energizing digital systems at the CORE

What They Never Taught You In UEFI 101

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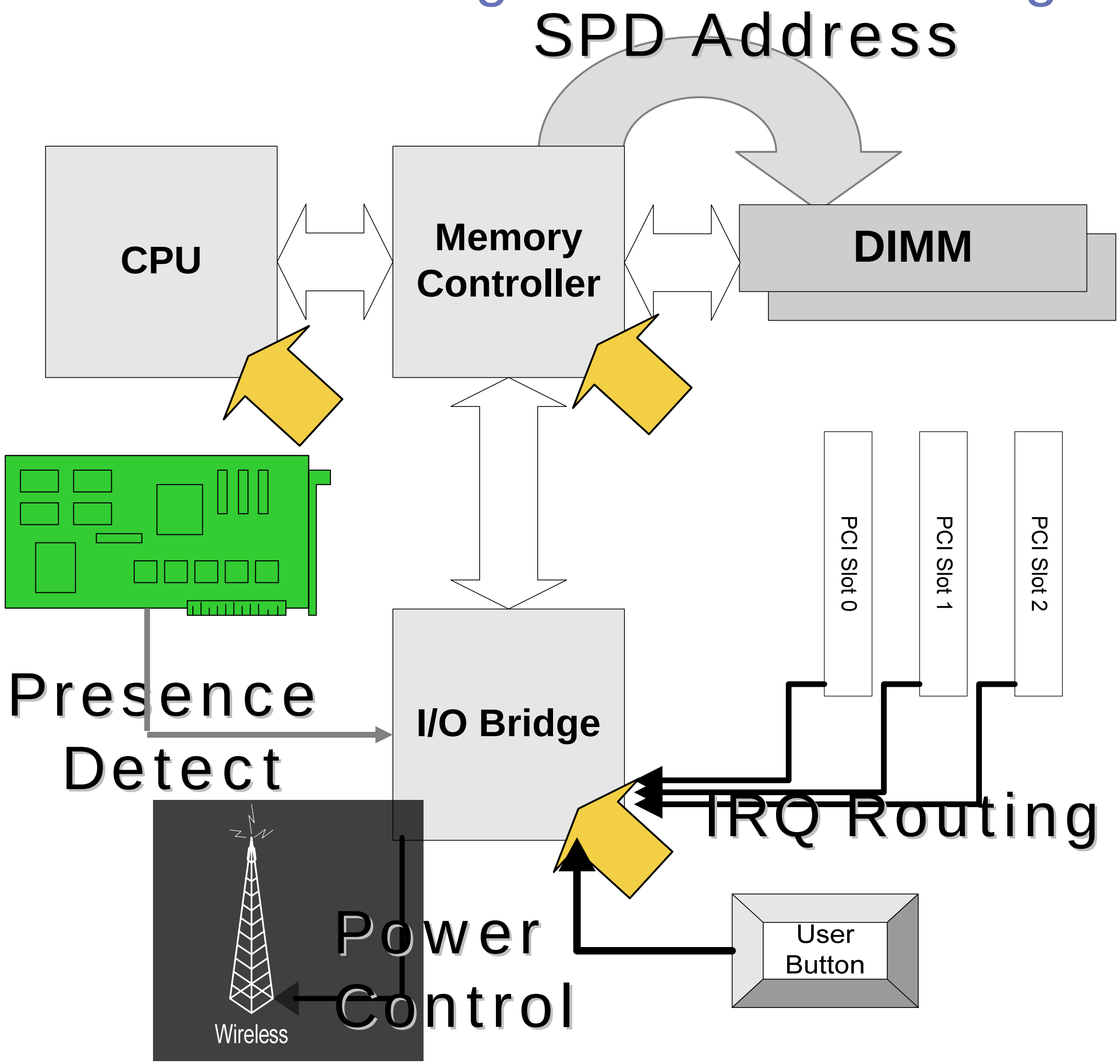
Overview

- UEFI and PI specifications create a driver model for the firmware, but…
- What else do I do to get my platform working?
  - I plug the drivers in, but it doesn't boot…
  - I plug the drivers in, but I'm not even sure they are being executed…
  - I want to run my own utilities by I can't figure out how…
  - I plug the drivers in, but they can't fit in my flash part

