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UEFI & EDK II Training

UEFI Capsule Update

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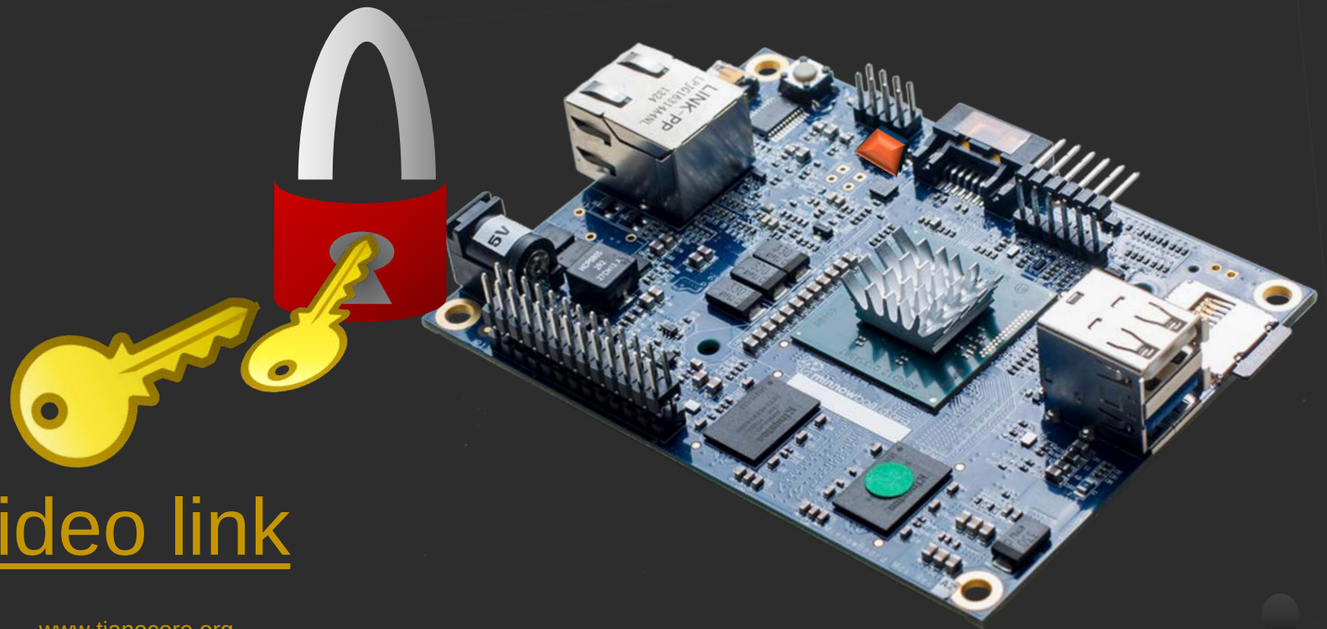
Lesson Objective

- What is Capsule Update
- Why is Capsule Update needed
- How to enable Capsule Update in Edk II platforms

UEFI CAPSULE UPDATE OVERVIEW

What is Capsule Update ?

- A more secure way to update firmware
- OS Agnostic



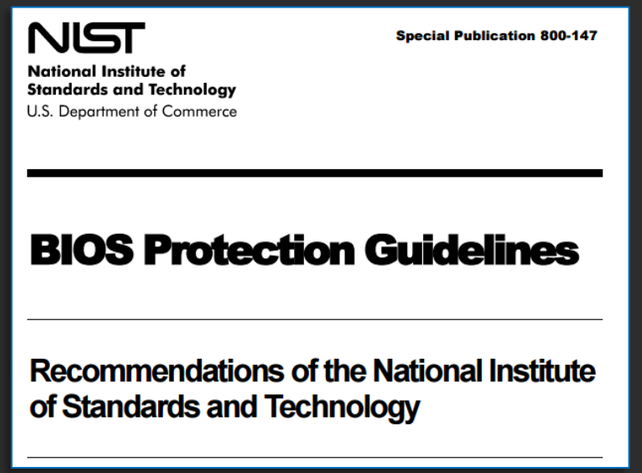
Video link

Why is Capsule Update Needed?

