### Summary

Enables the EfiCompatibility module to do any nonstandard processing of keyboard LEDs or state.

### Input Registers

AX = **Compatibility16SetKeyboardLeds**

CL = LED status.

Bit 0 – Scroll Lock      0 = Off

Bit 1 – Num Lock

Bit 2 – Caps Lock

### Output Registers

AX = Returned status codes

### Status Codes Returned

|             |        |
|-------------|--------|
| EFI_SUCCESS | 0x0000 |
|-------------|--------|

## Compatibility16InstallPciHandler()

### Summary

Enables the EfiCompatibility module to install an interrupt handler for PCI mass media devices that do not have an OpROM associated with them. An example is SATA.

### Input Registers

AX = **Compatibility16InstallPciHandler**

ES:BX = Pointer to **EFI\_LEGACY\_INSTALL\_PCI\_HANDLER** structure

### Output Registers

AX = Returned status codes

### Related Definitions

```

//*****
// EFI_LEGACY_INSTALL_PCI_HANDLER
//*****
typedef struct {
    UINT8          PciBus;
    UINT8          PciDeviceFun;
    UINT8          PciSegment;
    UINT8          PciClass;
    UINT8          PciSubclass;
    UINT8          PciInterface;
    //
    // Primary section
    //
    UINT8          PrimaryIrq;
    UINT8          PrimaryReserved;
    UINT16         PrimaryControl;
    UINT16         PrimaryBase;
    UINT16         PrimaryBusMaster;

    //
    // Secondary section
    //
    UINT8          SecondaryIrq;
    UINT8          SecondaryReserved;
    UINT16         SecondaryControl;

```

```
    UINT16          SecondaryBase;  
    UINT16          SecondaryBusMaster;  
} EFI_LEGACY_INSTALL_PCI_HANDLER;
```

*PciBus*

The PCI bus of the device.

*PciDeviceFun*

The PCI device in bits 7:3 and function in bits 2:0.

*PciSegment*

The PCI segment of the device.

*PciClass*

The PCI class code of the device.

*PciSubclass*

The PCI subclass code of the device.

*PciInterface*

The PCI interface code of the device.

*PrimaryIrq*

The primary device IRQ.

*PrimaryReserved*

Reserved.

*PrimaryControl*

The primary device control I/O base.

*PrimaryBase*

The primary device I/O base.

*PrimaryBusMaster*

The primary device bus master I/O base.

*SecondaryIrq*

The secondary device IRQ.

*SecondaryReserved*

Reserved.

*SecondaryControl*

The secondary device control I/O base.

*SecondaryBase*

The secondary device I/O base.

*SecondaryBusMaster*

The secondary device bus master I/O base.

**Status Codes Returned**

|             |        |
|-------------|--------|
| EFI_SUCCESS | 0x0000 |
|-------------|--------|

### 3.3.3.2 Legacy Soft SMI

#### Summary

SMM code is provided from the same IBV as the Compatibility16 and the Legacy BIOS Platform Protocol code. The soft SMI structures in **SMM\_TABLE** (defined in **Compatibility16PrepareToBoot()**) are meant to establish a common standard but are not required to be implemented by the IBV. If the structures are used, then the recommended interface between the SMM code and Compatibility16 code is defined below.

#### Input Registers

EAX, AX, AL = **SmmTable.SmmEntry.SmmData** (32-bit, 16-bit, or 8-bit)

EDX, DX, DL = **SmmTable.SmmEntry.SmmPort** (32-bit, 16-bit, or 8-bit)

ESI = Pointer to **EFI\_DWORD\_REGS**

#### Related Definitions

EFI\_DWORD\_REGS is defined in the **EFI\_LEGACY\_BIOS\_PROTOCOL.Int86()** function.

## 4.1 Example of a Dummy EFI SMM Child Driver

User defined areas are highlighted like this in yellow.

```
/**+

Module Name:

    UnitTestChild.c

Abstract:

    This is a generic template for a child of the IchSmm driver.

--*/

#include "Efi.h"
#include "EfiRuntimeLib.h"

#include "GetFvImage.h"

#include EFI_PROTOCOL_CONSUMER(SmmBase)
#include EFI_PROTOCOL_CONSUMER(FirmwareVolume)
#include EFI_PROTOCOL_CONSUMER(SmmSwDispatch)

EFI_SMM_BASE_PROTOCOL          *mSmmBase;
EFI_SMM_SYSTEM_TABLE          *mSmst;
EFI_SMM_SW_DISPATCH_PROTOCOL  *mSwDispatch;

// GUID for the FV file that this source file gets compiled into
EFI_GUID  mChildFileGuid = { your guid here };
```

```
////////////////////////////////////  
// Callback function prototypes  
  
VOID  
SwCallback (  
    IN  EFI_HANDLE          DispatchHandle,  
    IN  EFI_SMM_SW_DISPATCH_CONTEXT  *DispatchContext  
);
```

```
////////////////////////////////////
```

```
EFI_DRIVER_ENTRY_POINT(InitializeChild)
```

```
EFI_STATUS  
InitializeChild (  
    IN EFI_HANDLE          ImageHandle,  
    IN EFI_SYSTEM_TABLE  *SystemTable  
)  
/**+
```

Routine Description:

Initializes the SMM Handler Driver

Arguments:

ImageHandle -

SystemTable -

Returns:

