Secure Firmware Lockdown through Standardized (UEFI) Management Protocols

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EFIS002
AGENDA

• Why Firmware (FW) Management in UEFI
• FW Management Overview
• Some FW Management Subtleties
• Security and FW Management
• Implementing FMP
• Demo
UEFI & PI Security Evolution

- UEFI 2.0
  - BIS, UEFI driver signing, Hash protocol, Authentication info
- UEFI 2.1
  - Authenticated-Write Access for UEFI Variables
- UEFI 2.2
  - IPsec, Authenticode addition to driver signing, Driver / loader verification, User Identification
- UEFI 2.3
  - Firmware Management protocol
    - Assurance & interoperability around ‘updates’
What is Firmware Management

• Today's system contains number of firmware from various vendors
  – System BIOS
  – Network
  – Storage
  – Etc.

• Firmware Management is Keeping track of firmwares in the system
Firmware Management Lifecycle

- Having the right firmware level when the system is deployed
  - IT policy
  - The latest
  Or
  - Goldilocks
- Maintaining firmware during the life of the system
  - Bug fixes
  - Performance improvement
  - Etc.
Why Firmware Management Protocol

• IHVs need to provide update packages for different OS
  – Windows*
  – Linux*
  – Some other flavors
• Every vendor has a separate tool
  – Different UI
  – Different scripts

Result: More complexity, more IT cost
Why Firmware Management Protocol

- At the abstract level firmware management involves common set of functionality
  - Locating the device
  - Identifying the current firmware level
  - Update the firmware image

Need for OS agnostic standardized Firmware Management
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Firmware Management Protocol

- Industry standard interface
  - Defined in UEFI 2.3 Specification
- Abstracts device firmware management to common set of API
- Enables common management of different firmware using single interface / application
Firmware Management Protocol Overview

• Get information on firmware image(s)
• Check if firmware image is valid
• Program device with new firmware image
• Get a copy of firmware image
  – For management purposes
• Label all firmware images within a device
Possible Update Scenarios

Repository

Capsule from OS

UEFI Pre boot space

UEFI Fw Mgt App

UEFI Driver (BIOS) Fw Mgt Protocol

Set Image Get Info

UEFI Driver (PCI) Fw Mgt Protocol

Set Image Get Info

UEFI Driver (PCI) Fw Mgt Protocol

Set Image Get Info
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FMP: Image Info/Image Descriptor

***************
// EFI_FIRMWARE_IMAGE_DESCRIPTOR
//
***************
typedef struct {
    UINT8           ImageIndex;
    EFI_GUID        ImageTypeId;
    UINT64          ImageId;
    CHAR16          *ImageIdName;
    Version         *VersionName;
    UINT32          Size;
    UINT64          AttributesSupported;
    UINT64          AttributesSetting;
    UINT64          Compatibilities;
} EFI_FIRMWARE_IMAGE_DESCRIPTOR;

Version: Numerical representation of versioning scheme

1.2 = 102
1.10 = 110

Newer version is always numerically greater than the older one.
typedef struct {
    UINT8  ImageIndex;
    EFI_GUID ImageTypeId;
    UINT64 ImageId;
    CHAR16 *ImageIdName;
    CHAR16 *VersionName;
    UINT32 Size;
    UINTN AttributesSupported;
    UINT64 AttributesSetting;
    UINT64 Compatibilities;
} EFI_FIRMWARE_IMAGE_DESCRIPTOR;

**VersionName:** Text representation of versioning scheme

110 = L”1.1.0” or 110 = L”1.10”

102 = L”1.2” or 102 = L”1.0.2”

Used for display purpose
FMP: Image Info/Image Descriptor

```c
CHAR16
UINTN
UINT64
UINT64
} EFI_FIRMWARE_IMAGE_DESCRIPTOR;
```

- Value based on the current hardware support
FMP: Image Info/Image Descriptor

```c
CHAR16
UINTN
UINT64
UINT64
UINT64

} EFI_FIRMWARE_IMAGE_DESCRIPTOR;

*VersionName;
Size;
AttributesSupported;
AttributesSetting;
Compatibilities;
```

Image1
0x30001

Image2
0x20001
The typical usage of the compatibilities is for update app to make sure that the new image is compatible with the hardware.

How the FW Mgt App will get the compatibility value for the image to be updated is out of UEFI spec leaving room for further innovation.

