presented by

Best Practices for UEFI Driver & Option ROM Developers

UEFI Summer Plugfest – July 6-9, 2011

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Senior Technical Marketing Engineer

Agenda

- From BIOS to UEFI
- Best Practices for UEFI
- Common Driver Issues
- Summary
- Question & Answer

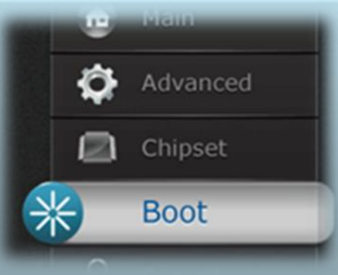
From BIOS to UEFI

- UEFI solves many problems for the IHV
  - Remove legacy memory & I/O limits
  - Clean driver/protocol model
  - Designed to reduce code size
- *Move from 16-bit legacy to UEFI Driver Model for add-on drivers & OpROM*
  - Generic model for multiple architectures
  - Designed to solve OEM, IBV & IHV problems

Why Standards Matter …

Don't let this happen to your product

UEFI – Technical Merits



Industry Standard

180+ members

C-based Coding

modern tools

Removes Legacy Limits

no dependency on 16-bit x86 design

HII User Interface

separates firmware data from interface

Agenda

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Best Practices for UEFI

- Simple version … use the UEFI spec!

