Secure Firmware Lockdown through Standardized (UEFI) Management Protocols

Vincent Zimmer
Principal Engineer, Intel
Anand Joshi
Sr. Developer, Dell Inc.
Marty Nicholes
Architect, Insyde Software

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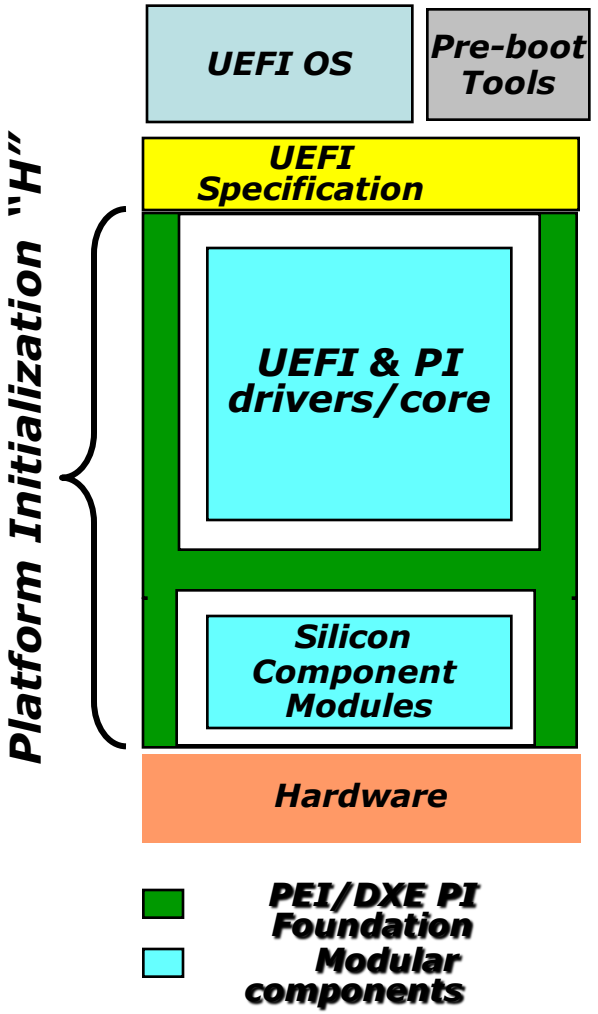
AGENDA

- Why Firmware (FW) Management in UEFI
- FW Management Overview
- Some FW Management Subtleties
- Security and FW Management
- Implementing FMP
- Demo

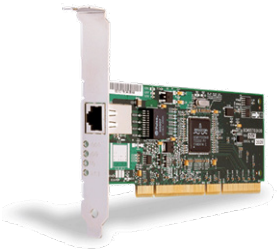
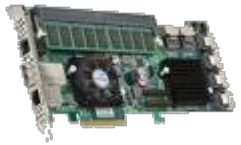
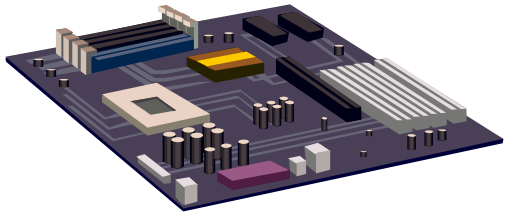
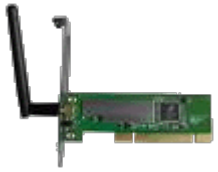
UEFI & PI Security Evolution



- UEFI 2.0
  - BIS, UEFI driver signing, Hash protocol, Authentication info
- UEFI 2.1
  - Authenticated-Write Access for UEFI Variables
- UEFI2.2
  - IPsec, Authenticode addition to driver signing, Driver / loader verification, User Identification
- UEFI2.3
  - ***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

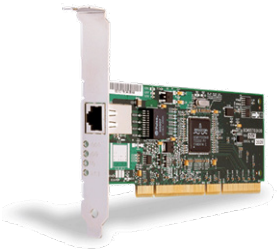
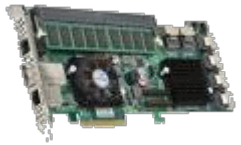
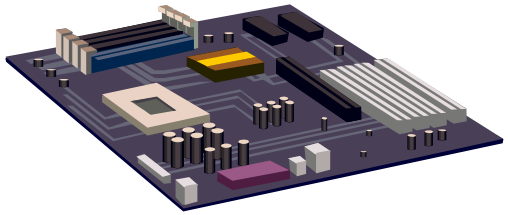
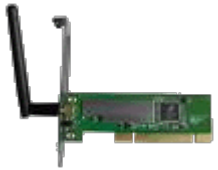






