

# Extreme Privilege Escalation on Windows 8/UEFI Systems

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# Introduction

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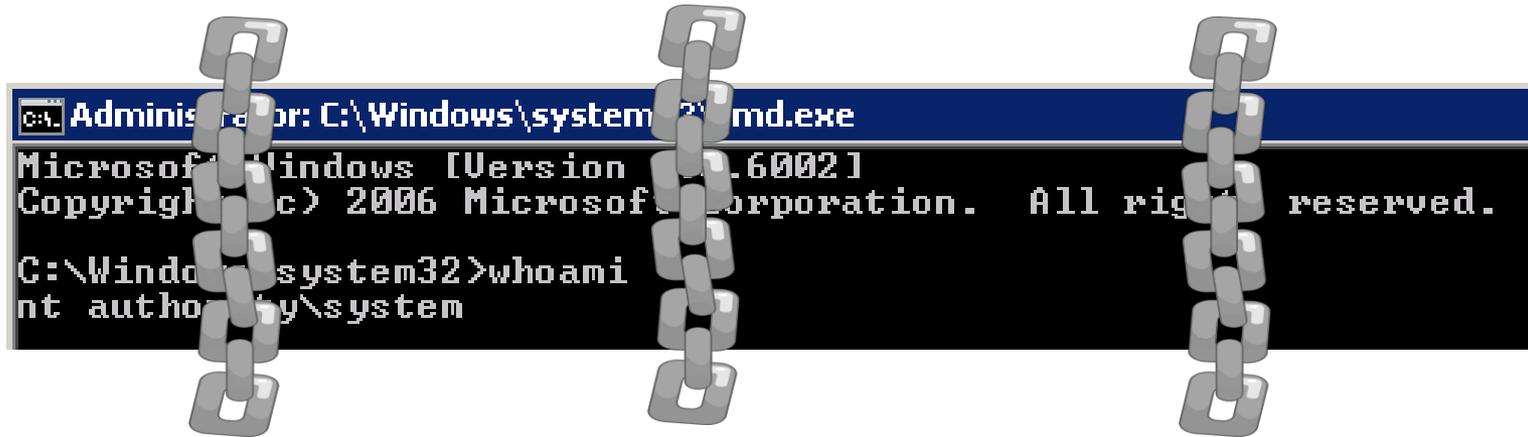
- **Who we are:**

- Trusted Computing and firmware security researchers at The MITRE Corporation

- **What MITRE is:**

- A not-for-profit company that runs six US Government "Federally Funded Research & Development Centers" (FFRDCs) dedicated to working in the public interest
- Technical lead for a number of standards and structured data exchange formats such as CVE, CWE, OVAL, CAPEC, STIX, TAXII, etc
- The first .org, !( .mil | .gov | .com | .edu | .net), on the ARPANET

# Attack Model (1 of 2)



```
Administrator: C:\Windows\system32\cmd.exe
Microsoft Windows [Version 6.0.6002]
Copyright (c) 2006 Microsoft Corporation. All rights reserved.

C:\Windows\system32>whoami
nt authority\system
```

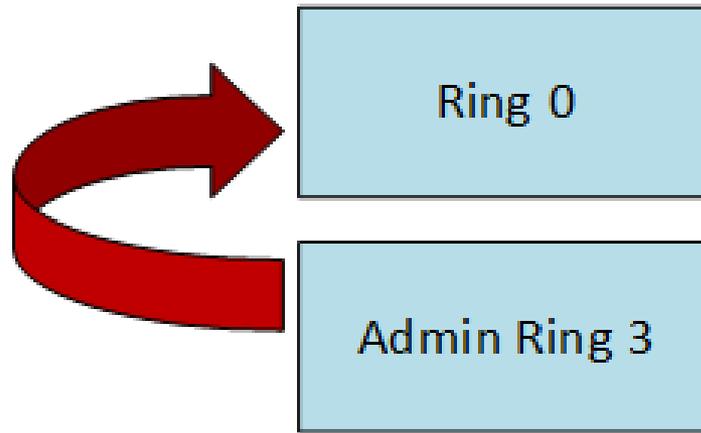
- An attacker has gained administrator access on a victim Windows 8 machine
- But they are still constrained by the limits of Ring 3