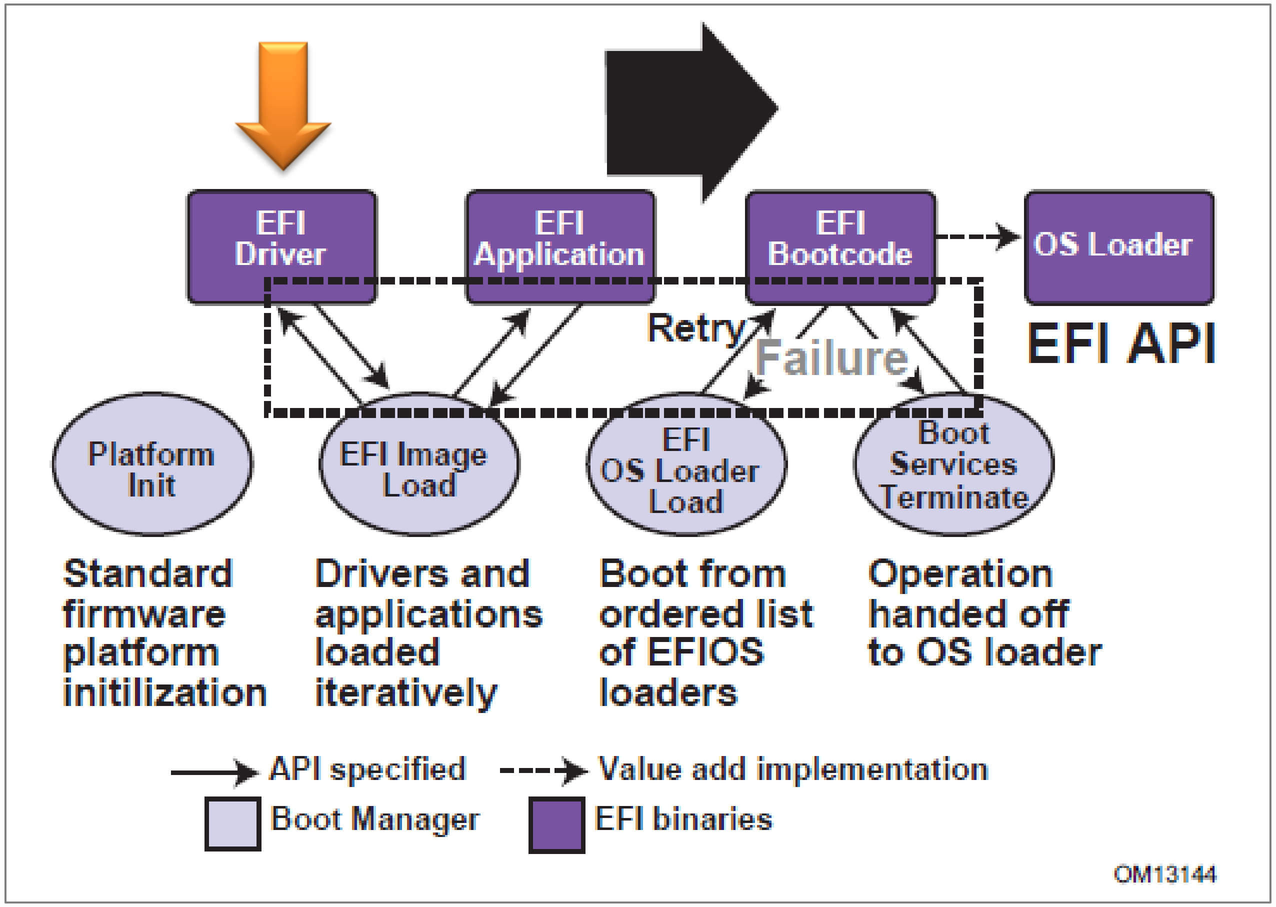
Best Practices for UEFI

- *Simple version … use the UEFI spec!*
- Slightly longer version …
  - Only use UEFI protocols
  - Make proper use of HII
  - Don’t make legacy assumptions
  - Test against multiple UEFI platforms

Let's go to the UEFI Spec …

UEFI 2.3.1, Pg. 17

"When UEFI drivers and UEFI applications are loaded they have access to all UEFI-defined runtime and boot services. See *Figure 2*."