Establish a **Root-of-Trust** at the low-level platform initialization

National Institute of Standards and Technology (NIST) provides guidelines on BIOS update, [800-147]

- BIOS Update Authentication
- Secure Local Update Method
- Integrity Protection
- Non-Bypassabilitiy



NIST : Nist SP 800-147 .pdf

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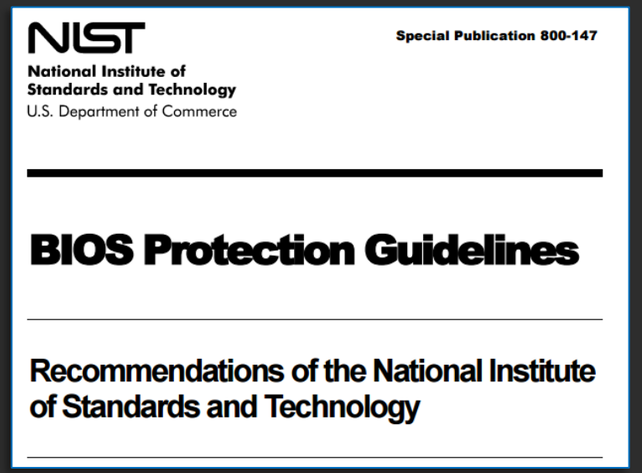
Does not describe implementation – the **“HOW?”**


NIST
National Institute of Standards and Technology
U.S. Department of Commerce

Special Publication 800-147

BIOS Protection Guidelines

Recommendations of the National Institute of Standards and Technology

NIST : Nist SP 800-147 .pdf

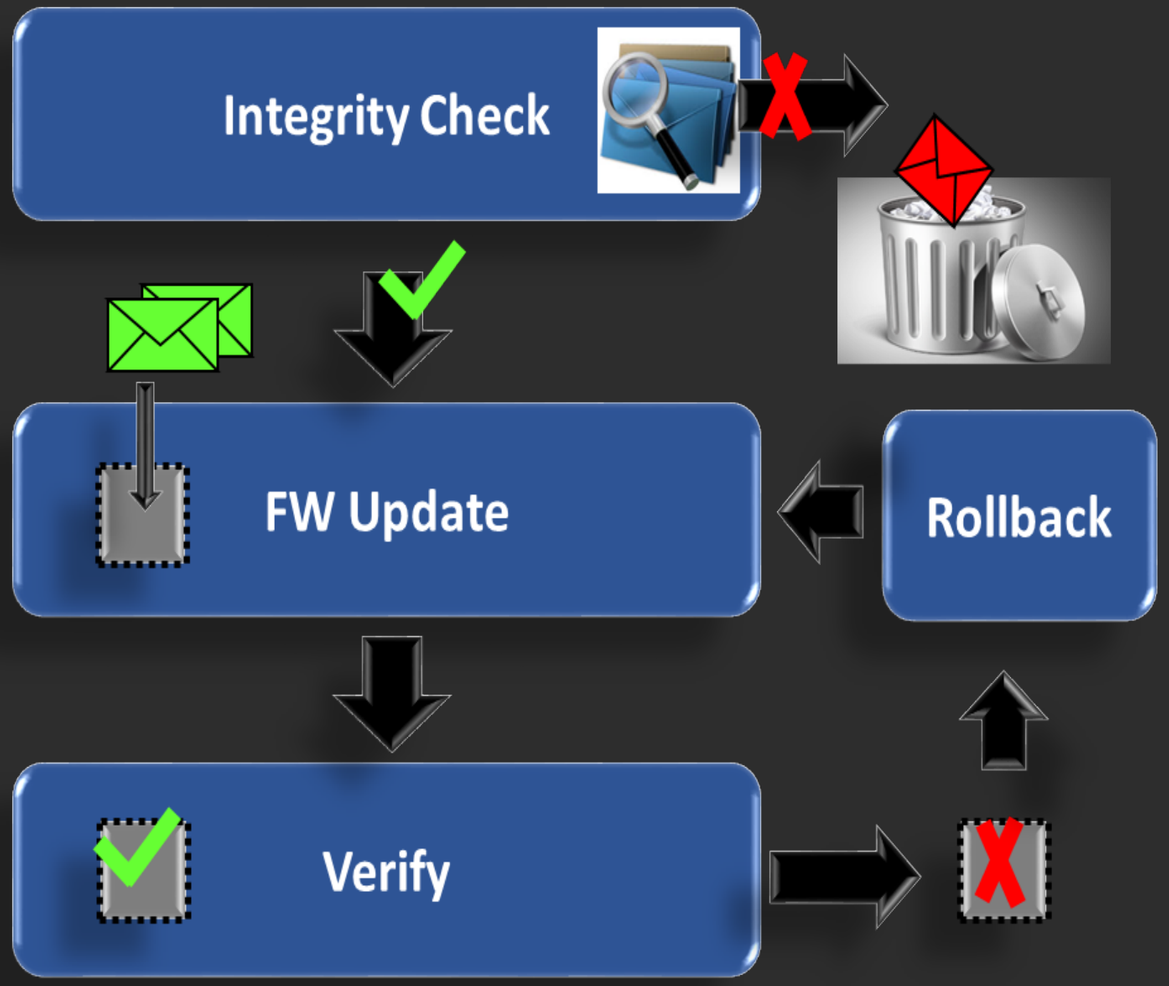
Solving Firmware Update

Reliable update story

- Fault tolerant
- Scalable & repeatable

How can UEFI Help?