None

```
--*/
```

```
{  
    EFI_STATUS          Status;
```

```

BOOLEAN                InSmm;
EFI_HANDLE              Handle;
UINT8*                 Buffer;
UINTN                   BufferSize;

EFI_SMM_SW_DISPATCH_CONTEXT SwContext = { 0 };
EFI_HANDLE              SwHandle = 0;

Status = BufferSize = InSmm = 0;
Handle = Buffer = NULL;

//
// Initialize the EFI Runtime Library
//
EfiInitializeSmmDriverLib (ImageHandle, SystemTable);

Status = gBS->LocateProtocol(&gEfiSmmBaseProtocolGuid, NULL, &mSmmBase);
if (EFI_ERROR(Status)) {
    return Status;
}

mSmmBase->InSmm(mSmmBase, &InSmm);

if (!InSmm) {
    //
    // This driver is dispatched by DXE, so first call to this
    // driver will not be in SMM. We need to load this driver
    // into SMRAM and then generate an SMI to initialize data
    // structures in SMRAM.
    //

    // Load this driver's image to memory
    Status = GetFvImage(&mChildFileGuid, &Buffer, &BufferSize);
    if (!EFI_ERROR(Status)) {
        // Load the image in memory to SMRAM; it will automatically
        // generate the SMI.
        mSmmBase->Register(mSmmBase, NULL, Buffer, BufferSize, &Handle,
FALSE);

```

```
        gBS->FreePool(Buffer);
    }

} else {
    //
    // Great! We're now in SMM!
    //

    // Initialize global variables
    mSmmBase->GetSmstLocation(mSmmBase, &mSmst);

    // Locate SwDispatch protocol
    Status = gBS->LocateProtocol(&gEfiSmmSwDispatchProtocolGuid, NULL,
&mSwDispatch);
    if (EFI_ERROR(Status)) {
        DEBUG(( EFI_D_ERROR, "Couldn't find SmmSwDispatch protocol: %r\n",
Status));
        return Status;
    }

    //
    // Register for callbacks
    //

    // Pick a value for the context and register for it
    SwContext.SwSmiInputValue = your value written to software SMI port;
    Status = mSwDispatch->Register( mSwDispatch, SwCallback, &SwContext,
&SwHandle );
    ASSERT_EFI_ERROR( Status );

    // If your SMM handler can be entered via multiple soft SMM values
    // then repeat the above 3 lines per additional value,

}

return EFI_SUCCESS;
}
```

```
////////////////////////////////////  
// Callback functions  
  
VOID  
SwCallback (  
    IN  EFI_HANDLE                DispatchHandle,  
    IN  EFI_SMM_SW_DISPATCH_CONTEXT *DispatchContext  
)  
{  
    DEBUG(( EFI_D_ERROR, "          Sw SMI captured w/ context  
0x%02x\n", DispatchContext->SwSmiInputValue));  
    // place your SMM code here  
  
}
```

```
////////////////////////////////////
```

## 4.2 Example of a Dummy EFI Hardware SMM Child Driver

User defined areas are highlighted like this.

```
/**++
```

```
Module Name:
```

```
    YourName.c
```

```
Abstract:
```

```
    This is a generic template for a child of the IchSmm driver.
```

```
Revision History
```

```
--*/
```

```
#include "Efi.h"
```

```
#include "EfiRuntimeLib.h"
```

```
#include "GetFvImage.h"
```

```
#include EFI_PROTOCOL_CONSUMER(SmmBase)
```

```
#include EFI_PROTOCOL_CONSUMER(FirmwareVolume)
```

```
#include EFI_PROTOCOL_CONSUMER(YourFileDispatch)
```

```
// GUID for the FV file that this source file gets compiled into
```

```
EFI_GUID mChildFileGuid = { Your GUID here };
```

```

////////////////////////////////////
// Callback function prototypes

VOID
YourCallback (
    IN EFI_HANDLE          DispatchHandle,
    IN EFI_SMM_YOUR_DISPATCH_CONTEXT *DispatchContext
);

////////////////////////////////////

EFI_DRIVER_ENTRY_POINT(InitializeChild)

EFI_STATUS
InitializeChild (
    IN EFI_HANDLE      ImageHandle,
    IN EFI_SYSTEM_TABLE *SystemTable
)
/*++

Routine Description:

    Initializes the SMM Handler Driver

Arguments:

    ImageHandle -

    SystemTable -

Returns:

    None

--*/
{

```

Your code here

```
//
// Initialize the EFI Runtime Library
//
EfiInitializeSmmDriverLib (ImageHandle, SystemTable);

Status = gBS->LocateProtocol(&gEfiSmmBaseProtocolGuid, NULL, &mSmmBase);
if (EFI_ERROR(Status)) {
    return Status;
}

mSmmBase->InSmm(mSmmBase, &InSmm);

if (!InSmm) {
    //
    // This driver is dispatched by DXE, so first call to this driver
    // will not be in SMM. We need to load this driver into SMRAM and
    // then generate an SMI to initialize data structures in SMRAM.
    //

    // Load this driver's image to memory
    Status = GetFvImage(&mChildFileGuid, &Buffer, &BufferSize);
    if (!EFI_ERROR(Status)) {
        // Load the image in memory to SMRAM; it will automatically
        // generate the SMI.
        mSmmBase->Register(mSmmBase, NULL, Buffer, BufferSize, &Handle,
FALSE);
        gBS->FreePool(Buffer);
    }
} else {
    //
    // Great! We're now in SMM!
    //

    // Initialize global variables
    mSmmBase->GetSmstLocation(mSmmBase, &mSmst);
}
```

```

// Get Your protocol
Status = gBS->LocateProtocol(&gEfiSmmYourGuid, NULL, &mYourFile);
if (EFI_ERROR(Status)) {
    DEBUG(( EFI_D_ERROR, "Couldn't find Your File protocol: %r\n",
Status));
    return Status;
}

// Register for the Your event. This defines the hardware path
// and bits associated with the hardware SMM. These are defined
// by the Framework.
//
YourContext.Type = Framework assigned type;
YourContext.Device = (EFI_DEVICE_PATH_PROTOCOL*)&Framework assigned
path;

Status = mYourFile->Register( mYourFile, YourCallback, &YourContext,
&YourHandle );
if (EFI_ERROR(Status)) {
    DEBUG(( EFI_D_ERROR, "Couldn't register for callback: %r\n",
Status));
    return Status;
}

DEBUG(( EFI_D_ERROR, "Your file device path address: 0x%x\n",
    &YourPATH
));

}

return EFI_SUCCESS;
}