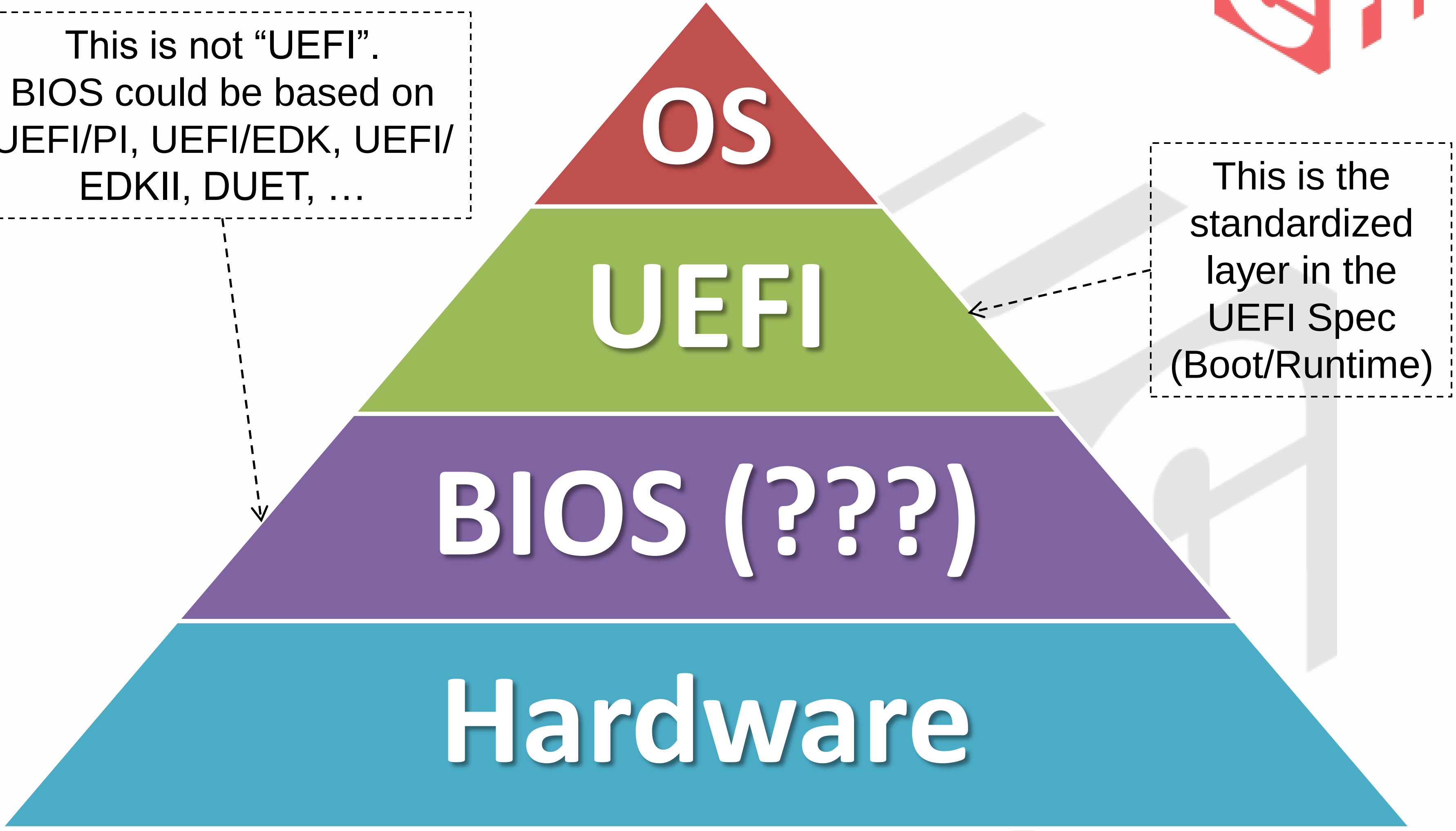


UEFI Driver Model

- Notice the UEFI Driver doesn't have arrows going back to "platform init"
- UEFI Drivers only make use of Boot Services and Runtime Services
  - No PI protocols
  - No EDK protocols