Firmware Management Lifecycle

- Having the right firmware level when the system is deployed
  - IT policy
  - The latest

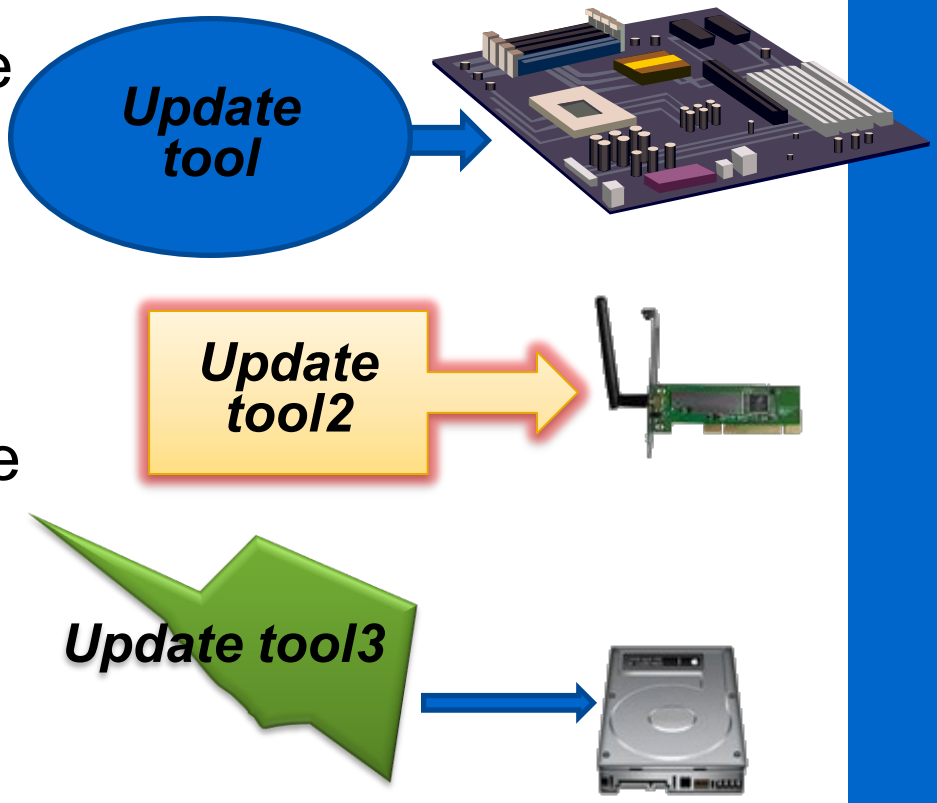
  Or

  - 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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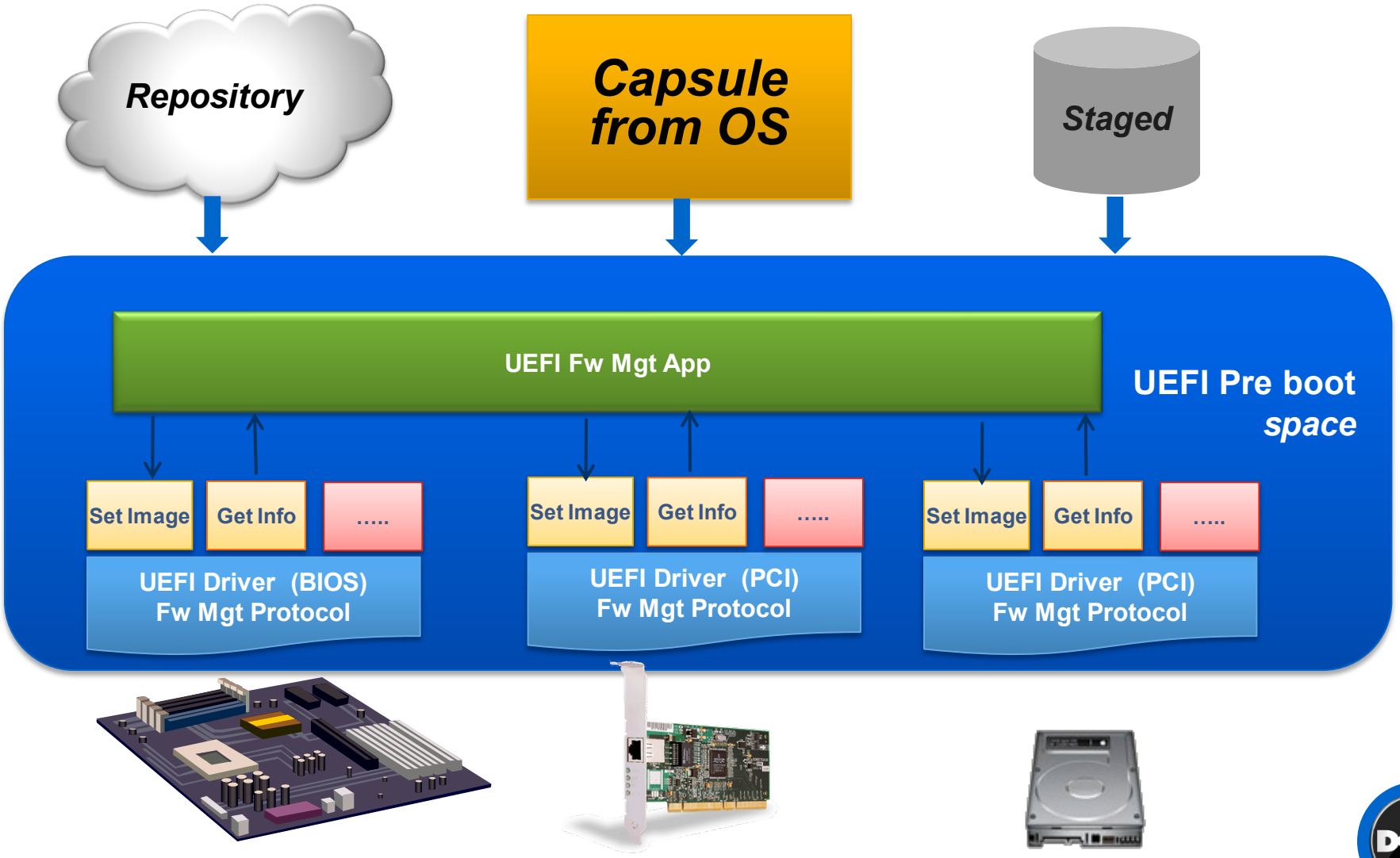
Firmware Management Protocol

- 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



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FMP: Image Info/Image Descriptor

```
**********************************************************
// EFI_FIRMWARE_IMAGE_DESCRIPTOR
//
**********************************************************
typedef struct {
  UINT8                         ImageIndex;
  EFI_GUID                      ImageTypeId;
  UINT64                        ImageId;
  CHAR16                        *ImageIdName;
  UINT32                        Version;
  CHAR16                        *VersionName;
  UINTN                         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.

FMP: Image Info/Image Descriptor

```
**********************************************************
// EFI_FIRMWARE_IMAGE_DESCRIPTOR
//
**********************************************************
typedef struct {
  UINT8                         ImageIndex;
  EFI_GUID                      ImageTypeId;
  UINT64                        ImageId;
  CHAR16                        *ImageIdName;
  UINT32                        Version;
  CHAR16                        *VersionName;
  UINTN                         Size;
  UINT64                        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

```
  CHAR16                          *VersionName;
  UINTN                           Size;
  UINT64                          AttributesSupported;
  UINT64                          AttributesSetting;
  UINT64                          Compatibilities;
} EFI_FIRMWARE_IMAGE_DESCRIPTOR;
```

- Value based on the current hardware support

FMP: Image Info/Image Descriptor

```
  CHAR16                              *VersionName;
  UINTN                               Size;
  UINT64                              AttributesSupported;
  UINT64                              AttributesSetting;
  UINT64                              Compatibilities;
} EFI_FIRMWARE_IMAGE_DESCRIPTOR;
```