How-To #1: Configure PI Drivers Using Platform Drivers

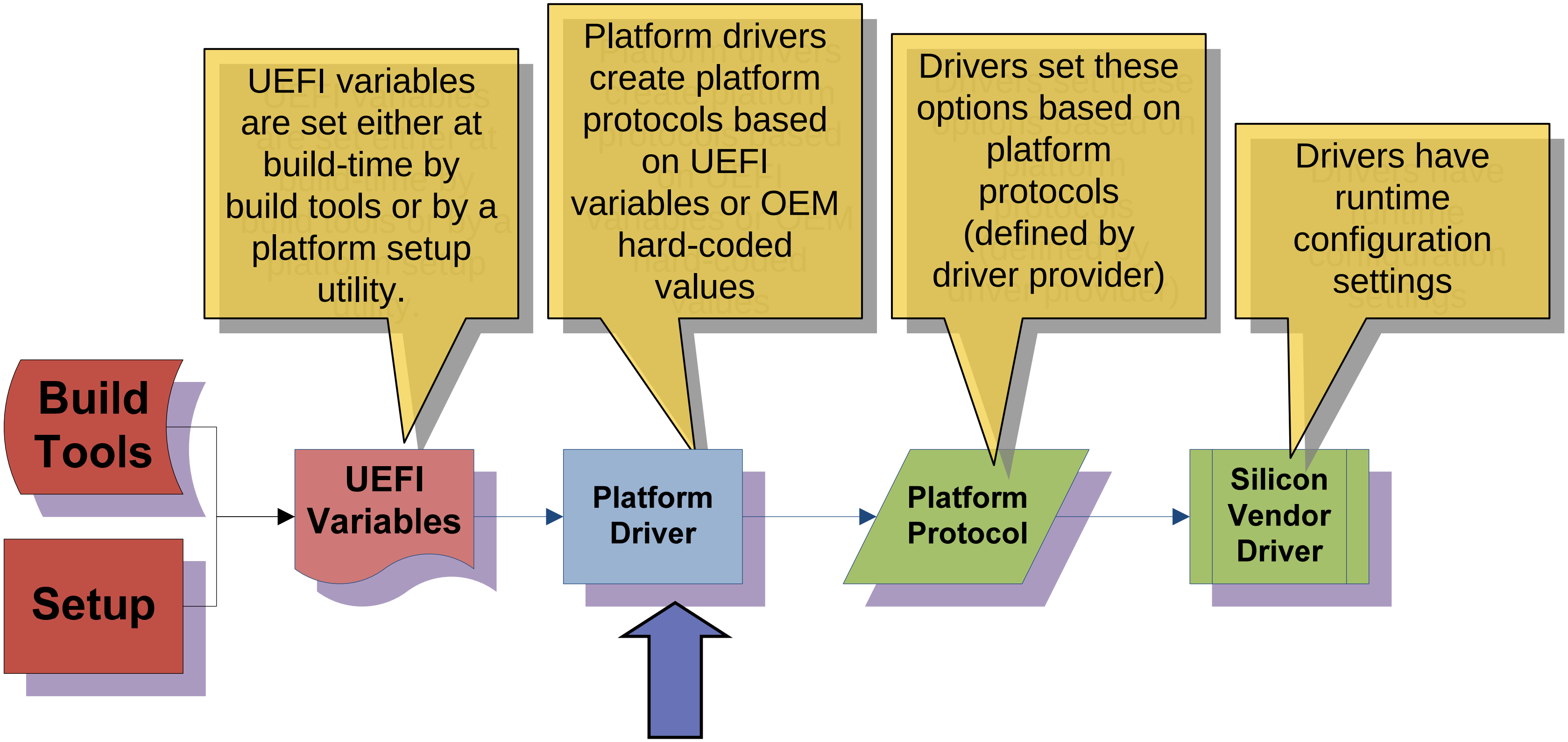


Driver for each of the components

But drivers need to be configured

How to do it?

How-To #1: Configure PI Drivers Using Platform Drivers



Q: Why Not Just Skip The Platform Driver Step?

A: Because Setup Screens Don't Always Match Configuration Settings Options 1:1!

What Do Platform Drivers Do?

- The PEI platform driver **must**:
  - Detect the boot mode. Prioritize the boot modes and install the **EFI_PEI_MASTER_BOOT_MODE_PPI** and, if necessary, the **EFI_PEI_BOOT_IN_RECOVERY_MODE_PPI**.
  - Create the CPU HOB
  - Handle ROM cache settings (prior to memory discovery) and default RAM cache settings (after memory discovery)
  - Create resource HOBs for devices with fixed I/O and memory requirements
    - Flash, HPET, APIC, SIO, etc.