  - No CSM callbacks

Calling these from UEFI drivers can be unpredictable …

Sticking to the Spec …



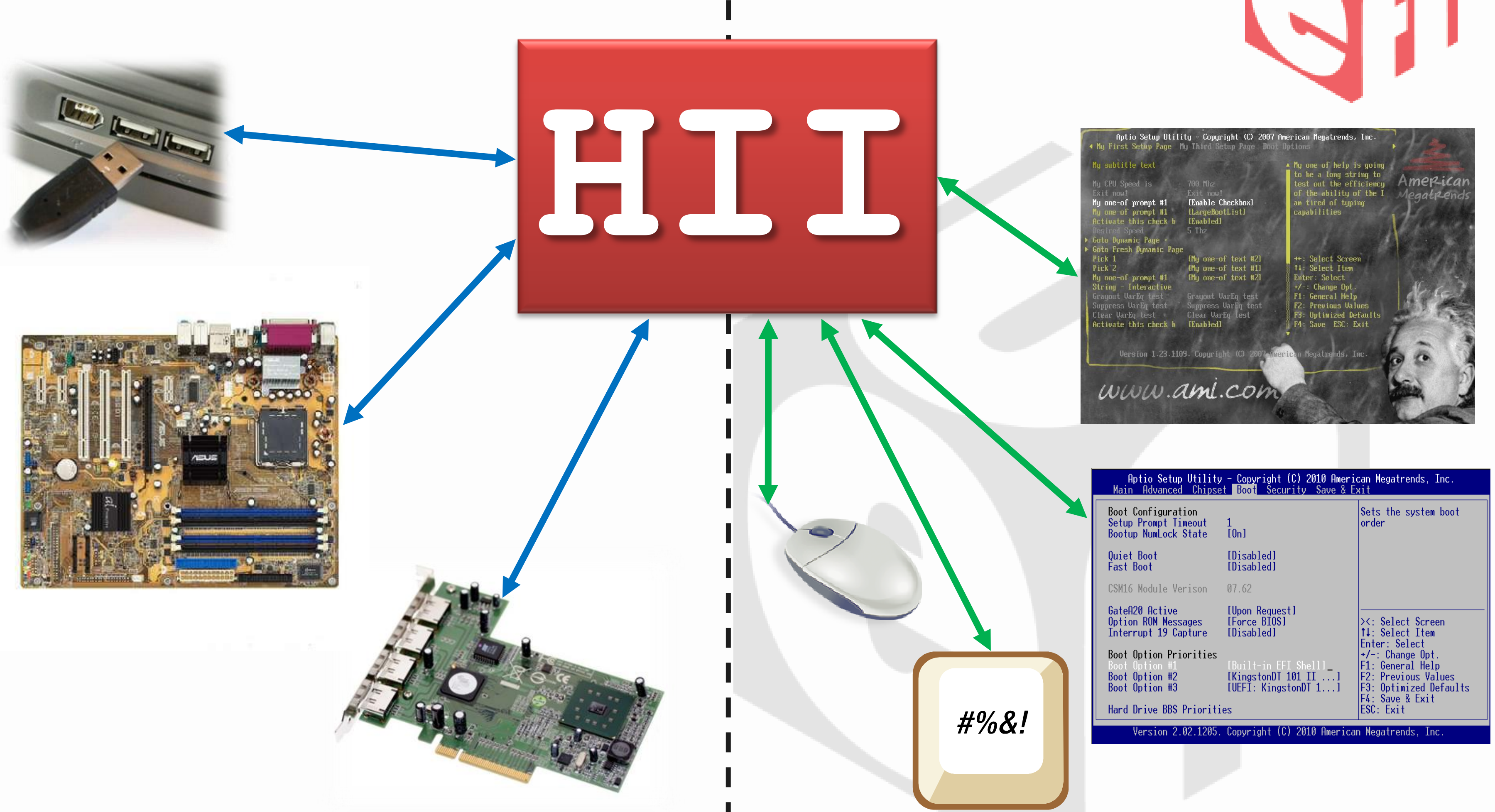
This is not "UEFI".
BIOS could be based on UEFI/PI, UEFI/EDK, UEFI/EDKII, DUET, …