- Capsule model for binary delivery
- Bus / Device Enumeration
- Managing updates via
  - EFI System Resource Table
  - Firmware Management Protocol
  - Capsule Signing



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HOW DOES THE CAPSULE UPDATE WORK?

UEFI Spec defines Capsule Services to meet NIST Requirement

- **EFI_FIRMWARE_MANAGEMENT_PROTOCOL,** (FMP) capsule format
- **EFI System Resource Table** (ESRT) to support system firmware and device firmware update
- An OS agent may call the UEFI service `UpdateCapsule()` to pass the capsule image from the OS to the firmware. Based upon the capsule flags, the firmware may process the capsule image immediately, or the firmware may reset the system and process the capsule image on the next boot

UEFI Capsule Update – Firmware Management Protocol (FMP)

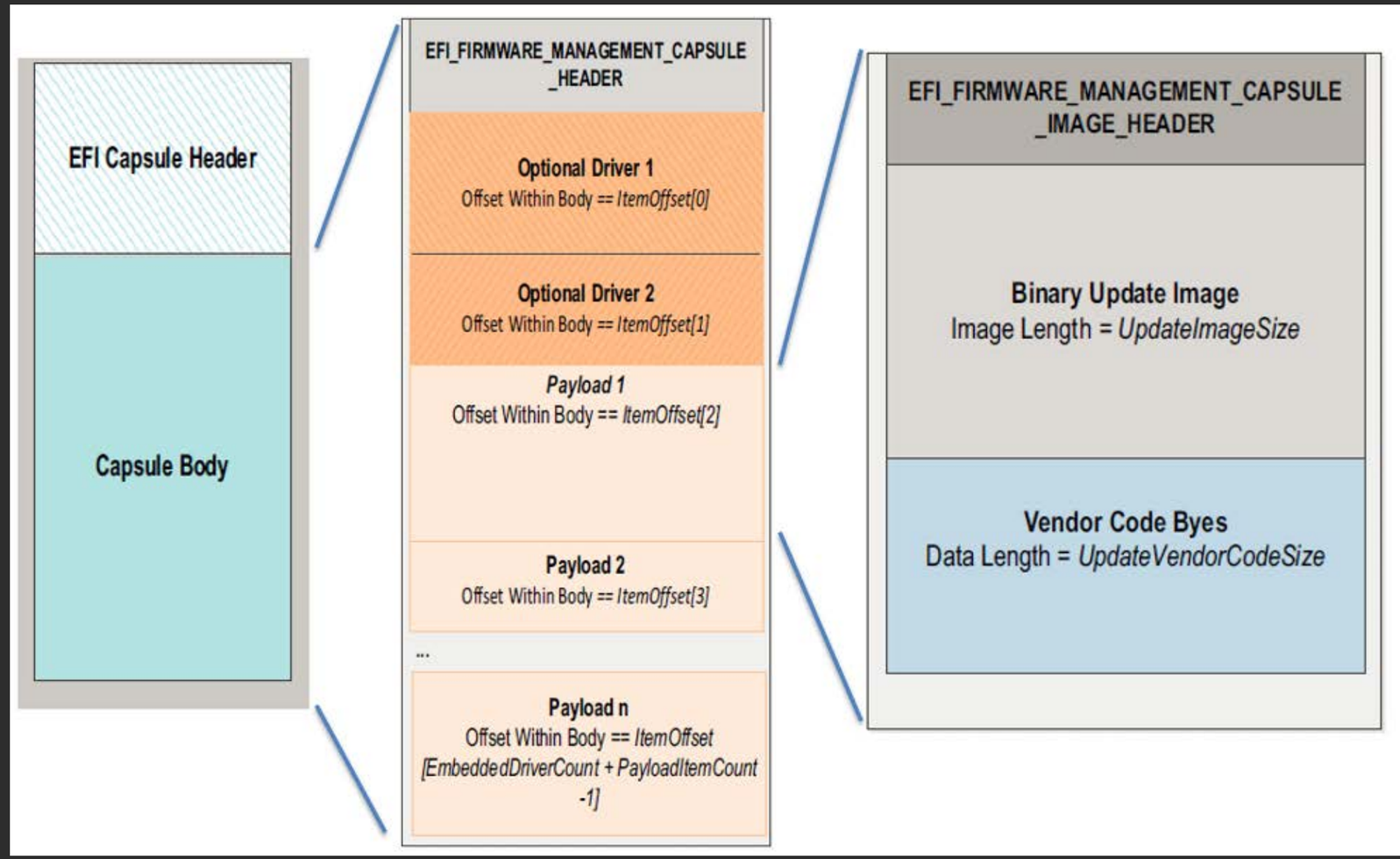
FMP capsule image format

Update FMP drivers

FMP payloads

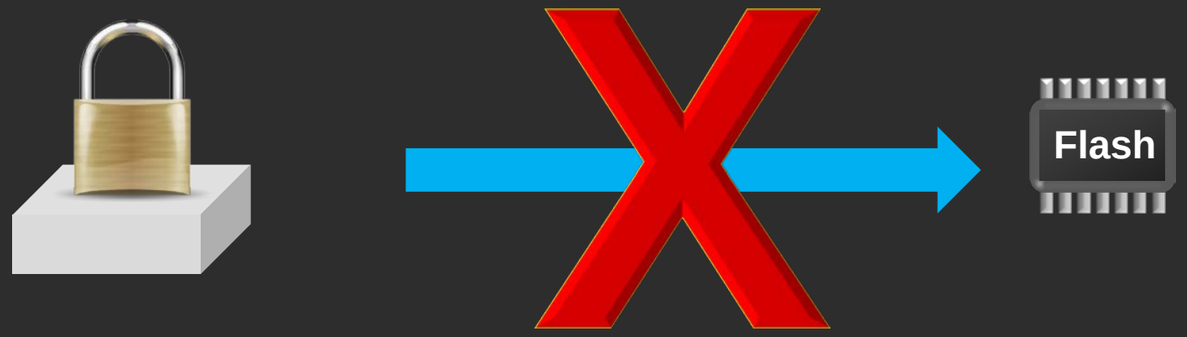
- binary update image and optional vendor code

- The platform may consume a FMP protocol to update the firmware image



CAPSULE UPDATE - FLOW

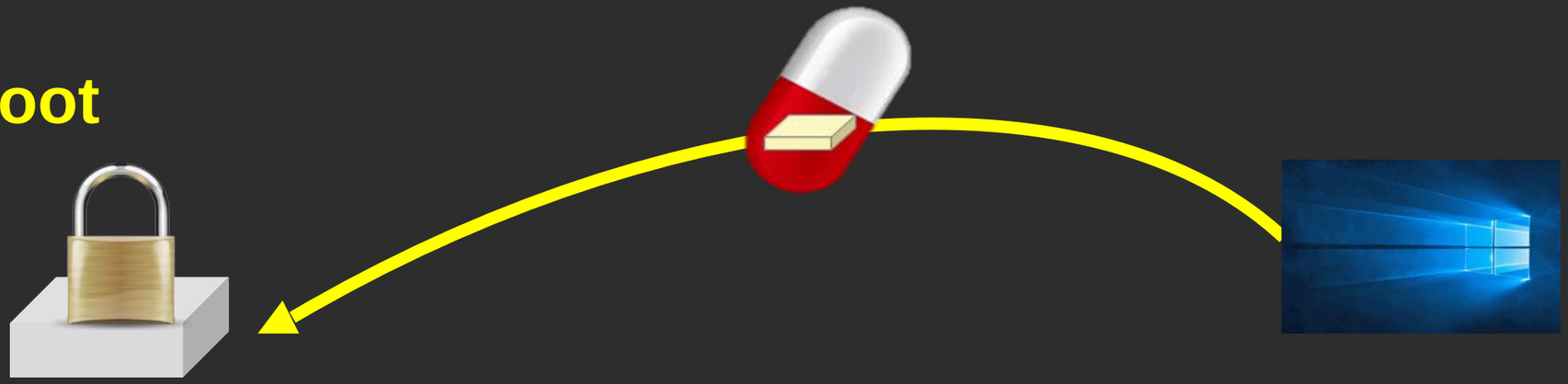
Flash Update



UEFI specification also defines the capsule image format for the EFI_FIRMWARE_MANAGEMENT_PROTOCOL (FMP).