0x10001

0x20001

0x10001

0x20001

FMP: Image Info/Image Descriptor

```
  CHAR16                              *VersionName;
  UINTN                               Size;
  UINT64                              AttributesSupported;
  UINT64                              AttributesSetting;
  UINT64                              Compatibilities;
} EFI_FIRMWARE_IMAGE_DESCRIPTOR;
```

- 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

```
  CHAR16                          *VersionName;
  UINTN                           Size;
  UINT64                          AttributesSupported;
  UINT64                          AttributesSetting;
  UINT64                          Compatibilities;
} 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"

Spiderman

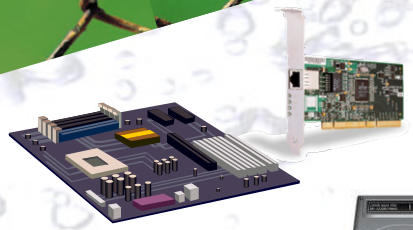
- One interface to affect many modules

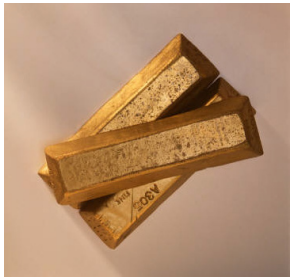
Potential Security Layers

FW Management Remote Service

FW Management Application

FW Management Protocol





Adding Security to FW Management

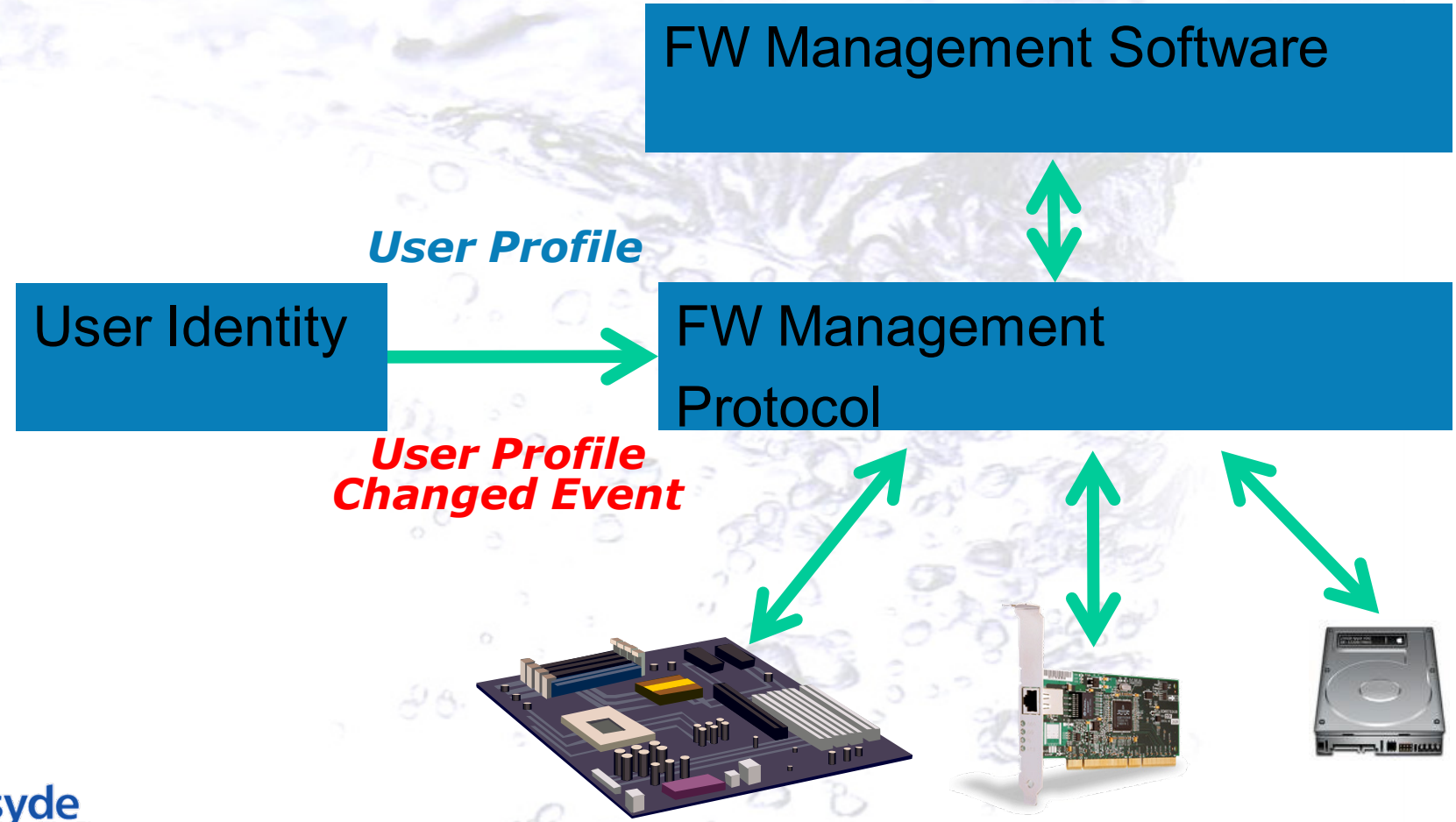
- Protect Access to Protocol
- Validate Image
- Authenticate Image

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



Validate Image

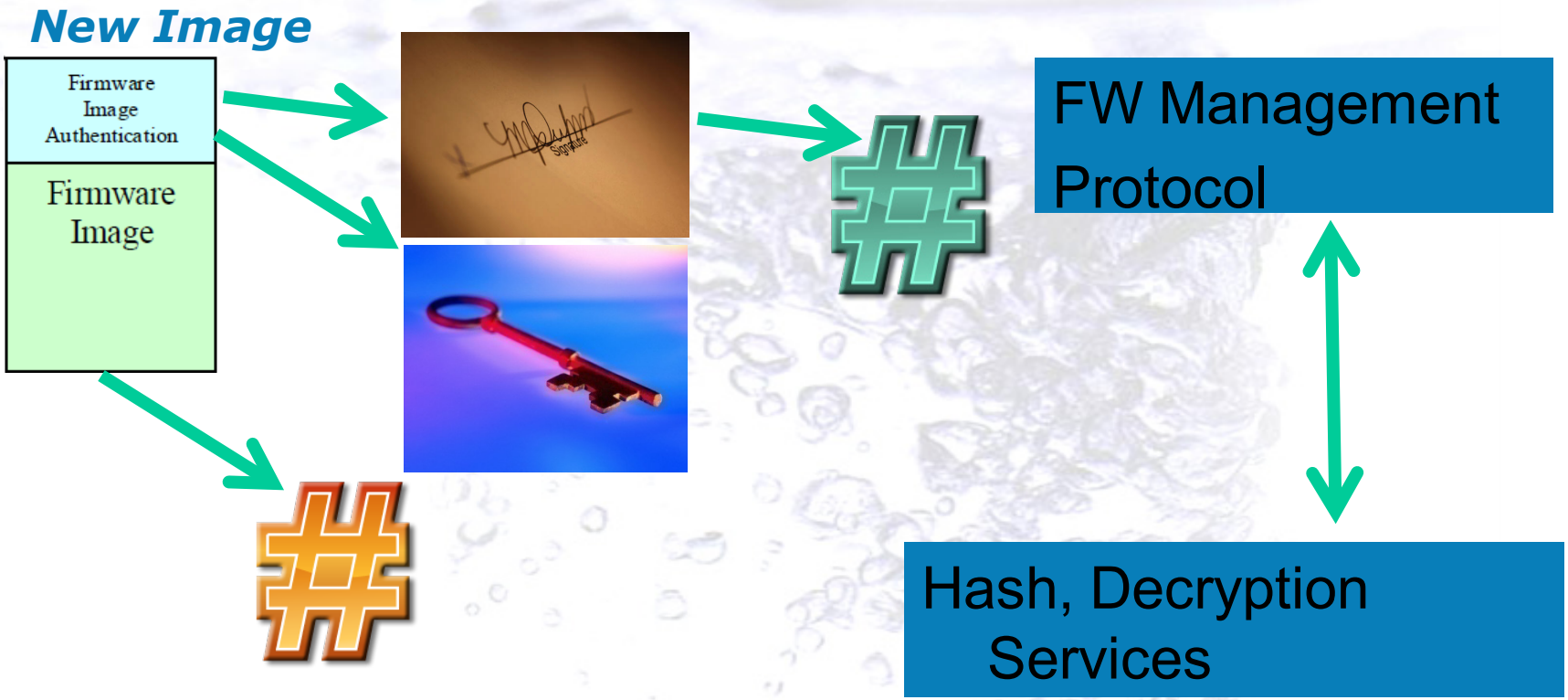
- Correct format for firmware image
  - Protection by obscurity – low security value
  - May prevent brick syndrome
  - Acceptable if device has internal security
    - Possible denial of service attack
- Use vendor specific policy
  - Can allow older firmware to be used

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



Security Summary

- Protect the Firmware Management Protocol