This is the standardized layer in the UEFI Spec (Boot/Runtime)

Use HII for User Interface

- *Human Interface Infrastructure (HII)*
  - Firmware & Drivers publish to a “database”
  - System firmware uses a common “browser”
- Drivers don’t have to carry their own UI
- OEMs get a consistent user experience
  - No switching between multiple menus
- OEM & ODM branding happens in setup

Use HII for User Interface



```
Aptio Setup Utility - Copyright (C) 2007 American Megatrends, Inc.
◀ My First Setup Page   My Third Setup Page   Boot Options                    ▶

 My subtitle text                                    ▲ My one-of help is going
                                                       to be a long string to
 My CPU Speed is          700 Mhz                      test out the efficiency
 Exit now!                Exit now!                    of the ability of the I
 My one-of prompt #1      [Enable Checkbox]            am tired of typing
 My one-of prompt #1      [LargeBootList]              capabilities
 Activate this check b    [Enabled]
 Desired Speed            5 Thz
▶ Goto Dynamic Page +
▶ Goto Fresh Dynamic Page
 Pick 1                   [My one-of text #2]          ++: Select Screen
 Pick 2                   [My one-of text #1]          ↑↓: Select Item
 My one-of prompt #1      [My one-of text #2]          Enter: Select
 String - Interactive                                  +/-: Change Opt.
 Grayout VarEq test       Grayout VarEq test           F1: General Help
 Suppress VarEq test      Suppress VarEq test          F2: Previous Values
 Clear VarEq test         Clear VarEq test             F3: Optimized Defaults
 Activate this check b    [Enabled]                    F4: Save   ESC: Exit
                                                     ▼
        Version 1.23.1109. Copyright (C) 2007 American Megatrends, Inc.
```