What Do Platform Drivers Do?

- The PEI platform driver Usually:
  - Configures GPIOs
  - Performs early chipset initialization missed by chipset drivers
  - Set up required BARs for memory controller registers, ACPI power management registers and PCI Express memory-mapped I/O.

What Do Platform Drivers Do?

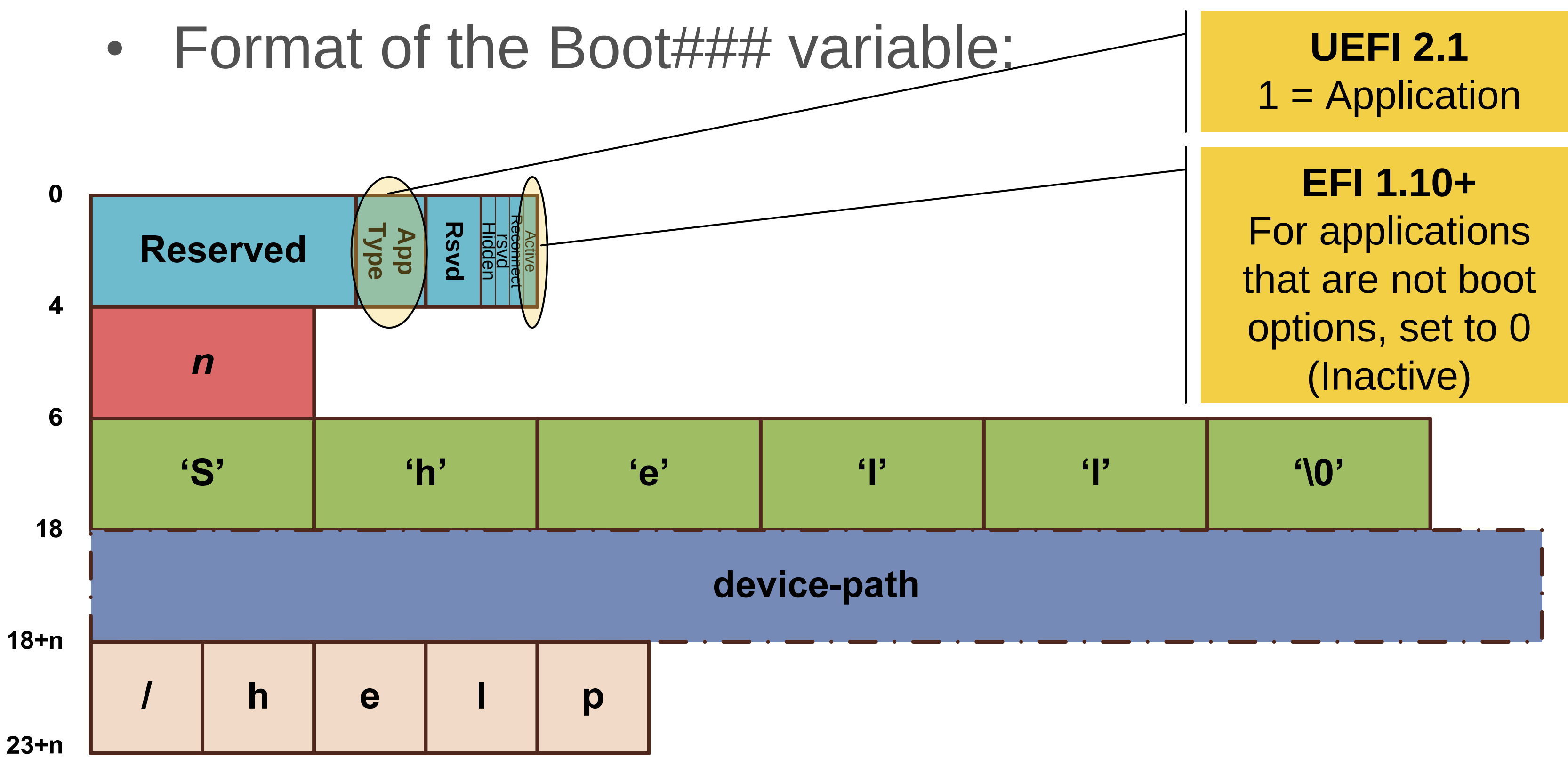
- The PEI platform driver may:
  - Configure the clock generator
  - Increase the size of the boot block
    - Programming flash-device-specific registers to lock the additional sections of the flash until (AT LEAST) the next platform reset or power-on.
  - Create policy PPIs for other PEI drivers.
    - Policy PPIs are defined by the driver author, NOT the PI or UEFI specifications.
    - Hard-coded values or read from UEFI variables
    - Other PEI drivers include PPI GUID in dependency expression

What Do Platform Drivers Do?