CAPSULE UPDATE - FLOW

Normal Boot



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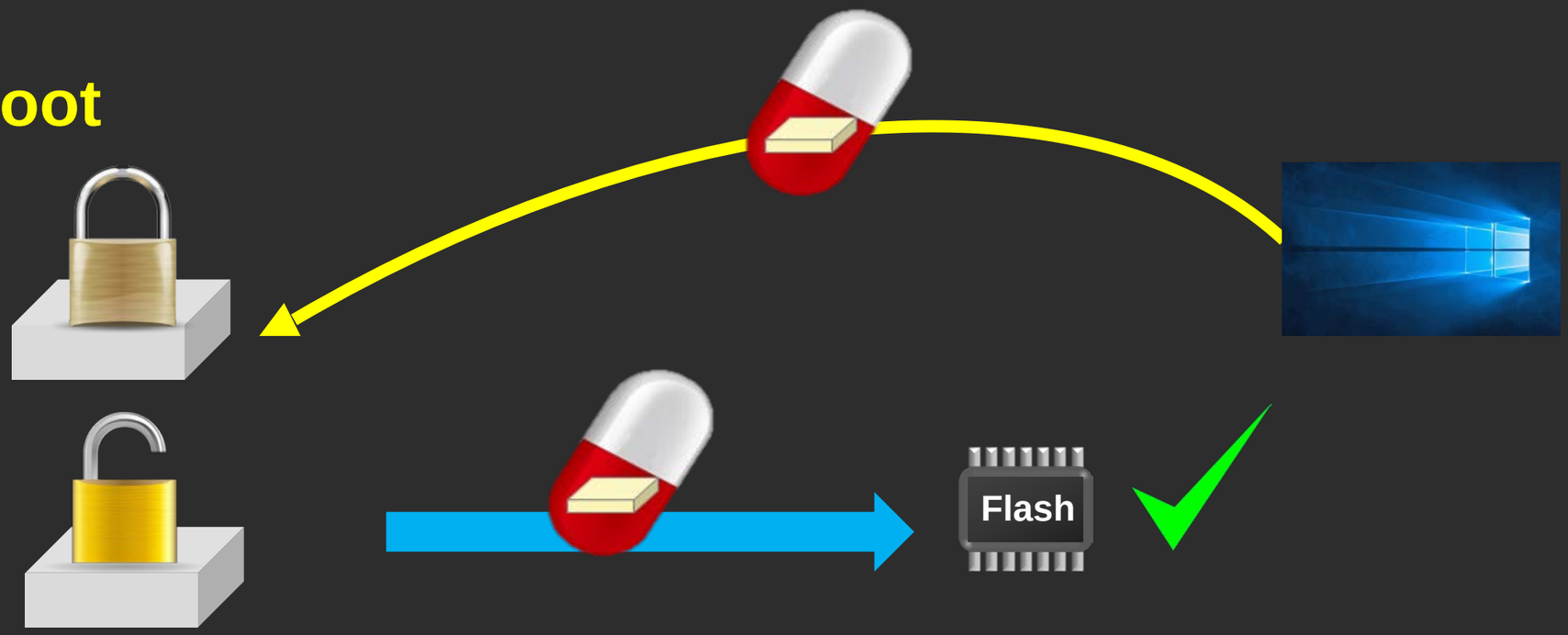
CAPSULE UPDATE - FLOW

Normal Boot

Capsule Update



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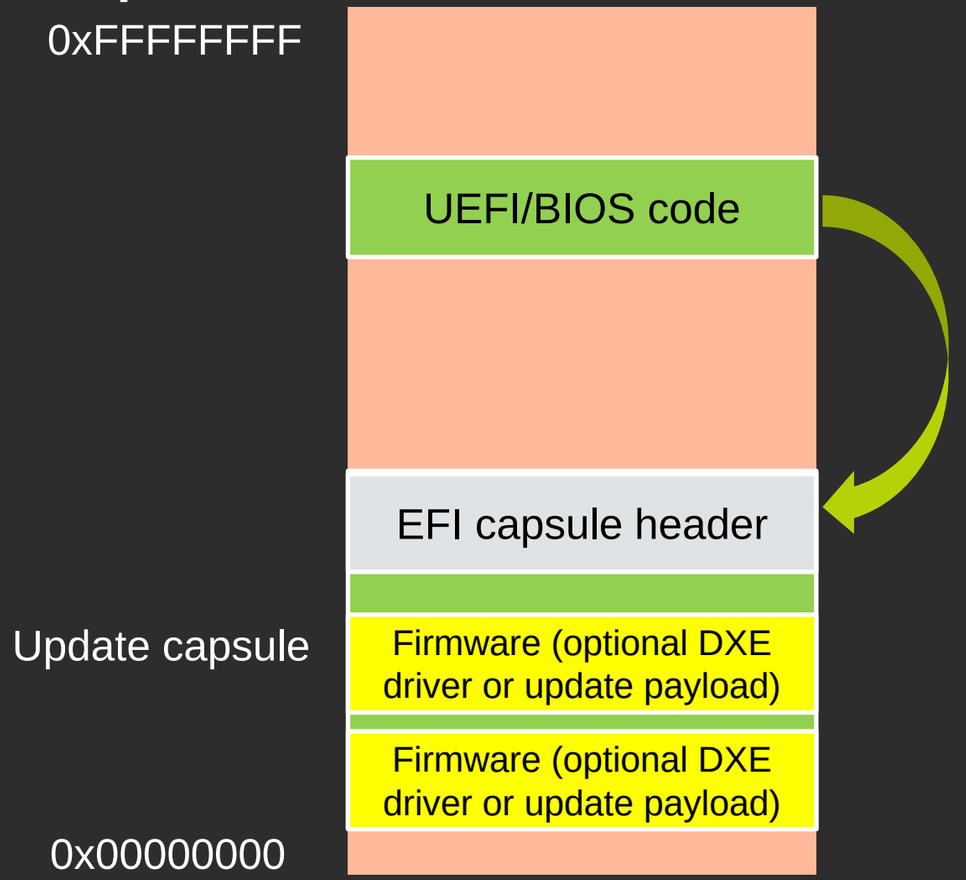
UEFI Firmware Secure “Capsule” Update