```

```
////////////////////////////////////  
// Callback functions  
  
VOID  
YourCallback (  
    IN  EFI_HANDLE                DispatchHandle,  
    IN  EFI_SMM_USB_DISPATCH_CONTEXT *DispatchContext  
    )  
{  
  
    DEBUG(( EFI_D_ERROR, "          Your SMI captured T%d D%x\n",  
           DispatchContext->Type,  
           DispatchContext->Device  
           ));  
  
    Your code here  
  
////////////////////////////////////
```

## Legacy BIOS References

---

### 5.1 BIOS INTs

This document lists only the INTs to be supported and does not list all subfunctions unless they are not required. Refer to the *IBM\* Personal System/2 and Personal Computer BIOS Interface Technical Reference* or any of the AMI\* or Phoenix\* BIOS manuals for full information on all subfunctions.

#### **INT 0x02 - NMI**

There needs to be a NMI handler.

#### **INT 0x05 - Print Screen**

This INT must be supported. Note that this INT modifies memory location 50:00.

#### **Memory Location 50:00**

This is a Byte memory location. A value of 0x00 indicates that the print screen successfully completed or was not invoked. A value of 0x01 indicates that a print screen is in progress and subsequent print screens are ignored. A value of 0xFF indicates that the print screen terminated due to an error.

#### **INT 0x08 - System Timer**

This INT must be supported. Note that this INT modifies memory locations 40:6C, 40:70, 40:40, and 40:3F. It also invokes software INT 1C.

#### **Memory Location 40:6C**

This location is a Dword memory location. The value is incremented every INT 08 tick or 18.2 times a second. The memory location is reset to 0x00000000 when a 24-hour duration has elapsed.

#### **Memory Location 40:70**

This location is a Byte memory location. This location has a value of 0x00 until a 24-hour duration has elapsed. It is then set to 0x01. The byte must be manually reset back to 0x00.

#### **Memory Location 40:40**

This location is a Byte memory location. The value is decremented every INT 08 tick or 18.2 times a second. If the timer goes to 0x00, the floppy motor is turned off and resets the floppy flags in memory location 40:3F.

#### **Memory Location 40:3F**

This location is a Byte memory location. Bit 1 is set if drive B motor is on. Bit 0 is set if drive A motor is on.

## INT 0x09 - Keyboard

This INT must be supported. It is called on every make or break keystroke. The 32-byte buffer starting at 40:1E is updated at the address pointed by the keyboard-buffer tail pointer. The keyboard-buffer tail pointer at memory location 40:1C is incremented by 2 unless it extends past the keyboard-buffer, in which case it wraps. When a key is read, the keyboard-buffer head pointer at memory location 40:1A is incremented by 2 unless it extends past the keyboard-buffer, in which case it wraps. Special keys such as CTRL, ALT, or Shift update the status at memory location 40:17, 40:18 and 40:96. A CTRL-ALT-DELETE key sequence sets the reset flag at memory location 40:72 to 0x1234 and jumps to the reset vector.

Pressing the Pause key causes the interrupt handler to loop until a valid ASCII keystroke occurs.

Pressing the Print Screen key causes an INT 0x05 to be issued.

A CTRL-BREAK sequence causes INT 0x1B to be issued.

Pressing the SysReq key causes INT 0x15 Function 0x85 (System Request Key Pressed) to be issued.

Any make keystroke causes INT 0x15 Function 0x91, Subfunction 0x02 (Interrupt complete from Keyboard) to be issued.

After any scan code is read from I/O port 0x60 and INT 0x15, Function 0x4F (Keyboard Intercept) is issued. An EOI is issued upon returning from the Keyboard Intercept.

### Memory Location 40:1E

This location is the start of a 32-byte keyboard buffer.

### Memory Location 40:1A

This location is a Word memory location. It points to the next character in the keyboard buffer.

### Memory Location 40:1C

This location is a Word memory location. It points to the last character in the keyboard buffer. If the value equals the value in memory location 40:1A, the keyboard buffer is empty. If the value is two bytes from the contents of memory location 40:1A, the keyboard buffer is full.

### Memory Location 40:17

This location is a Byte memory location and contains the keyboard status byte.

### Memory Location 40:18

This location is a Byte memory location and contains the extended keyboard status byte.

### Memory Location 40:96

This location is a Word memory location and contains the extended keyboard status.

### Memory Location 40:72

This location is a Word memory location and contains the soft reset flag.

## INT 0x10 - Video

This INT is supported by the video OpROM. There is no native planar BIOS support.

### **INT 0x11 - Equipment Determination**

This INT must be supported. This INT returns the data at memory location 40:10.

### **Memory Location 40:10**

This location is a Word memory location and contains the equipment list.