- The DXE platform drivers **may**:
  - Create policy protocols for other DXE drivers.
    - Policy protocols are defined by the driver author, NOT the PI or UEFI specifications.
    - Hard-coded values or converted from UEFI variables
    - Other DXE drivers include protocol GUID in dependency expression
  - Save settings needed for S3 resume
    - What to save? Anything that's not restored by the device's driver.
      - For multi-mode drivers (such as SATA controllers), this is often the mode settings.
      - For host controllers (USB, PCIe) this is usually some host controller settings.
      - For devices with no specific drivers (SIOs) this is usually the SIO configureation.
    - Where to save? UEFI variables or DRAM (if initialized after the memory controller)

How-To #2: Boot menu apps are disabled boot options

- Info about apps stored in UEFI global variables with the name **`Boot####`** (####=hex number)
- #### must be listed in **`BootOrder`** global variable
- Format of the Boot### variable:

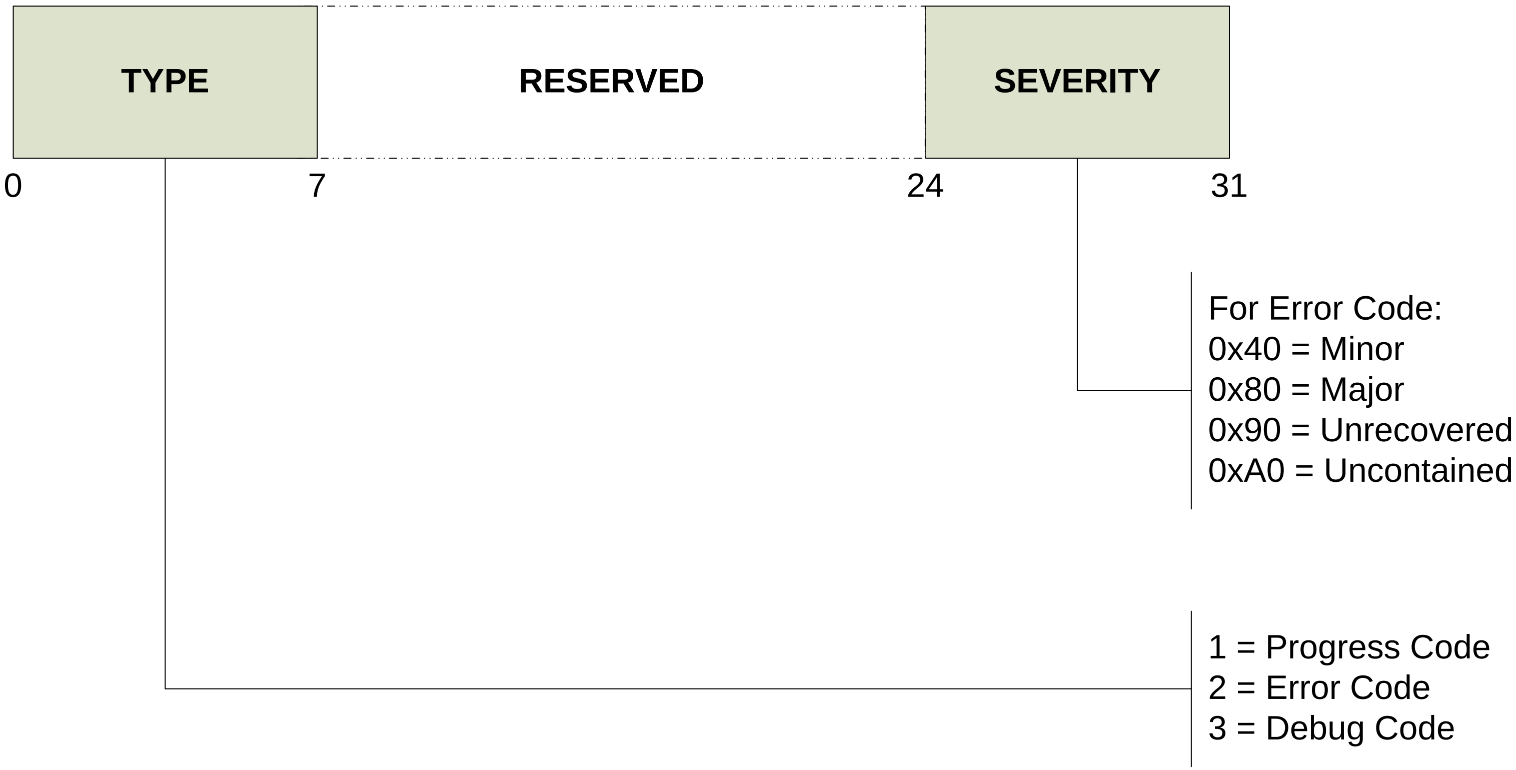


How-To #3: Report Status Via ReportStatusCode

- PI Specification Has **`ReportStatusCode`** PPI/Protocol
- Allows Different Plug-Ins for Progress/Error Reporting
  - 8-bit Port 0x80, 16-bit Port 0x80, Serial Port, Debugger, etc.

```
ReportStatusProtocol->ReportStatusCode(
  TypeSeverity,