# Attack Model (2 of 2)



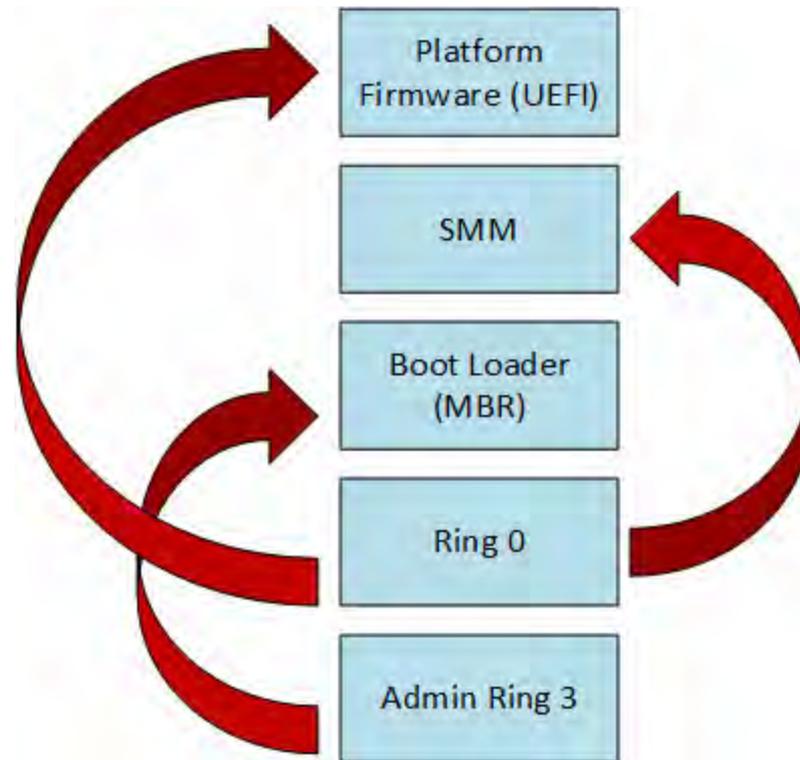
- **Attackers always want**
  - More Power
  - More Persistence
  - More Stealth