### **INT 0x12 - Base Memory Size**

This INT must be supported and returns the value at memory location 40:13.

### **Memory Location 40:13**

This location is a Word memory location and contains the amount of memory up to 640 KB. It is set to 0x280 regardless of the Extended BIOS Data Area (EBDA) size because the 512 KB option has been obsoleted.

### **INT 0x13 - HDD and Floppy Diskette Services**

This INT must be supported, including the Microsoft\* extensions. IDE, floppy diskette, ATAPI, ATA, El Torito, and ARMD drives must be supported. Note that if non-floppy controllers are present, INT 0x40 must be supported.

### **INT 0x14 - Serial Communication Services**

This INT must be supported.

### **INT 0x15 - System Services**

This INT must be supported. Subfunctions are those defined by the *IBM\* Personal System/2 and Personal Computer BIOS Interface Technical Reference* manual. Additional subfunction support is OEM and/or IBV dependent.

### **INT 0x16 - Keyboard Services**

This INT must be supported.

### **INT 0x17 - Printer Services**

This INT must be supported.

### **INT 0x1A - System-Timer Services**

This INT must be supported, including the PCI BIOS extensions.

### **INT 0x1B - CTRL- BREAK Services**

The BIOS sets this to IRET and the OS hooks it.

### **INT 0x1C - Periodic Timer Interrupt**

The BIOS sets this to IRET and the OS hooks it.

### **INT 0x1D - Video Parameter Table**

Set by the video BIOS.

### **INT 0x1E - Floppy Diskette Drive Parameters**

Points to an 11-byte data structure.

### **INT 0x1F - Video Graphics Characters**

Set by the video BIOS.

### **INT 0x40 - Floppy Diskette Services**

This INT must be supported if non-floppy controllers are present.

### **INT 0x41 - HDD C: Drive Parameters**

Points to a 16-byte data structure for drive C:.

### **INT 0x46 - HDD D: Drive Parameters**

Points to a 16-byte data structure for drive D:.

## 5.2 Fixed BIOS Entry Points

The fixed entry points in F000: xxxx must be supported for traditional reasons. The table below lists the fixed BIOS entry points.

**Table 14 Fixed BIOS Entry Points**

| Location   | Description                                   |
|------------|---|
| F000: E05B | POST Entry Point                              |
| F000: E2C3 | NMI Entry Point                               |
| F000: E401 | HDD Parameter Table                           |
| F000: E6F2 | INT 19 Entry Point                            |
| F000: E6F5 | Configuration Data Table                      |
| F000: E729 | Baud Rate Generator Table                     |
| F000: E739 | INT 14 Entry Point                            |
| F000: E82E | INT 16 Entry Point                            |
| F000: E987 | INT 09 Entry Point                            |
| F000: EC59 | INT 13 Floppy Entry Point                     |
| F000: EF57 | INT 0E Entry Point                            |
| F000: EFC7 | Floppy Disk Controller Parameter Table        |
| F000: EFD  | INT 17  |
| F000: F065 | INT Video                                     |
| F000: F0A4 | MDA and CGA Video Parameter Table INT 1D      |
| F000: F841 | INT 12 Entry Point                            |
| F000: F84D | INT 11 Entry Point                            |
| F000: F859 | INT 15 Entry Point                            |
| F000: FA6E | Low 128 character of graphic video font       |
| F000: FE6E | INT 1A Entry Point                            |
| F000: FEA  | INT 08 Entry Point                            |
| F000: FF53 | Dummy Interrupt Handler                       |
| F000: FF54 | INT 05 Print Screen Entry Point               |
| F000: FFF0 | Power-On Entry Point                          |
| F000: FFF5 | ROM Date in ASCII "MM/DD/YY" for 8 characters |
| F000: FFFE | System Model 0xFC                             |

### 5.3 Fixed CMOS Locations

The table below lists the fixed CMOS locations.

**Table 15 Fixed CMOS Locations**

| Start Location | Length in bytes | Description                   | Modified by Traditional BIOS | Comments   |
|----------------|-----------------|-------------------------------|------------------------------|--|
| 0x00           | 10              | RTC                           | Yes                          | INT1A  |
| 0x0A           | 6               | CMOS Status                   | No                           |  |
| 0x10           | 1               | Floppy drive type             | No                           |  |
| 0x12           | 1               | Hard Disk                     | No                           |  |
| 0x14           | 1               | Equipment byte                | No                           |  |
| 0x15           | 2               | Base memory size              | No                           |  |
| 0x17           | 2               | Extended memory size          | No                           |  |
| 0x19           |                 | Hard disk C drive type        | No                           |  |
| 0x1A           |                 | Hard Disk D drive type        | No                           |  |
| 0x2E           | 2               | Standard CMOS checksum        | Yes                          | If any location 0x10 through 0x2D is changed                             |
| 0x30           | 2               | Extended memory found by BIOS | No                           |  |
| 0x32           | 1               | Century byte                  | Yes                          | On Roll over, IN 1A  |
| 0x33           | 1               | Information Flag              | No                           | Bit 0 =1 - Cache good. Not check summed.                                 |
| 0x3E           | 2               | Extended CMOS checksum        | Yes                          | If any location 0x30 through 0x7F is changed and in check summed region. |

**Notes:**

If CMOS is not supported by standard EFI, then the bytes that are labeled as not modified by the traditional BIOS must be initialized by EfiCompatibility but are not modified at runtime.

The CSM may use other CMOS bytes. If standard EFI supports CMOS, then the CMOS usage must not conflict.