  ClassSubclassOperation,
  Instance,
  CallerId,
  AdditionalData
  );
```

ReportStatusCode: Type & Severity



ReportStatusCode: Class/Subclass/Operation

OPERATION	SUB-CLASS	CLASS
0 – 16	16 – 24	24 – 31

0x00 = Computing
0x01 = Peripheral
0x02 = I/O Bus
0x03 = Softare

For Computing:
0x00 = Unspecified
0x01 = Host Processor
0x02 = Firmware Processor
0x03 = I/O Processor
0x04 = Cache
0x05 = Memory
0x06 = Chipset

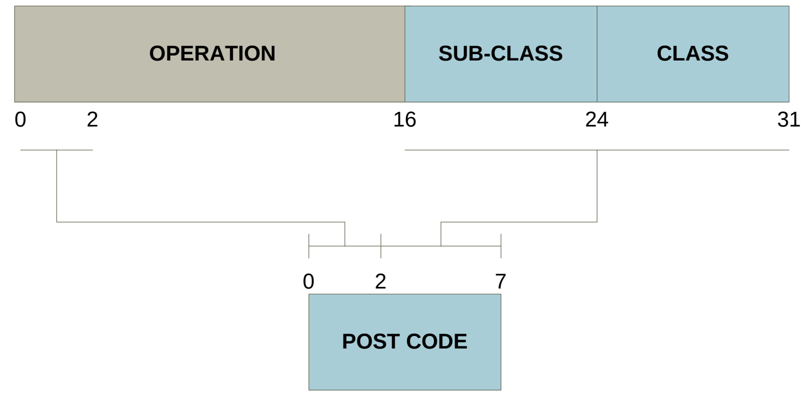
For Peripheral:
0x00 = Unspecified
0x01 = Keyboard
0x02 = Mouse
0x03 = Local Console
0x04 = Remote Console
0x05 = Serial Port
0x06 = Parallel Port
0x07 = Fixed Media
0x08 = Removable Media
0x09 = Audio Input
0x0A = Audio Output
0x0B = LCD Device
0x0C = Network

For I/O Bus:
0x00 = Unspecified
0x01 = PCI
0x02 = USB
0x06 = LPC
0x07 = SCSI
0x08 = ATAPI
0x0B = SMBUS
0x0C = I2C

For Software:
0x00 = Unspecified
0x01 = SEC
0x02 = PEI Core
0x03 = PEI Driver
0x04 = DXE Core
0x05 = DXE Boot Driver
0x06 = DXE Runtime Driver
0x07 = SMM Driver
0x08 = EFI Application
0x09 = OS Loader
0x0C = EBC Exception
0x0D = X86 Exception
0x0F = PEI Service
0x10 = UEFI Boot Service
0x11 = UEFI Runtime Service
0x12 = DXE Service

Translating **ReportStatusCode** To Port 80 (8-bit)

- Boards Still Have Port 80 LEDs For Progress
  - Class/Subclass Translated To Upper 5 Bits
  - Progress/Error Code Translated To Lower 3 Bits