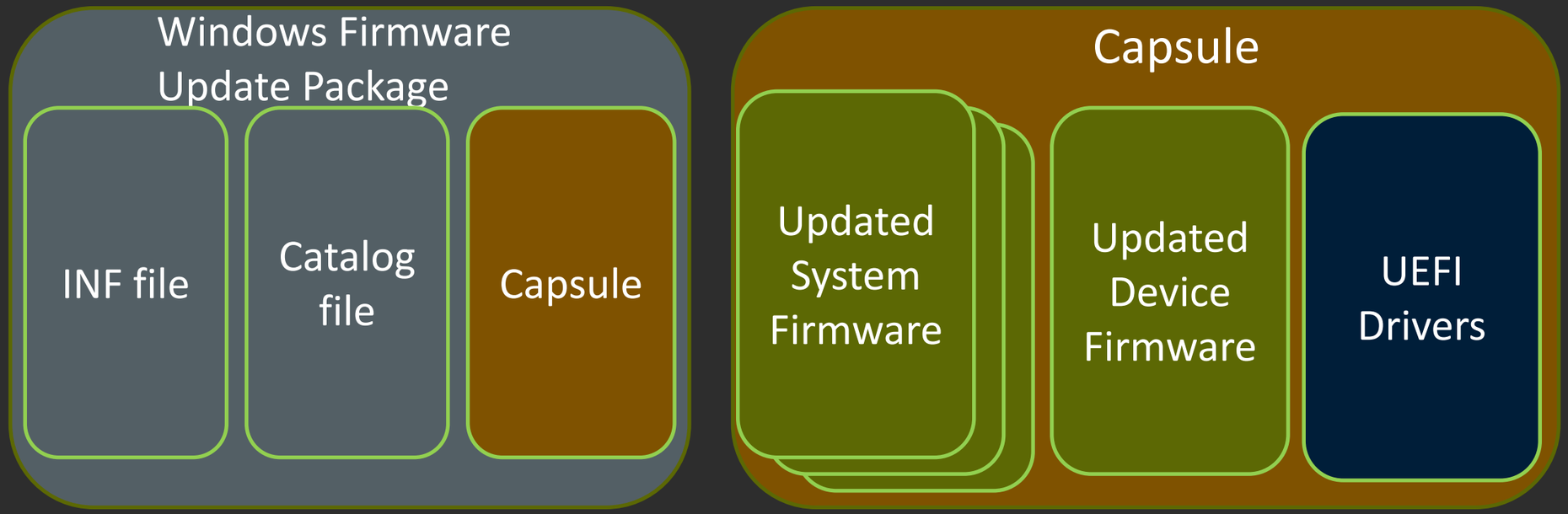
Capsule update is a runtime service used to update UEFI FW



1. Update is initiated by update application/OS run-time
2. Update application stores update “capsule” in DRAM or HDD on ESP (e.g. **`\EFI\CapsuleUpdate`**)
3. Upon reboot or S3 resume, FW finds and parses update capsule
4. After FW verifies digital signature of the capsule, FW writes new BIOS FV(s) to SPI flash memory

Source: UEFI Spec Version 2.4 Facilitates Secure Update UEFI Summerfest – July 15-19, 2013