American Megatrends

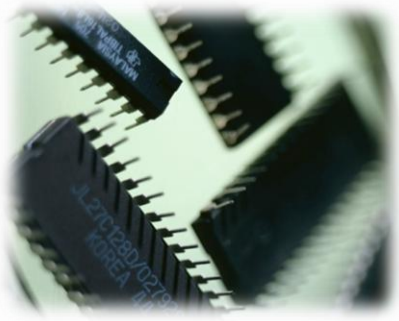
www.ami.com

```
     Aptio Setup Utility - Copyright (C) 2010 American Megatrends, Inc.
   Main  Advanced  Chipset  Boot  Security  Save & Exit

  Boot Configuration                               Sets the system boot
  Setup Prompt Timeout     1                       order
  Bootup NumLock State     [On]

  Quiet Boot               [Disabled]
  Fast Boot                [Disabled]

  CSM16 Module Verison     07.62

  GateA20 Active           [Upon Request]
  Option ROM Messages      [Force BIOS]            ><: Select Screen
  Interrupt 19 Capture     [Disabled]              ↑↓: Select Item
                                                   Enter: Select
  Boot Option Priorities                           +/-: Change Opt.
  Boot Option #1           [Built-in EFI Shell]_   F1: General Help
  Boot Option #2           [KingstonDT 101 II ...] F2: Previous Values
  Boot Option #3           [UEFI: KingstonDT 1...] F3: Optimized Defaults
                                                   F4: Save & Exit
  Hard Drive BBS Priorities                        ESC: Exit

      Version 2.02.1205. Copyright (C) 2010 American Megatrends, Inc.
```

Questions, Data & Strings

Localization, Input & Display

Mixing Legacy/UEFI OpROM



- Many UEFI drivers are packaged as an OpROM
- PCI spec allows multiple OpROM images on a device
  - Includes Legacy x86 & UEFI
- UEFI firmware sets platform policy for running OpROM

Common OpROM Combos

- 🔻 Legacy ROM Only
- 🔻 UEFI “native” OpROM
- ☺ Legacy ROM + UEFI EBC OpROM
- ⬆ Legacy ROM + UEFI x64 OpROM
- ⬆ Legacy ROM + UEFI x64 + UEFI IA32

OpROM “Awareness”

- UEFI firmware “policy” can change
  - Example: Run legacy OpROM or UEFI first?
  - IBV/OEM/ODM policy may be different
- Developers cannot assume that the UEFI firmware will run OpROM a certain way
- *Make OpROM & driver code as platform independent as possible*

Driver/OpROM Execution

- UEFI Drivers & UEFI OpROMs will only be executed for devices in the boot path
- Different from legacy BIOS, where all OpROMs are executed on every boot
  - This is a huge advantage for the boot time
- *The OS driver cannot assume the UEFI driver/OpROM has been executed!*

Make sure your OS driver team understands this fact …

Check the specs …

- New Driver Model protocols in UEFI 2.2
  - Driver Family Override (optional)
  - Driver Supported EFI Version (required)
- Device config uses Driver Health protocol
  - In UEFI 2.1+ **`DriverConfiguration`** and **`DriverConfiguration2`** are depreciated
- All this and more can be discovered in the *UEFI Specification* at uefi.org

click me … click me …

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- **Common Driver Issues**
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Common Driver Issues

- Calling non-UEFI protocols (PI & EDK)
- Poor handling of function returns
  - Error returns & unsupported functions
- Misusing HII Database Protocols
  - Managing HII packs, generating UI elements
- "Inappropriate Touching"
  - Trying to configure other platform hardware

Focus: non-UEFI Protocols

- Some protocols come from specific implementations, so don't rely on them
  - **UEFI != EDK … UEFI != PI … UEFI != CSM**
  - *Code to the spec, not an implementation*
- Other UEFI protocols are *optional*
  - Check to make sure protocols are installed before calling and handle errors gracefully

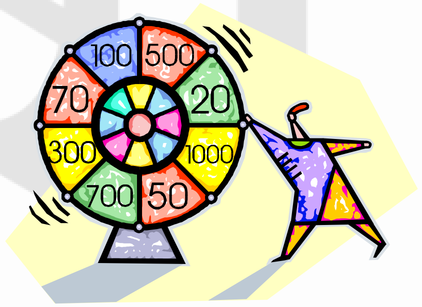
And while we're on the subject …

Focus: Function Returns

- Per spec, if a service returns an error, *the output parameters are undefined*
- *Check the return code* instead of just checking the output parameters
- Use return codes to *verify protocols are installed*

Focus: Function Returns

- Invalid return values when calling **`RouteConfig()`** and **`ExtractConfig()`**
  - Example: routine returns **`EFI_SUCCESS`** when it is unsupported (incorrect)
  - Browser reads **`EFI_SUCCESS`** value and tries to interpret an invalid return string
- Result: ***unknown behavior***