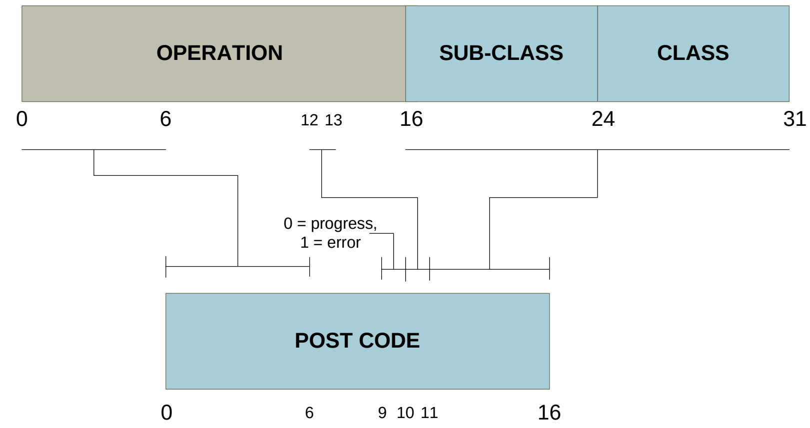


CLASS:	Port80(7:3)
0001 = Host Processor	(0x00)
0002 = Firmware Processor	(0x01)
0003 = I/O Processor	(0x02)
0004 = Cache	(0x03)
0005 = Memory	(0x04)
0006 = Chipset	(0x05)
0101 = Keyboard	(0x06)
0102 = Mouse	(0x07)
0105 = Serial Port	(0x08)
0106 = Parallel Port	(0x09)
0107 = Fixed Media	(0x0A)
0108 = Removable Media	(0x0B)
0109 = Audio Input	(0x0C)
010A = Audio Output	(0x0D)
010B = LCD	(0x0E)
010C = Network	(0x0F)

0201 = PCI	(0x10)
0202 = USB	(0x11)
0205 = PC/CARD	(0x12)
0206 = LPC	(0x13)
0208 = ATA/ATAPI	(0x14)
020B = SMBUS	(0x15)
0301 = SEC	(0x16)
0302 = PEI Core	(0x17)
0303 = PEI Module	(0x18)
0304 = DXE Core	(0x19)
0305 = DXE Boot Service Driver	(0x1A)
0306 = DXE Runtime Service Driver	(0x1B)
0307 = SMM	(0x1C)
0308 = Application	(0x1D)
0309 = Boot Loader	(0x1E)
xxxx = Other	(0x1F)

Translating **`ReportStatusCode`** To Port 80 (16-bit)

- Some boards have 4 LED digits
  - [15:11] Class/Subclass Translated To Upper 5 Bits
  - [10] Error Code(1)/Progress Code(0)
  - [9] Subclass Specific(1), General(0)
  - [8:0] Operation Lower 9 Bits




```
CLASS:                     Port80(15:11)
0001 = Host Processor           (0x00)
0002 = Firmware Processor       (0x01)
0003 = I/O Processor            (0x02)
0004 = Cache                    (0x03)
0005 = Memory                   (0x04)
0006 = Chipset                  (0x05)
0101 = Keyboard                 (0x06)
0102 = Mouse                    (0x07)
0105 = Serial Port              (0x08)
0106 = Parallel Port            (0x09)
0107 = Fixed Media              (0x0A)
0108 = Removable Media          (0x0B)
0109 = Audio Input              (0x0C)
010A = Audio Output             (0x0D)
010B = LCD                      (0x0E)
010C = Network                  (0x0F)
```

```
0201 = PCI                          (0x10)
0202 = USB                          (0x11)
0205 = PC/CARD                      (0x12)
0206 = LPC                          (0x13)
0208 = ATA/ATAPI                    (0x14)
020B = SMBUS                        (0x15)
0301 = SEC                          (0x16)
0302 = PEI Core                     (0x17)
0303 = PEI Module                   (0x18)
0304 = DXE Core                     (0x19)
0305 = DXE Boot Service Driver      (0x1A)
0306 = DXE Runtime Service Driver   (0x1B)
0307 = SMM                          (0x1C)
0308 = Application                  (0x1D)
0309 = Boot Loader                  (0x1E)
xxxx = Other                        (0x1F)
```

ReportStatusCode: Operation Values

- The operation values depend on class/subclass.
  - Ex: Memory Controller:
    - 0 = Reading configuration data (i.e. SPD) from memory devices.
    - 1 = Detecting presence of memory devices.
    - 2 = Determining optimum configuration (i.e. timing)
    - 3 = Initial configuration of memory devices/controller
    - 4 = Optimized settings for memory devices/controller
    - 5 = Memory initialization (ECC, etc.)
    - 6 = Memory test
- OR with **`0x20`** (**`0x04 << 3`**) gives port 80 values of **`0x20`**-**`0x26`** for the memory controller.