CMOS locations greater than 0x33 are up to the implementer as far as inclusion/exclusion in a checksum range.

## 5.4 BDA and EBDA Memory Addresses

The BIOS Data Area (BDA) starts at 40:0 and is 257 bytes in length. Byte 40:100 is byted by INT 0x05.

**Table 16 BIOS Data Area**

| Start Location | Length in bytes | Description               | Modified by Legacy BIOS | INT Using It | Comments |
|----------------|-----------------|---------------------------|-------------------------|--------------|----------|
| 0x00           | 2               | COM 1 base address        | No                      | 14           |          |
| 0x02           | 2               | COM 2 base address        | No                      | 14           |          |
| 0x04           | 2               | COM 3 base address        | No                      | 14           |          |
| 0x06           | 2               | COM 4 base address        | No                      | 14           |          |
| 0x08           | 2               | LPT 1 base address        | No                      | 17           |          |
| 0x0A           | 2               | LPT 2 base address        | No                      | 17           |          |
| 0x0C           | 2               | LPT 3 base address        | No                      | 17           |          |
| 0x0E           | 2               | EBDA segment              | No                      |              |          |
| 0x10           | 2               | Installed hardware        | No                      | 11           |          |
| 0x12           | 1               | Reserved                  | No                      |              |          |
| 0x13           | 2               | Base memory size          | No                      | 12           |          |
| 0x15           | 2               | Reserved                  | No                      |              |          |
| 0x17           | 1               | Keyboard control 1        | Yes                     | 16           |          |
| 0x18           | 1               | Keyboard control 2        | Yes                     | 16           |          |
| 0x19           | 1               | Work area for ALT key     | Yes                     | 16           |          |
| 0x1A           | 2               | Keyboard-buffer Head      | Yes                     | 16           |          |
| 0x1C           | 2               | Keyboard-buffer Tail      | Yes                     | 16           |          |
| 0x1E           | 32              | Keyboard Buffer           | Yes                     | 16           |          |
| 0x3E           | 1               | Floppy recalibrate status | Yes                     | 13           |          |
| 0x3F           | 1               | Floppy motor status       | Yes                     | 13           |          |
| 0x40           | 1               | Floppy motor timeout      | Yes                     | 13           |          |
| 0x41           | 1               | Floppy operation status   | Yes                     | 13           |          |
| 0x42           | 7               | Floppy controller status  | Yes                     | 13           |          |
| 0x49           | 30              | Video info                | No                      | 10           |          |
| 0x67           | 4               | POST re-entry ptr         |                         |              |          |
| 0x6B           | 1               | Last Unexpected interrupt | Yes                     |              |          |

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| Start Location | Length in bytes | Description                 | Modified by Legacy BIOS | INT Using It | Comments |
|----------------|-----------------|-----------------------------|-------------------------|--------------|----------|
| 0x6C           | 4               | Timer Counter               | Yes                     | 1A           |          |
| 0x70           | 1               | Timer Overflow              | Yes                     | 1A           |          |
| 0x71           | 1               | Break key state             | Yes                     | 16           |          |
| 0x72           | 2               | Reset Flag                  | Yes                     |              |          |
| 0x74           | 1               | HDD operation status        | Yes                     | 13           |          |
| 0x75           | 1               | Number of HDDs attached     | No                      | 13           |          |
| 0x76           | 2               | Reserved                    | No                      | 13           |          |
| 0x78           | 1               | LPT 1 time-out              | Yes                     | 14           |          |
| 0x79           | 1               | LPT 2 time-out              | Yes                     | 14           |          |
| 0x7A           | 1               | LPT 3 time-out              | Yes                     | 14           |          |
| 0x7B           | 1               | Reserved                    | No                      |              |          |
| 0x7C           | 1               | COM 1 time-out              | Yes                     |              |          |
| 0x7D           | 1               | COM 2 time-out              | Yes                     |              |          |
| 0x7E           | 1               | COM 3 time-out              | Yes                     |              |          |
| 0x7F           | 1               | COM 4 time-out              | Yes                     |              |          |
| 0x80           | 2               | Keyboard buffer start ptr   |                         | 16           |          |
| 0x82           | 2               | Keyboard buffer end ptr     |                         | 16           |          |
| 0x84           | 7               | Video info                  | No                      | 10           |          |
| 0x89           | 2               | Reserved                    | No                      |              |          |
| 0x8B           | 1               | Floppy media control        | Yes                     | 13           |          |
| 0x8C           | 1               | HDD Controller status       | Yes                     | 13           |          |
| 0x8D           | 1               | HDD Controller error status | Yes                     | 13           |          |
| 0x8E           | 1               | HDD Interrupt control       | Yes                     | 13           |          |
| 0x8F           | 1               | Reserved                    | No                      |              |          |
| 0x90           | 1               | Floppy 0 media status       | Yes                     | 13           |          |
| 0x91           | 1               | Floppy 1 media status       | Yes                     | 13           |          |
| 0x92           | 1               | Floppy 2 media status       | No?                     | 13           |          |
| 0x93           | 1               | Floppy 3 media status       | No?                     | 13           |          |
| 0x94           | 1               | Drive 0 current cylinder    | Yes                     | 13           |          |
| 0x95           | 1               | Drive 1 current cylinder    | Yes                     | 13           |          |