FMP Check and Set routines should always do the internal compatibility check.
FMP: Image Info/Image Descriptor

```c
CHAR16
UINTN
UINT64
UINT64
UINT64

} EFI_FIRMWARE_IMAGE_DESCRIPTOR;
```

- Way to provide instruction to the update app like
  - IMAGE_ATTRIBUTE_RESET_REQUIRED – Reset the system after update. FMP does not reset the system on its own. Single reset after multiple updates
  - IMAGE_ATTRIBUTE_IN_USE – May be update app needs to stop the device driver before update
  - IMAGE_ATTRIBUTE_AUTHENTICATION_REQUIRED – We check ID!
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Why Bother with Security?

- FW Management Protocol makes it easy
  - For trusted and untrusted users

"With great power, comes great responsibility”

- One interface to affect many modules
Potential Security Layers

- FW Management Remote Service
- FW Management Application
- FW Management Protocol
Adding Security to FW Management

- Protect Access to Protocol
- Validate Image
- Authenticate Image
Protect Access to Protocol

- Require Credentials
  - User Identity Manager from UEFI
  - FW management protocol notified about user
- Conditional load of Protocol
  - LoadImage can defer image execution for security
    - User privileges not correct
    - EFI_DEFERRED_IMAGE_LOAD_PROTOCOL
- Physical access requirements
  - Verify user has physical access to platform

Know who is using the Firmware Management Protocol
Require Credentials

FW Management Software

User Profile

User Identity

User Profile

FW Management Protocol

User Profile Changed Event
Validate Image

- Correct format for firmware image
  - Protection by obscurity – low security value
  - May prevent brick syndrome
  - Acceptable if device has internal security
    - Possible denial of service attack
- Use vendor specific policy
  - Can allow older firmware to be used
Authenticate Image

- Adds information to firmware image
  - Minimum information
    - Public Key
    - Signature
  - Can verify image source
  - Can verify image integrity
- Will require security support
  - UEFI Key Exchange, Hash & Decryption protocols
- Set image attribute
  - IMAGE_ATTRIBUTE_AUTHENTICATION_REQUIRED

Verify the image is good before commit!
Authenticate Image

New Image

Firmware Image Authentication

Firmware Image

FW Management Protocol

Hash, Decryption Services
Security Summary

- Protect the Firmware Management Protocol
- Validate or Authenticate the images
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Implementing FMP: UEFI Driver

- FMP implemented as a non-device driver
  - For BIOS, Management Firmware etc.
  - Installed with new handle
  - In this case management app strictly depends on information provided in image descriptor
Implementing FMP: UEFI Device driver

• FMP implemented as a part of device driver
  – For PCI devices
    – Storage
    – network
    – Etc..
  – Installed on the same handle as the controller handle
  – Associating with the device allows management app to gather more relevant information like
    – Device ID, Vendor ID
    – Device Class
    – Component Name Too

Choose right implementation for added benefit
Implementation flexibility

- UEFI spec always builds on top of the previous one
- Choose your base support level
- FMP can be implemented independently
- Choose security measures as your base implementation

UEFI 2.1
Hash, Decrypt. Services

UEFI 2.2
User Identity

UEFI 2.3
FW Mgt. Protocol

TARGET UEFI 2.x
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Demo

- Unified Server Configurator is Dell’s embedded deployment infrastructure based on UEFI 2.1
- Dell’s update manager that uses UEFI Firmware Management Protocol
  - Provides ability to upgrade or downgrade firmware image
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• Summary / Take aways
Summary/Take Aways

- Proprietary interface to common set of functions is not efficient
- Firmware management protocol makes managing firmware easy
- FMP abstracts only the external interface not the actual update logic allowing a common UI for all firmware updates
- FMP is part of UEFI 2.3 spec but can be implemented independently
- FMP is required for Dell enterprise servers
- Securing Firmware Management Protocol is essential
Additional resources on UEFI:

- Other UEFI Sessions – Next slide
- Visit UEFI Booth #136 & Insyde SW #312
- More web based info:
  Specifications and Implementation sites:
  - www.tianocore.org
  - www.uefi.org
  - www.intel.com/technology/efi
## IDF 2009 UEFI Sessions

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<tr>
<th>EFI#</th>
<th>Company</th>
<th>Description</th>
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<td>- Reducing Platform Boot Times</td>
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<td>- Firmware Debugging: UEFI and USB for platform forensics</td>
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Backup Slides
FMP: Get Image Info

- Retrieves Information about the firmware image(s) supported by the instance of FMP
  - BIOS
  - Option ROM1 (Legacy), Option ROM2 (UEFI) ...
  - Option Rom or Controller firmware