Debugger Output

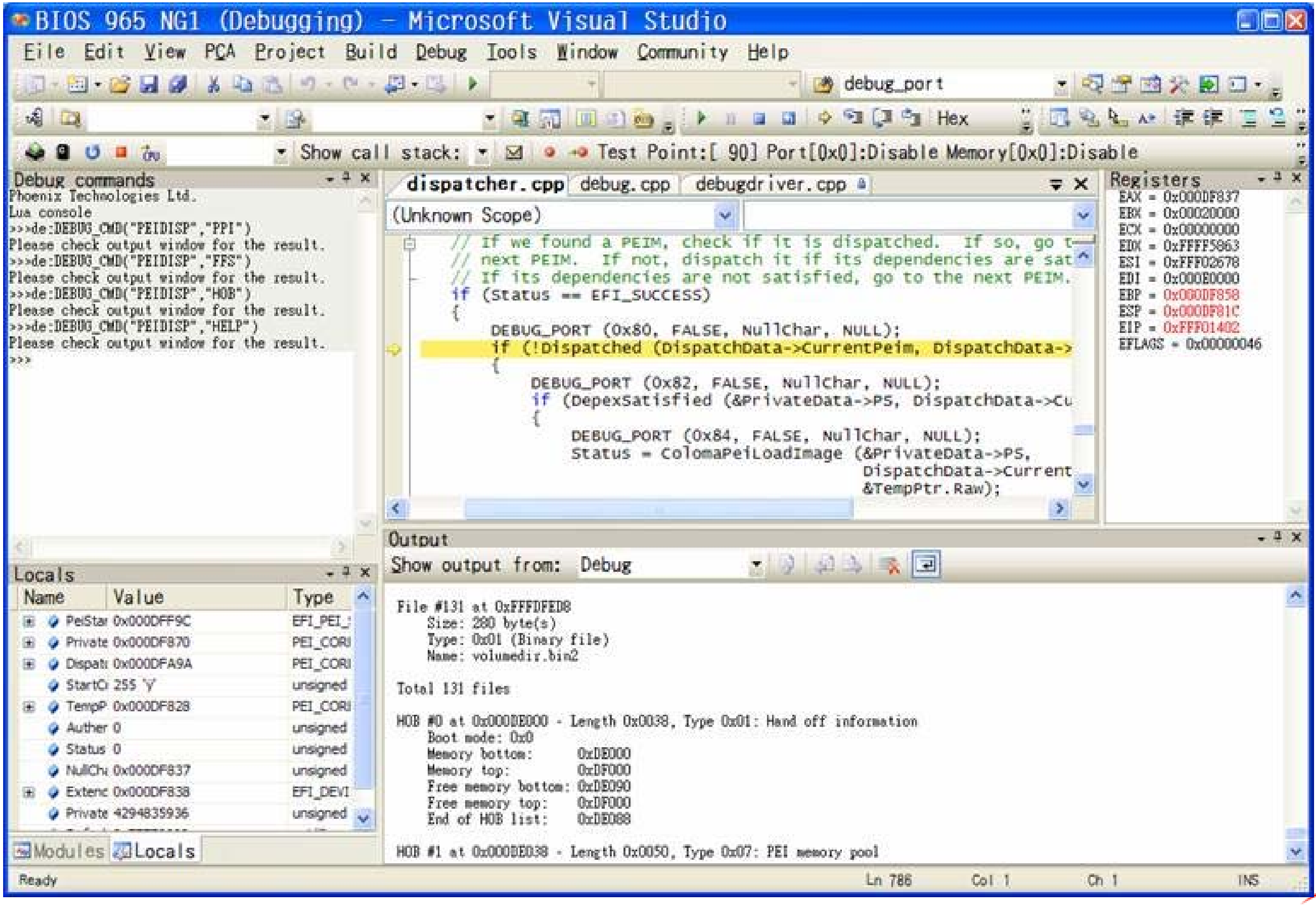
```
POST CODE: 0x80
POST CODE: 0x82
POST CODE: 0x84
POST CODE: 0x88
Executing PEIM at FFFFDB8A
  PEIM name: BasememoryTest
  Entry point: 0xFFFFD220
Installing PPI at 0xFFFFD2E4
  Flags: 0x80000010 (PPI + Terminate List)
  GUID: B6EC423C-21D2-490D-85C6-DD5864EAA674
  Entry pointer: 0xFFFFD2E0
POST CODE: 0x8A
POST CODE: 0x80
POST CODE: 0x82
POST CODE: 0x84
POST CODE: 0x88
Executing PEIM at FFFFDBC2
  PEIM name: Variable1
  Entry point: 0xFFFFC814
Installing PPI at 0xFFFFC940
  Flags: 0x80000010 (PPI + Terminate List)
  GUID: 3CDC90C6-13FB-4A75-9E79-59E9DD78B9FA
  Entry pointer: 0xFFFFC938
POST CODE: 0x8A
POST CODE: 0x80
```