| Start Location | Length in bytes | Description                  | Modified by Legacy BIOS | INT Using It | Comments |
|----------------|-----------------|------------------------------|-------------------------|--------------|----------|
| 0x96           | 1               | Keyboard mode state & flags  | Yes                     | 16           |          |
| 0x97           | 1               | Keyboard LED flags           | Yes                     | 16           |          |
| 0x98           | 2               | User Wait flag offset        | Yes                     | 15           |          |
| 0x9A           | 2               | User wait flag segment       | Yes                     | 15           |          |
| 0x9C           | 2               | Low word of user wait count  | Yes                     | 15           |          |
| 0x9E           | 2               | High word of user wait count | Yes                     | 15           |          |
| 0xA0           | 1               | Wait active flag             | Yes                     | 15           |          |
| 0xA1           | 7               | Reserved                     | No                      |              |          |
| 0xA8           | 4               | Video info                   | No                      | 10           |          |
| 0xAC           | 0x54            | Reserved                     | No                      |              |          |
| 0x100          | 1               | Print Screen status          | Yes                     | 05           |          |

## 5.5 EBDA (Extended BIOS Data Area)

This area starts at the segment pointed to by the contents of 40:0E.

**Table 17 Extended BIOS Data Area**

| Start Location | Length in bytes | Description           | Modified by Legacy BIOS | Comments                                  |
|----------------|-----------------|-----------------------|-------------------------|---|
| 0x00           | 1               | Length of EBDA in KB  | No                      |   |
| 0x01           | 32              | Reserved              | No                      |   |
| 0x17           | 1               | Number of POST errors | No                      |   |
| 0x18           | 5               | POST error log        | No                      |   |
| 0x22           | 4               | Mouse Driver Ptr      | No                      | INT74; Compatibility16 calls this pointer |
| 0x26           | 1               | Mouse flag byte 1     | Yes                     | INT74                                     |
| 0x27           | 1               | Mouse flag byte 2     | Yes                     | INT74                                     |
| 0x28           | 8               | Mouse data            | Yes                     | INT74                                     |
| 0x30           | 0x3D0           | Reserved              | No                      |   |

## 5.6 IA-32 and Itanium Processor Family Interrupts

### 5.6.1 EFI Environment

An EFI-only environment normally only has the timer interrupt hooked. The processor traps, exceptions and faults are also trapped. There is only one supported hardware interrupt for IA-32 (Timer interrupt). For the Itanium® processor family, the only supported hardware interrupt is a processor counter ITC generated interrupt. There are no software interrupts supported by either processor family.

### 5.6.2 IA-32

Traditionally IRQ0 through IRQ7 are allocated to INT 0x08 through INT 0x0F, and IRQ8 through IRQ15 are allocated to INT 0x70 through INT 0x77. The traditional allocation of INT 0x08 through INT 0x0F overlay with processor faults, exceptions and traps. It is safe to move IRQ0 through IRQ7 to INT 0x68 through 0x6F, thus leaving INT 0x08 through INT 0x0F free for the processor faults, exceptions and traps. The only interrupt unmasked in the PIC registers 0x21 and 0xA1 should be the timer or IRQ0. APICs in non-8259 mode are platform specific and outside the scope of this document.

#### NOTE

*SYNC1 IRQ0–7 are at traditional INTs and need to be moved.*

### 5.6.2.1 IA-32 Faults, Exceptions, and Traps

The table below lists the IA-32 faults, exceptions, and traps.

**Table 18 IA-32 Faults, Exceptions, and Traps**

| <b>INT</b> | <b>Fault, Exception, or Trap</b>                  |
|------------|---|
| 00         | Divide by Zero Fault                              |
| 01         | Code Breakpoint Fault                             |
| 02         | NMI Trap  |
| 03         | INT 3 Breakpoint Trap                             |
| 04         | Overflow Exception                                |
| 05         | Bounds Fault                                      |
| 06         | Invalid Opcode Fault                              |
| 07         | No Math Coprocessor or Device Not Available Fault |
| 08         | Double Fault                                      |
| 09         | Coprocessor Segment Overrun – Obsolete            |
| 0A         | Invalid TSS Fault                                 |
| 0B         | Segment Not Present Fault                         |
| 0C         | Stack Segment Fault                               |
| 0D         | General Protection Fault                          |
| 0E         | Page Fault  |
| 0F         | Reserved  |
| 10         | Floating-Point Error                              |
| 11         | Alignment Check Fault                             |
| 12         | Machine Check                                     |
| 13-1F      | Reserved by Intel                                 |

### 5.6.2.2 IA-32 Interrupts

The table below lists the IA-32 interrupts.

**Table 19 IA-32 Interrupts**

| INT   | Description             |
|-------|-------------------------|
| 20-67 | Unused                  |
| 68    | IRQ 0 – Timer interrupt |
| 69    | IRQ 1 - Unused          |
| 6A    | IRQ 2 - Unused          |
| 6B    | IRQ 3 - Unused          |
| 6C    | IRQ 4 - Unused          |
| 6D    | IRQ 5 - Unused          |
| 6E    | IRQ 6 - Unused          |
| 6F    | IRQ 7 - Unused          |
| 70    | IRQ 8 - Unused          |
| 71    | IRQ 9 - Unused          |
| 72    | IRQ 10 - Unused         |
| 73    | IRQ 11 - Unused         |
| 74    | IRQ 12 - Unused         |
| 75    | IRQ 13 - Unused         |
| 76    | IRQ 14 - Unused         |
| 77    | IRQ 15 - Unused         |
| 78-FF | Unused                  |

### 5.6.3 Intel® Itanium® Processor Family

The Itanium® processor family has two generic types of interrupts:

- PAL-based interrupts
- Interruption Vector Table (IVA)–based interrupts

PAL-based interrupts are handled by the PAL firmware, system firmware, or possibly the OS. IVA-based interrupts are handled by the system firmware and operating system. The following topics discuss these interrupts in more detail.