- Validate or Authenticate the images

Secure the Firmware Management Protocol

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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

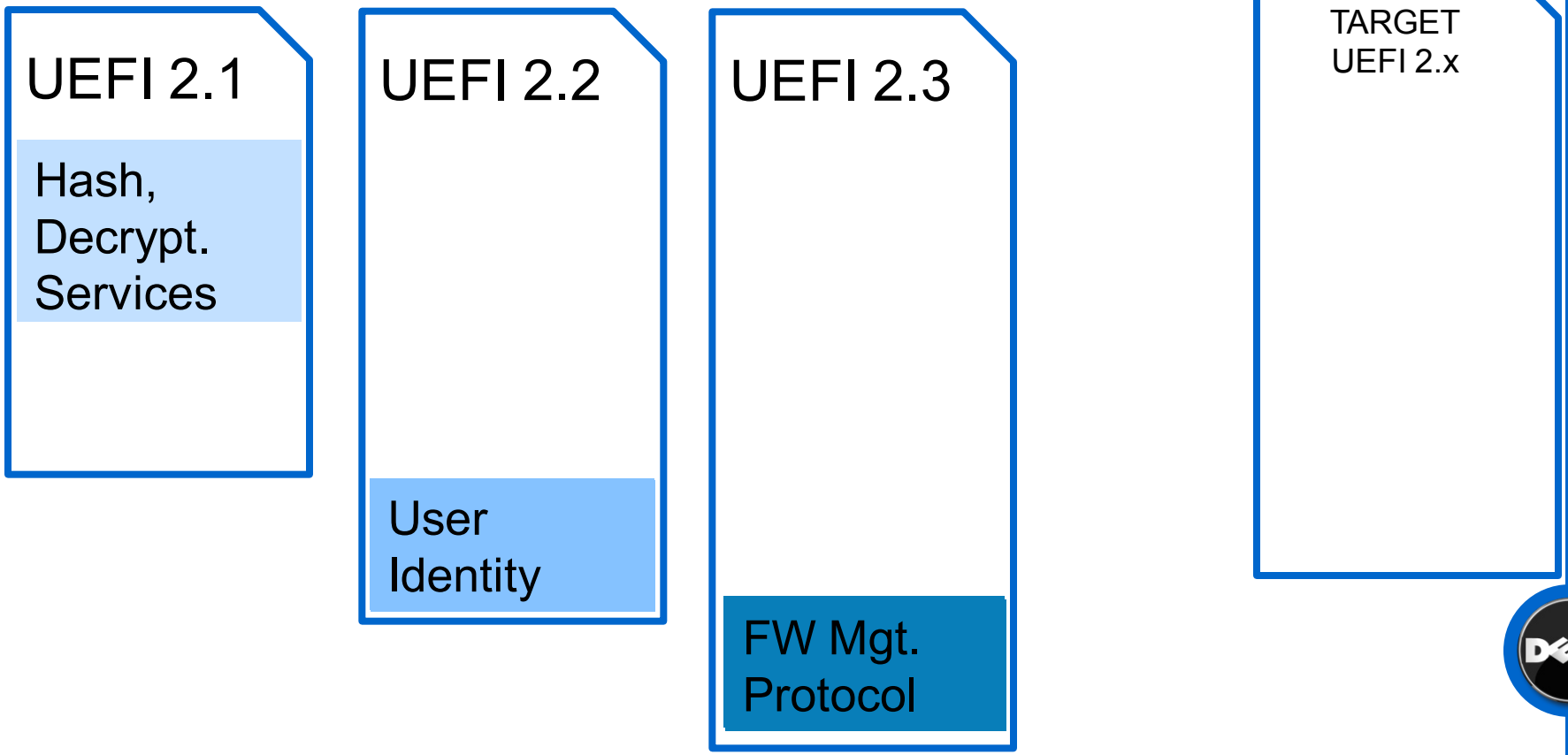
Implementing FMP: UEFI Device driver

- 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



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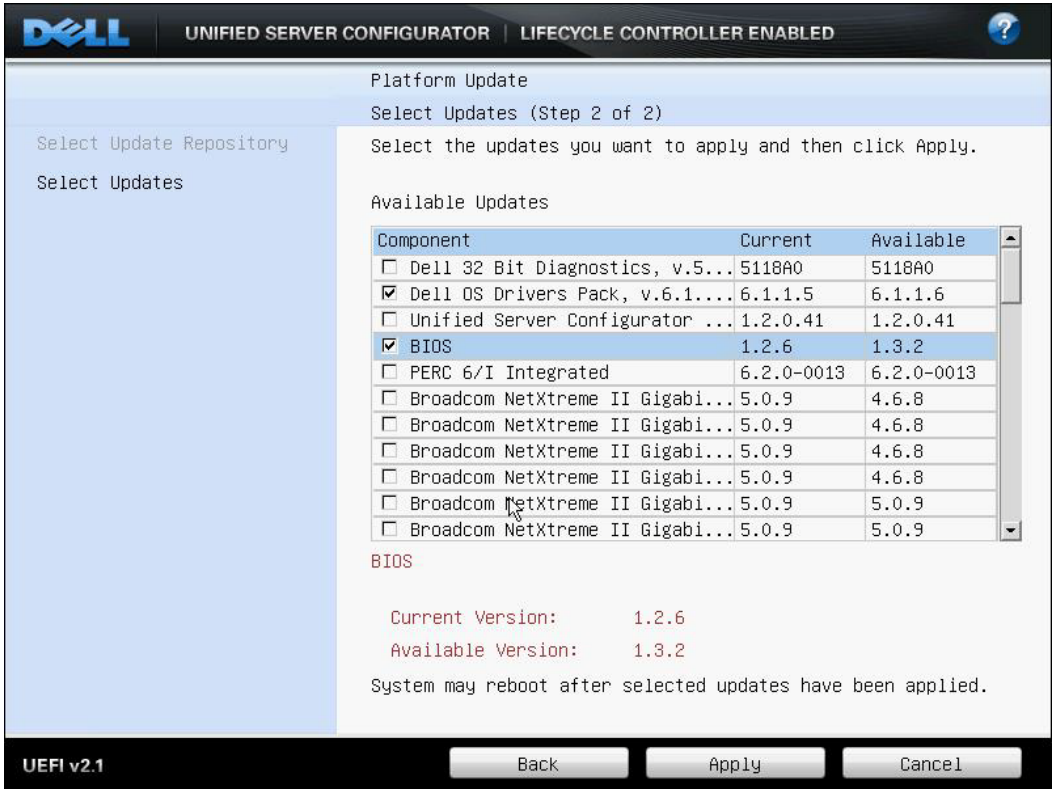
Demo

- 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
- Technical book from Intel Press: "Beyond BIOS: Implementing the Unified Extensible Firmware Interface with Intel's Framework" www.intel.com/intelpress

IDF 2009 UEFI Sessions

EFI#	Company	Description	Time	RM	D
P001 ✓	Dell, HP, IBM, Intel, Microsoft	Using UEFI as the Foundation for Innovation	10:15	2005	T
S001 ✓	IBM, Intel	Intel Advanced Technology in the Enterprise: Best Security Practices	16:15	2001	W
S002 ✓	Dell, Intel, Insyde SW	Secure FW Lockdown through Standardized UEFI Management Protocols	17:15	2001	W
S003	Intel, AMI	Best Technical Methods for UEFI Development -Reducing Platform Boot Times -Firmware Debugging: UEFI and USB for platform forensics	11:10	2002	Th
S004	Microsoft, Insyde SW, Intel	UEFI Boot Time Opt. Under Microsoft Windows 7	13:40	2002	Th
S005	Phoenix, Intel	Transitioning the Plug-In Industry from Legacy to UEFI: Real World Cases	14:40	2002	Th
Q001	Intel, All	UEFI Q & A session	15:40	2002	Th

✓ DONE

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Q&A

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Rev. 7/27/09

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