Test point, can be used as a break condition

Useful message upon dispatching PEIM

Useful message upon installing PPI

Dumping Information From The Debugger



Example: `de:PEIDISP("PPI")`

```
PPI #0 at 0x000DF99A -> 0xFFF053C8
  Flags: 0x80000010 (PPI + Terminate List)
  GUID: CA3B3A50-5698-4551-8B18-CEAEEF917D50
  Entry pointer: 0xFFF053C0
PPI #1 at 0x000DF99E -> 0xFFF0552C
  Flags: 0x80000010 (PPI + Terminate List)
  GUID: 229832D3-7A30-4B36-B827-F40CB7D45436
  Entry pointer: 0xFFF05528
PPI #2 at 0x000DF9A2 -> 0xFFF055E0
  Flags: 0x80000010 (PPI + Terminate List)
  GUID: 44010885-9F0B-4AA8-826F-B455958D1531
  Entry pointer: 0xFFF055D8
PPI #3 at 0x000DF9A6 -> 0x000DE078
  Flags: 0x80000010 (PPI + Terminate List)
  GUID: D03EC65A-C31E-4ABD-909C-8BBAA5DD4233
  Entry pointer: 0x000DE040
PPI #4 at 0x000DF9AA -> 0xFFFF6E58
  Flags: 0x80000010 (PPI + Terminate List)
  GUID: C9737920-C2AD-41C3-B133-0F9C251B6743
  Entry pointer: 0xFFFF6E40
Total 5 PPI function(s)
```

How-To #4: Saving Space

Driver Type	64-Bit DDK Compiler	64-Bit VS2005 SP1
Driver A	Total Size: 11,616 Code: 8,416 Initialized Data: 2,592 Compressed: 6,395 (55%)	Total Size: 7,552 Code: 6,416 Initialized Data: 528 Compressed: 4,439 (58%)
Driver B	Total Size: 6,336 Code: 4,224 Initialized Data: 1,472 Compressed: 3,861 (61%)	Total Size: 5,328 Code: 3,586 Initialized Data: 848 Compressed: 3,328 (62%)
Driver C:	Total Size: 7,680 Code: 6,048 Initialized Data: 1,024 Compressed: 5,096 (66%)	Total Size: 6,096 Code: 5,040 Initialized Data: 448 Compressed: 4,121 (68%)
Driver D:	Total Size: 4,608 Code: 2,368 Initialized Data: 1,568 Compressed: 2,738 (59%)	Total Size: 1,888 Code: 944 Initialized Data: 304 Compressed: 1,193 (63%)

35% Smaller

27% Smaller

21% Smaller

59% Smaller

How-To #4: What Made The Difference?

- Code: Alignment of 16-bytes vs. 32-bits
- Code: Register usage
  - Better register usage (esp. pointers to interfaces)
  - Better instruction selection (e.g. AND x,0, not MOV x,0)
- Code: Link-Time Code Generation
  - Eliminates common subroutines
  - Calling conventions for static routines optimized
  - Constant folding for function parameters
- Data: Unintentional static data left in driver.
  - Usually debug strings and file names (even in release)

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Summary

- How-To #1: Platform drivers customize other drivers for your platform.
- How-To #2: Use Boot Options to add your apps to the boot manager menu
- How-To #3: Use ReportStatusCode to track progress during POST
- How-To #4: Configure the right tools and the right flags to fit your drivers into the flash part.