### 5.6.3.1 PAL-Based Interrupts

The table below lists the PAL-based interrupts for the Itanium® processor family.

**Table 20 PAL-Based Interrupts**

| Type                           | Name                 | PALE Entry | Description  |
|--------------------------------|----------------------|------------|--|
| Abort                          | Machine Checks (MCA) | PALE_CHECK | An immediate action hardware error has occurred.               |
| Abort                          | Processor Reset      | PALE_RESET | A processor has been powered on or a reset request sent to it. |
| Initialization interrupts      | INIT                 | PALE_INIT  | A processor has received an initialization interrupt.          |
| Platform Management interrupts | PMI                  | PALE_PMI   | A platform management request has been received..              |

### 5.6.3.2 IVA-Based Interrupts

Itanium processors support a SAPIC component and an internal ITC (Interval Timer Counter – AR44), which counts up at a fixed relationship to the processor clock frequency. The controlling parameter for this internally delivered interrupt can be programmed into ITV (CR72). When the ITC count reaches the value programmed into the Interval Timer Match Register (ITM-CR1), the interval timer interrupt is raised. In the SAPIC mode, they are directly delivered internally to the processor. This mechanism is used to get the timer tick interrupt that is needed for EFI core operation.

Interrupt Vector Table (IVA)–based interrupts function very differently in the Itanium processor family but allow the management of traditional 8259-based interrupts. When a hardware interrupt occurs, the processor switches to an alternate bank of registers, loads the preinterrupt context to several control registers (such as ipsr, iip, and so on), and then branches to a location pointed by  $cr.IVA + 0x3000$ . At this location, the hardware interrupt management code starts executing. This code will read  $cr.ivr$  and if the vector is 00, then it is a traditional 8259-generated interrupt. If it is nonzero, then it is a SAPIC-programmed interrupt. The ITC interrupt mentioned earlier is one such thing with a distinct SAPIC-supplied nonzero vector.

If it is a traditional interrupt, then the Itanium® architecture interrupt handler code will do a non-cached one-byte load from a special cycle location at offset 0x1e00 from the base of processor interrupt block region, which has been programmed into the processor through a PAL call. Either the internal bus unit or the chipset would then recognize the special cycle (for the Itanium processor family, the logic is in the processor) and will produce two INTA bus cycles to 8259. The first cycle is ignored by 8259 as it is programmed to 8086 mode by the CSM code/8259 INIT code (the first cycle will produce a call 8085 opcode if 8259 is programmed into 8085 mode, which is not the case). The 8259 will respond to the second INTA cycle and will send the vector up the bus, and the Itanium architecture code will read it by its special cycle one-byte load.

This Itanium architecture code has an option of processing this vector. The CSM design must be such that the code reflects this option to 16-bit IA-32 code. This vector number will be multiplied by 4 and code segment and offset shall be read. Itanium architecture will save the machine context, including floating point registers, and then loads the CS and IP value to the appropriate Itanium processor family

registers and prepares the 16-bit IA-32 code environment. The new stack and then the Itanium architecture code is provided. Then it will branch to the Itanium architecture code with a special `br.ia` instruction. The saving of the context is necessary as IVE microcode uses all the Itanium architecture registers.

When the IA-32 handler does an `Iret` instruction, this instruction is trapped by Itanium architecture and the Itanium architecture trap handler restores the caller context and returns through an RFI.

It is possible that IA-32 code may not do an `Iret` but does “`ret 2.`” There are several ways to handle this situation. One way is to let the Itanium architecture handler point the IA-32 stack to a deliberately and intentionally faulting instruction such as `rep:HLT` (IA-32 opcode `0xf, 0xf4`) and then take control in the Itanium architecture fault handler to restore the context.

### 5.6.3.3 Assumptions

The previous topics in this section assumed that the platform has an 8259 PIC and an IVE (Intel® value-added engine core that executes most of the IA-32 instructions). But future processors may not have those elements. In that case, traditional mode can be handled only by an IA-32 instruction emulator. One way of doing this handling is to set the `psr` (processor status register) in such a way that execution of all IA-32 instructions fault into native code and hence get emulated.

IVA-based interrupts include external interrupts, NMI, faults and traps. A unique vector number `0,2,0x10` through `0xFF` defines external interrupts. The list below in the Description field is a list of IVA-based interrupts that may be used by the Framework.

**Table 21 IVA-Based Interrupts Useable in the Framework**

| Type                | Name                      | Description |
|---------------------|---------------------------|-------------|
| External Interrupts | INT 0                     | Unused      |
| External Interrupt  | INT 2                     | Unused      |
| External Interrupt  | INT 0x10- 0xFF            | Unused      |
|                     | Alternate Data TLB        |             |
|                     | Alternate Instruction TLB |             |
|                     | Break Instruction         | Used        |
|                     | Data Access Rights        |             |
|                     | Data Access-Bit           |             |
|                     | Data Key Miss             |             |
|                     | Data Nested TLB           |             |
|                     | Data TLB                  |             |
|                     | Debug                     | Used        |
|                     | Dirty-Bit                 |             |
|                     | Disable FP-Register       |             |
|                     | Floating-point Fault      |             |
|                     | Floating-point trap       |             |
|                     | General Exception         | Used        |

|  |                               |                          |
|--|-------------------------------|--------------------------|
|  | IA-32 Exception               | General IA-32 fault      |
|  | IA-32 Interrupt               | IA-32 invalid opcode     |
|  | IA-32 Interrupt               | IA-32 software interrupt |
|  | Instruction Access Rights     |                          |
|  | Instruction Access-Bit        |                          |
|  | Instruction Key Miss          |                          |
|  | Instruction TLB               |                          |
|  | Key Permission                |                          |
|  | Lower-Privilege Transfer Trap |                          |
|  | NaT Consumption               |                          |
|  | Page Not Present              |                          |
|  | Single Step Trap              | Used                     |
|  | Speculation                   |                          |
|  | Taken Branch Trap             |                          |
|  | Unaligned Reference           |                          |
|  | Unsupported Data Reference    |                          |
|  | VHPT Translation              |                          |