Focus: User Interface

- Check if the Console is installed *before* use
  - Check for NULL pointer in the system table
  - What if it's a headless system (no console)?
  - Always consider possibility of NULL pointers
- Proper use of add/remove formset pack
  - Only update when something changes
  - The firmware won't check if something is different (too much overhead)

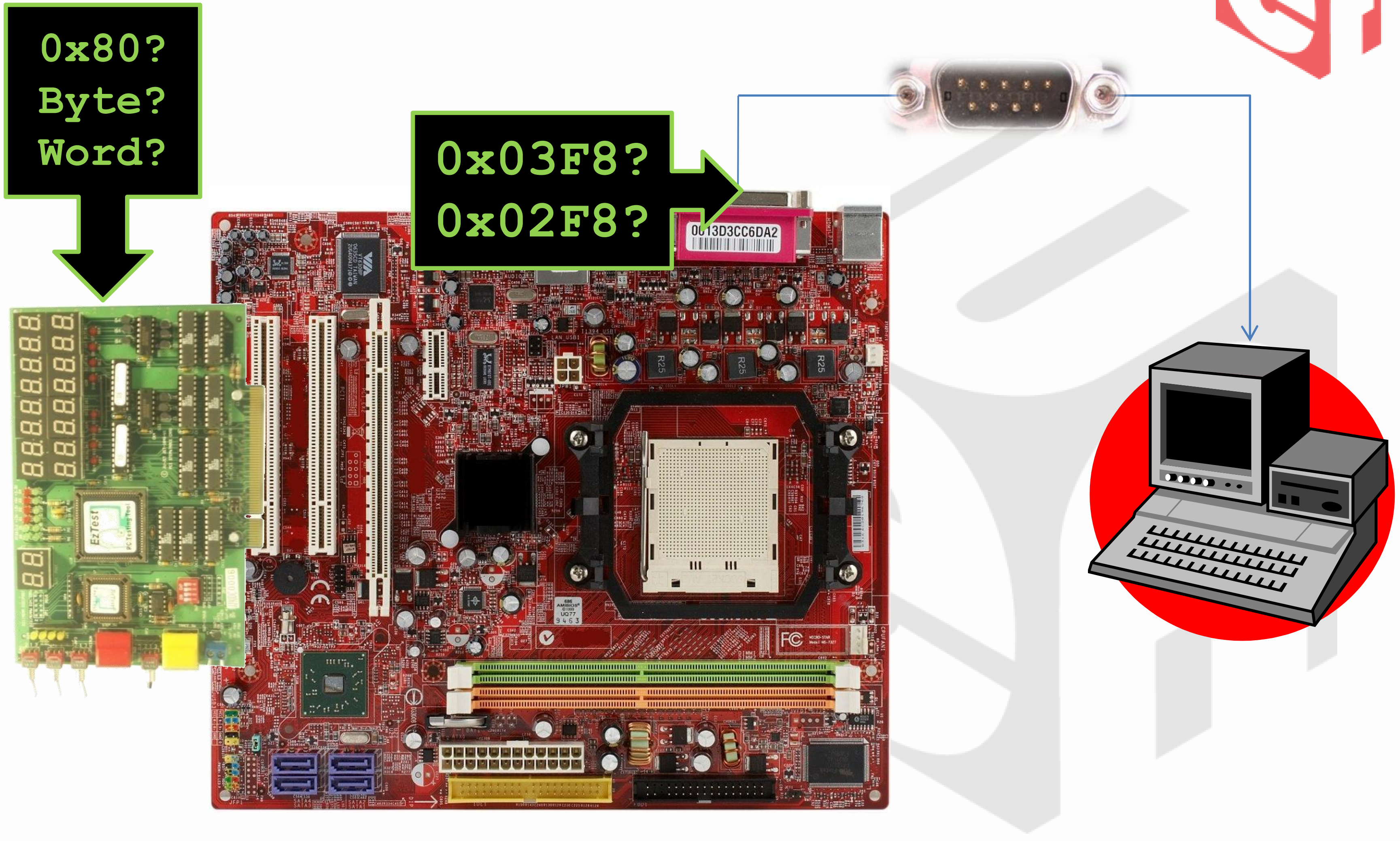
Focus: User Interface

- Avoid direct user interaction
  - Publish protocols for firmware interaction
  - Use `DriverHealth` protocol for mandatory configuration or repair operations
- Don't directly invoke popup windows
  - Formset elements such as `InconsistentIF` can create conditions to trigger a popup
- Remember … *drivers provide forms, the HII browser provides the user experience*
  - Look & feel varies between platforms