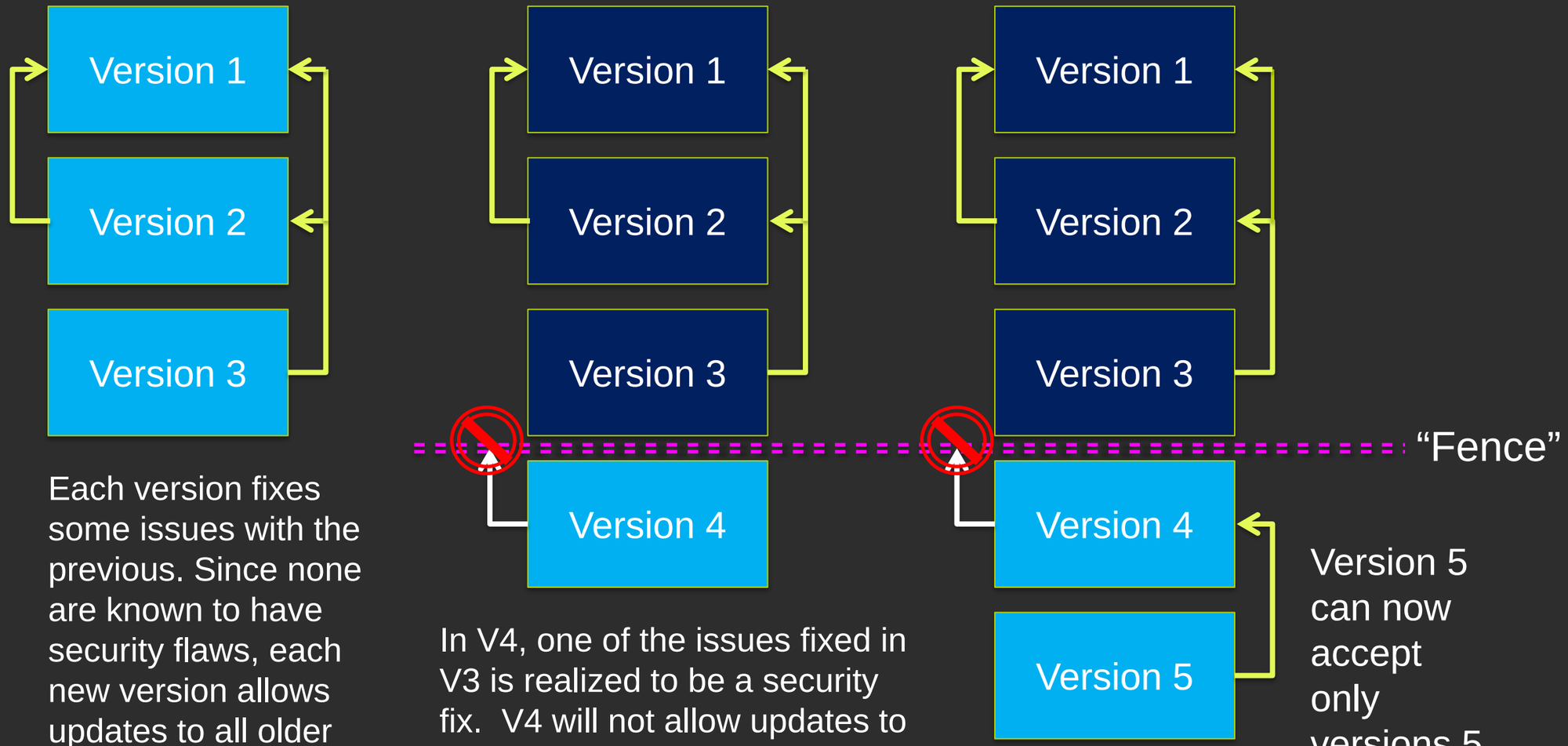
Delivering Update “Capsules” in OS



Color marking:

- Microsoft-signed
- OEM-signed
- OEM-signed or IHV-signed (device firmware)
- Signed with key in UEFI “db” (not applicable to ARM)

Firmware Update Rollback Protection



Each version fixes some issues with the previous. Since none are known to have security flaws, each new version allows updates to all older versions.

In V4, one of the issues fixed in V3 is realized to be a security fix. V4 will not allow updates to earlier versions, even V3 since it allows update to V2.

Version 5 can now accept only versions 5 and 4.

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HOW TO ENABLE?

How to Enable Capsule Update on a EDK II Platform?

UEFI Capsule Implementation in EDK II

SignedCapsulePkg . Uses OpenSSL to sign and authenticate firmware update capsules and firmware recovery images

KEYS

UEFI Capsule Implementation in EDK II

SignedCapsulePkg . Uses OpenSSL to sign and authenticate firmware update capsules and firmware recovery images

KEYS

- Used for firmware development and debug
- Used by OEM to create and manage their own
  - OpenSLL utilities can be used to create key

Enable Capsule Based System Firmware Update

The following wiki pages provide details on how to add the system firmware update using Signed UEFI Capsules

- Implement Platform Components for UEFI Capsule: Link
- Add **CAPSULE_ENABLE** feature to Platform DSC/FDF Files : Link
- Verify **CAPSULE_ENABLE** Feature using Test Signing Keys: Link
- Change System Firmware Update Version : Link
- Change ESRT System Firmware Update GUID: Link
- How to Generate Signing Keys using OpenSSL Command Line Utilities: Link
- Verify **CAPSULE_ENABLE** Feature using Generated Signing Keys: Link

Implement Platform Components for UEFI Capsule

Requirements for EDK II Projects to support `SignedCapsulePkg`

Library

An instance of **`PlatformFlashAccessLib`** must be implemented to provide API to update a portion of the non-volatile storage device.

`<Your Platform Package>/Feature/Capsule/Library/PlatformFlashAccessLib`

Example from Minnowboard Max/Turbot platform: github link

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Descriptor

PEIM System Firmware Descriptor

`<Your Platform Package>/Feature/Capsule/SystemFirmwareDescriptor`

- Requires .aslc (C structure syntax)

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PEIM System Firmware Descriptor

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- Requires .aslc (C structure syntax)

Config INI

System Firmware Update Configuration INI File

`<Your Platform Package>/Feature/Capsule/SystemFirmwareUpdateConfig.ini`

Example from Minnowboard Max/Turbot platform: github link

Add CAPSULE_ENABLE feature to Platform Files

- Add **`-D CAPSULE_ENABLE`** to the build command line to enable capsule update features.
- The build process generates a capsule update image (.cap file) along with the UEFI application `CapsuleApp.efi`.
  - Copy .cap file and `CapsuleApp.efi` to USB thumb drive.
  - Boot to UEFI Shell and use `CapsuleApp.efi` with .cap signed capsule file.
- Once the system is rebooted, the signed capsule is authenticated, and the firmware is update with the new system firmware version.