#### 5.6.4 Mixed EFI and Traditional Environment

The mixed EFI and traditional environment imposes several complexities over the EFI-only environment. The main complexity is a transition to/from 32-bit/16-bit mode. An additional complexity is that the traditional environment must handle many more interrupts as devices are interrupt driven versus polled. The hardware and software interrupts that are used depend upon the traditional OpROMs invoked. The following is a high-level view and the reader should refer to the appropriate AMI\* or Phoenix\* BIOS specifications for details.

1. Set the appropriate flags as current operating mode.
2. Allocate area on the 16-bit stack for registers.
3. Copy current EFI registers to 16-bit stack.
4. Save the current interrupt state.
5. Disable interrupts.
6. Change the interrupt mask to traditional mode.
7. Invoke EFI to legacy thunk code.
8. Perform legacy operations.
9. Disable interrupts; traditional code may re-enable them.
10. Change the interrupt mask to EFI mode.

11. Thunk back to EFI.
12. Restore the interrupt state.
13. Invoke the timer tick interrupt, if needed.
14. Copy the 16-bit register stack to the EFI stack.
15. Return the carry flag state for successful/unsucessful completion.

#### 5.6.4.1 IA-32

The Legacy section supports all the traditional BIOS software and hardware interrupts.

#### 5.6.4.2 Itanium Processor Family

See the comments on executing 16-bit code. There is some added complexity because, at a minimum, 8 nested interrupts need to be handled, and a few instructions such as IGDT, CLI, and STI, need to be emulated. See the SAL specification for a complete list. Also, we have to care for software interrupts, which can be done by careful thunking. Also, special software interrupts such as AH=88, INT15, and other interrupts that need to go to protected IA-32 mode must be serviced in 64-bit native mode itself by filtering them out.

**E820 CALL BUILDING:** The E820 call runs in pure 16-bit real mode, so none of the EFI memory records or SAL system records can be touched as they exist above 1 MB. So, we need to steal some EBDA and copy them into it and modify the E820 call to translate these records from EBDA into E820 records.

#### 5.6.5 Traditional-Only Environment

The traditional-only environment is similar to the mixed EFI and traditional operation, except that once the EFI code thunks into traditional mode, the traditional code never returns to EFI mode. The traditional hardware and software interrupts are supported.

Note the following information for the Itanium® processor family in the traditional-only environment:

- There must be a PAL emulation layer that is invoked by the PAL\_enter\_IA32 call.
- If the traditional OS returns that it is unable to load or that the OS was not found, the code must go back to the EFI loader. To go back to native 64-bit code, execute a special instruction called “jmpe” in the traditional 32-bit mode. This instruction will abort the PAL emulation layer and will return to the PAL emulation retiring address that is registered by native code before invoking the PAL emulation layer. The native code will take over from there.

## #

**16-bit legacy:** The traditional PC environment and includes traditional OpROMs and Compatibility16 code.

## B

**BDA:** BIOS Data Area.

## C

**Compatibility16:** The traditional BIOS with POST and BIOS Setup removed. Executes in 16-bit real mode.

**CompatibilitySmm:** Any IBV-provided SMM code to perform traditional functions that are not provided by EFI.

**CSM:** Compatibility Support Module. The combination of EfiCompatibility, CompatibilitySmm, and Compatibility16.

## E

**EBDA:** Extended BIOS Data Area.

**EfiCompatibility:** 32-bit EFI code to generate data for traditional BIOS interfaces or EFI Compatibility Support Module (CSM) drivers or code to invoke traditional BIOS services.

**EOI:** End of Interrupt.

## I

**IDT:** Interrupt Descriptor Table.

**ITC:** Interval Timer Counter.

**ITM:** Interval Timer Match.

**IVA:** Interruption Vector Table.

## N

**NV:** Nonvolatile.

## P

**PIC:** (2) Programmable Interrupt Controller.

**PMM:** Post Memory Manager.

## R

**RACBA:** Reserve Area Boot Code Address.

## T

**traditional OpROM:** 16-bit OpROMs that are executed in real mode.

Filename: CSM096Apr18.doc  
Directory: O:\Tiano\Misc\CSM  
Template: C:\Documents and Settings\mphelps\Application  
Data\Microsoft\Templates\Framework-EFI\_template.dot  
Title: CSM95  
Subject:  
Author: mporter  
Keywords:  
Comments:  
Creation Date: 4/18/2006 9:37:00 AM  
Change Number: 11  
Last Saved On: 4/18/2006 1:10:00 PM  
Last Saved By: mporter  
Total Editing Time: 184 Minutes  
Last Printed On: 4/18/2006 1:40:00 PM  
As of Last Complete Printing  
Number of Pages: 180  
Number of Words: 29,132 (approx.)  
Number of Characters: 183,242 (approx.)