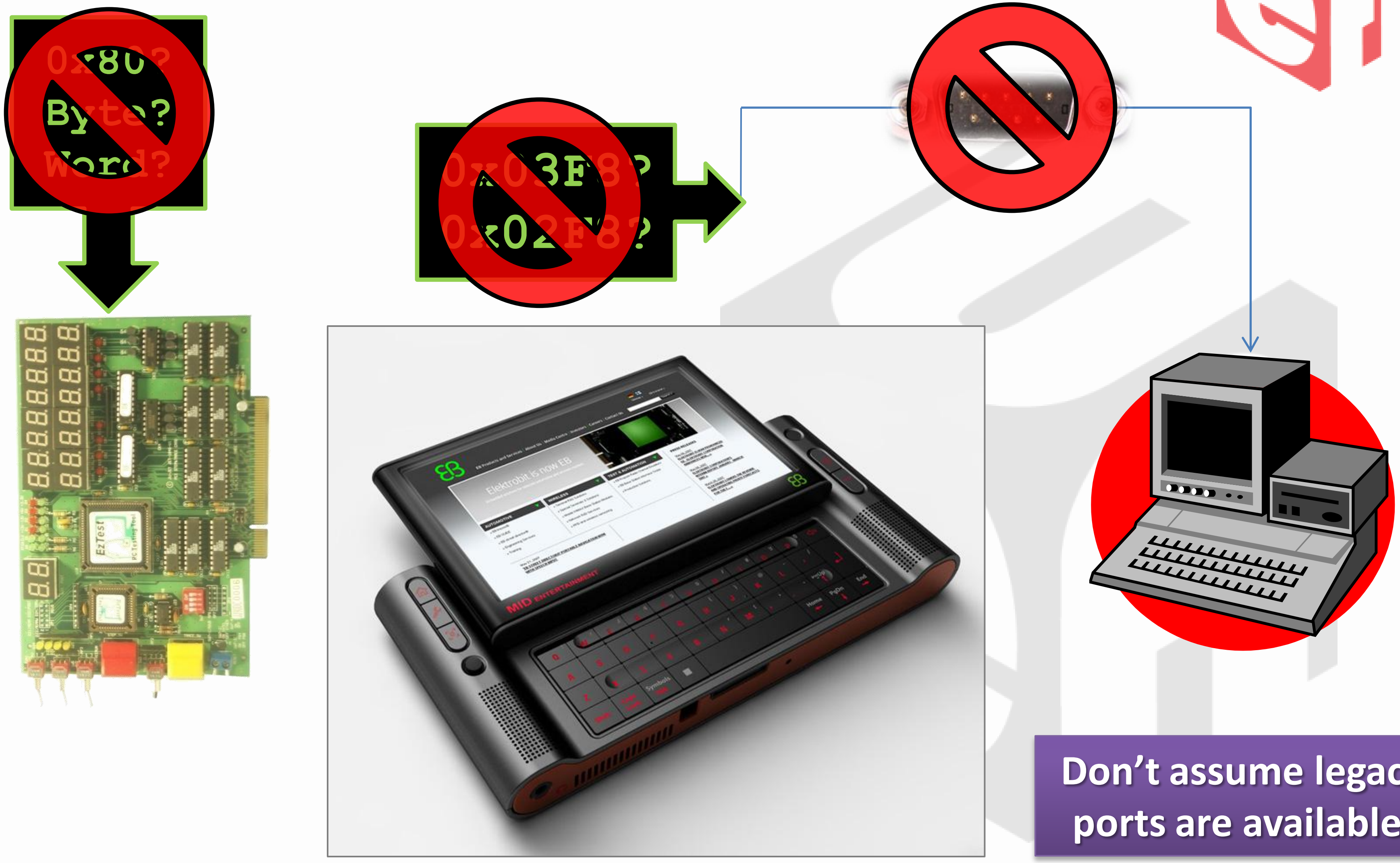
Focus: Inappropriate Touching

- Configure *your* hardware … *don't configure theirs*
- Yes, this seems obvious … but it can be a problem
- UEFI encourages portable code, so making platform assumptions doesn't work

Debug Output: Old School



Debug Output: New School



Don’t assume legacy ports are available.

Example: Debug Output

- Some drivers try directly access hardware for debug output (USB, COM, Port 80)
  - Problem: *hardware is already in use*
  - Result: the driver breaks system output
- Solution: *call standard output protocols*
  - **`gST->StdErr`**
  - More flexible
  - Works with new tools

Example: PciIo Attributes

- Avoid enabling unsupported PCI attributes
  - **`PciIo->Attributes`**
  - Support is required from the PCI Controller, PCI-to-PCI Bridge and PCI Bus Controller for an attribute to properly take effect
- Check platform attributes before enabling **`EfiPciIoAttributeOperationSupported`**
- Avoid using EDK macros to enable devices

Example: PciIo Attributes

- `EFI_PCI_IO_ATTRIBUTE_ISA_IO_16`
- `EFI_PCI_IO_ATTRIBUTE_VGA_PALETTE_IO_16`
- `EFI_PCI_IO_ATTRIBUTE_VGA_IO_16`
- `EFI_PCI_IO_ATTRIBUTE_ISA_MOTHERBOARD_IO`
- `EFI_PCI_IO_ATTRIBUTE_ISA_IO`
- `EFI_PCI_IO_ATTRIBUTE_VGA_PALETTE_IO`
- `EFI_PCI_IO_ATTRIBUTE_VGA_MEMORY`
- `EFI_PCI_IO_ATTRIBUTE_VGA_IO`
- `EFI_PCI_IO_ATTRIBUTE_IDE_PRIMARY_IO`
- `EFI_PCI_IO_ATTRIBUTE_IDE_SECONDARY_IO`
- `EFI_PCI_IO_ATTRIBUTE_DUAL_ADDRESS_CYCLE`

Check platform attributes before enabling

Other Areas of Concern

- Hooking periodic timers
- MP Aware Code … *"Unless otherwise specified a protocol's member function is not reentrant or MP safe."*
  - Many firmware implementations will block this type of call to avoid reentrance issues
- Using **`BrowserCallback()`** properly
  - This is driver function intended to be called by a callback handler … weird things may happen if other functions call it

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Summary

- The UEFI Driver Model has multiple benefits over Legacy BIOS Option ROMs
  - Removes legacy x86 hardware limitations
  - Based on well documented standards
  - Decoupling driver & OpROM from the UI
- Code to specification, not implementation
- Test against multiple UEFI implementations
- This presentation is only the beginning … *check uefi.org for more information*

Relevant UEFI Spec Sections

Based on UEFI 2.3.1 Specification

2.5.1	Legacy Option ROM Issues
10	Protocols – UEFI Driver Model
13.4.2	PCI Option ROMs
20	EFI Byte Code Virtual Machine
28	HII Overview
29	HII Protocols
30	HII Configuration Processing and Browser Protocol

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Thanks for attending the
UEFI Summer Plugfest 2011

For more information on
the Unified EFI Forum and
UEFI Specifications, visit
http://www.uefi.org

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But wait, there's more …

Wed (July 6)

- UEFI State of the Union (10:30am, Intel)
- Implementing a Secure Boot Path with UEFI
- UEFI SCT Overview (2:30pm, HP/In

Thu

- Replacin
- ent (1:00pm,

- for UEFI Option ROM Developers (10:30am, AMI)

That's it for now …
Visit uefi.org to download presentations, specifications and other documentation.

Download presentations after the plugfest at www.uefi.org