Platform DSC Sections:

```
[LibraryClasses]
[Pcds]
[Components]
```

Platform FDF Sections:

```
[FV] PEI
[FV] DXE
[FV] Platform
[VmpPayload]
[Capsule]
[Rule]
```

Verify CAPSULE_ENABLE Feature w/ Test Signing Keys

- Download the OpenSSL library
- Build the Boot Firmware image with CAPSULE_ENABLE
- Copy the CapsuleApp.efi to USB thumb drive and run on Target system

```
FS0:\> CapsuleApp.efi
CapsuleApp:  usage
  CapsuleApp <Capsule...>
  CapsuleApp -S
  CapsuleApp -C
  CapsuleApp -P
  CapsuleApp -E
  CapsuleApp -G <BMP> -O <Capsule>
  CapsuleApp -N <Capsule> -O <NestedCapsule>
  CapsuleApp -D <Capsule>
Parameter:
  -S:  Dump capsule report variable (EFI_CAPSULE_REPORT_GUID),
       which is defined in UEFI specification.
  -C:  Clear capsule report variable (EFI_CAPSULE_RPORT_GUID),
       which is defined in UEFI specification.
  -P:  Dump UEFI FMP protocol info.
  -E:  Dump UEFI ESRT table info.
  -G:  Convert a BMP file to be a UX capsule,
       according to Windows Firmware Update document
  -N:  Append a Capsule Header to an existing capsule image,
       according to Windows Firmware Update document
  -O:  Output new Capsule file name
  -D:  Dump Capsule image header information and FMP header
       information, if it is an FMP capsule
```

Verify CAPSULE_ENABLE with CapsuleApp -P option

```
FS0:\> CapsuleApp.efi -P
#############
# FMP DATA #
#############
FMP (0) ImageInfo:
  DescriptorVersion  - 0x3
  DescriptorCount    - 0x1
  DescriptorSize     - 0x70
  PackageVersion     - 0xFFFFFFFF
  PackageVersionName - "Unknown"
  ImageDescriptor (0)
    ImageIndex                 - 0x1
    ImageTypeId                - 4096267B-DA0A-42EB-B5EB-FEF31D207CB4
    ImageId                    - 0x64465F5F32564C56
    ImageIdName                - "Vlv2Fd"
    Version                    - 0x2
    VersionName                - "0x00000002"
    Size                       - 0x800000
    AttributesSupported        - 0xF
      IMAGE_UPDATABLE          - 0x1
      RESET_REQUIRED           - 0x2
      AUTHENTICATION_REQUIRED  - 0x4
      IN_USE                   - 0x8
      UEFI_IMAGE               - 0x0
    AttributesSetting          - 0xF
      IMAGE_UPDATABLE          - 0x1
      RESET_REQUIRED           - 0x2
      AUTHENTICATION_REQUIRED  - 0x4
      IN_USE                   - 0x8
      UEFI_IMAGE               - 0x0
    Compatibilities            - 0x0
      COMPATIB_CHECK_SUPPORTED - 0x0
    LowestSupportedImageVersion - 0x1
    LastAttemptVersion         - 0x0
    LastAttemptStatus          - 0x0
    HardwareInstance           - 0x0
FMP (0) PackageInfo - Unsupported
```

Verify CAPSULE_ENABLE with CapsuleApp -E option

```
FS0:\> CapsuleApp.efi -E
##############
# ESRT TABLE #
##############
EFI_SYSTEM_RESOURCE_TABLE:
FwResourceCount    - 0x1
FwResourceCountMax - 0x40
FwResourceVersion  - 0x1
EFI_SYSTEM_RESOURCE_ENTRY (0):
  FwClass                 - 4096267B-DA0A-42EB-B5EB-FEF31D207CB4
  FwType                  - 0x1 (SystemFirmware)
  FwVersion               - 0x2
  LowestSupportedFwVersion - 0x1
  CapsuleFlags            - 0x1
    PERSIST_ACROSS_RESET  - 0x0
    POPULATE_SYSTEM_TABLE - 0x0
    INITIATE_RESET        - 0x0
  LastAttemptVersion      - 0x0
  LastAttemptStatus       - 0x0 (Success)
```

Summary

- What is Capsule Update
- Why is Capsule Update needed
- How to enable Capsule Update in Edk II platforms

Questions?

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ACKNOWLEDGEMENTS