# Typical Post-Exploitation Privilege Escalation



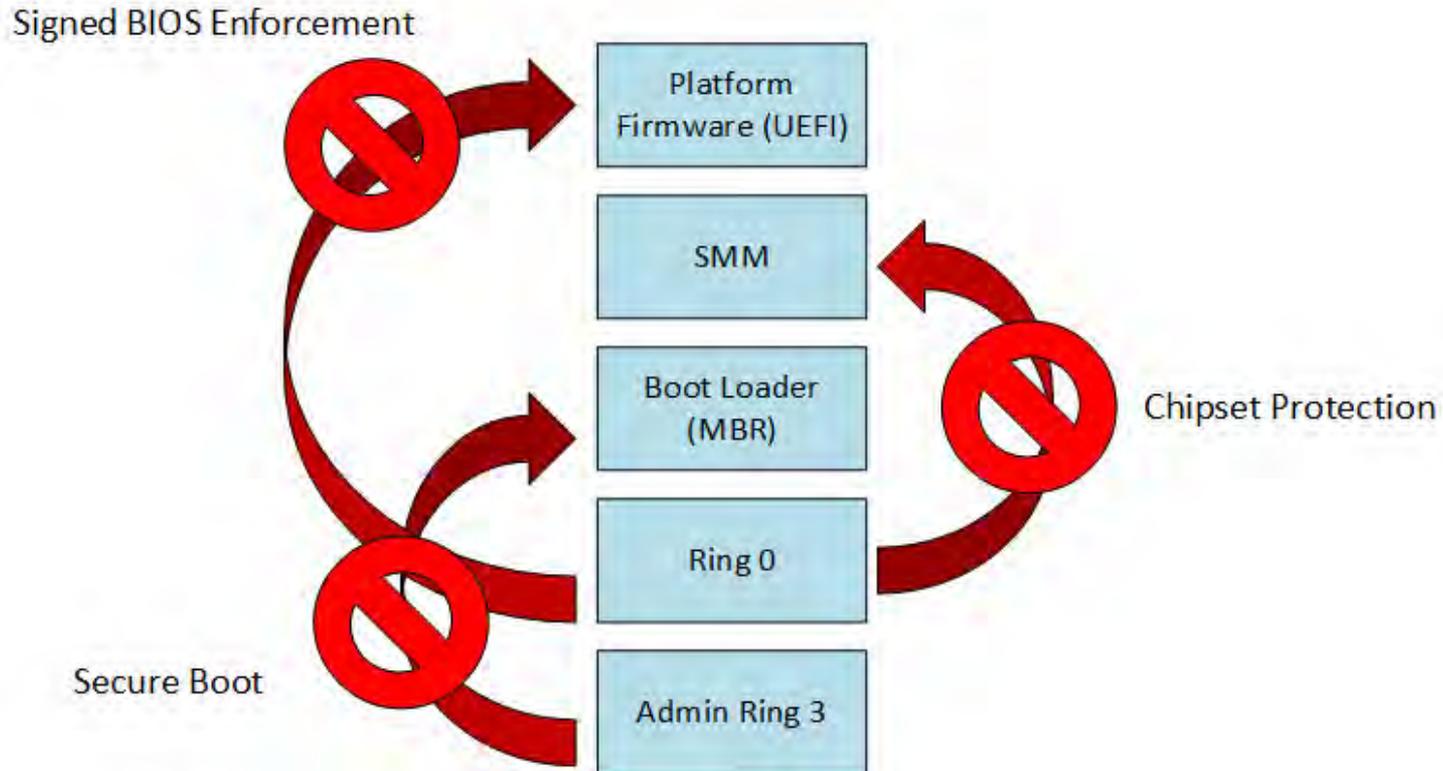
- Starting with x64 Windows vista, kernel drivers must be signed and contain an Authenticode certificate
- In a typical post-exploitation privilege escalation, the attacker wants to bypass the signed driver requirement to install a kernel level rootkit
- Various methods to achieve this are possible, including:
  - Exploit existing kernel drivers
  - Install a legitimate (signed), but vulnerable, driver and exploit it
- This style of privilege escalation has been well explored by other researchers such as [6][7].
- There are other, more *extreme*, lands the attacker may wish to explore

# Other Escalation Options (1 of 2)



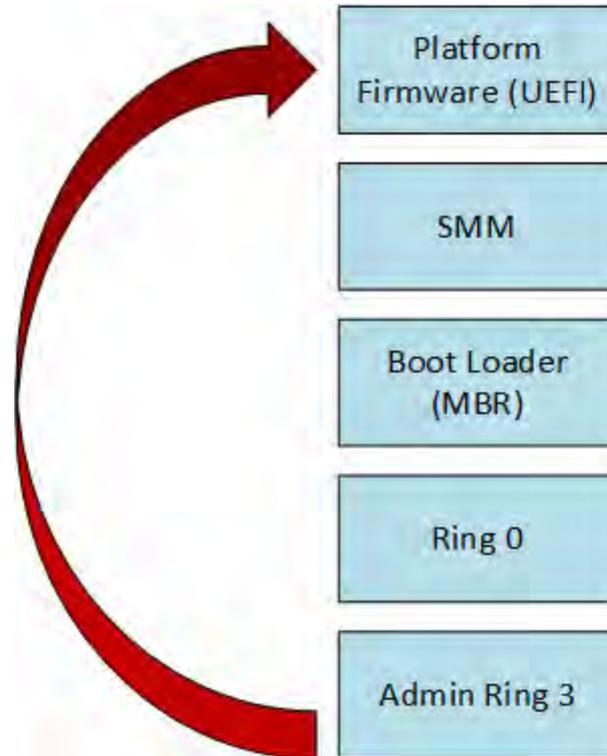
- **There are other more interesting post-exploitation options an attacker may consider:**
  - Bootkit the system
  - Install SMM rootkit
  - Install BIOS rootkit

# Other Escalation Options (2 of 2)



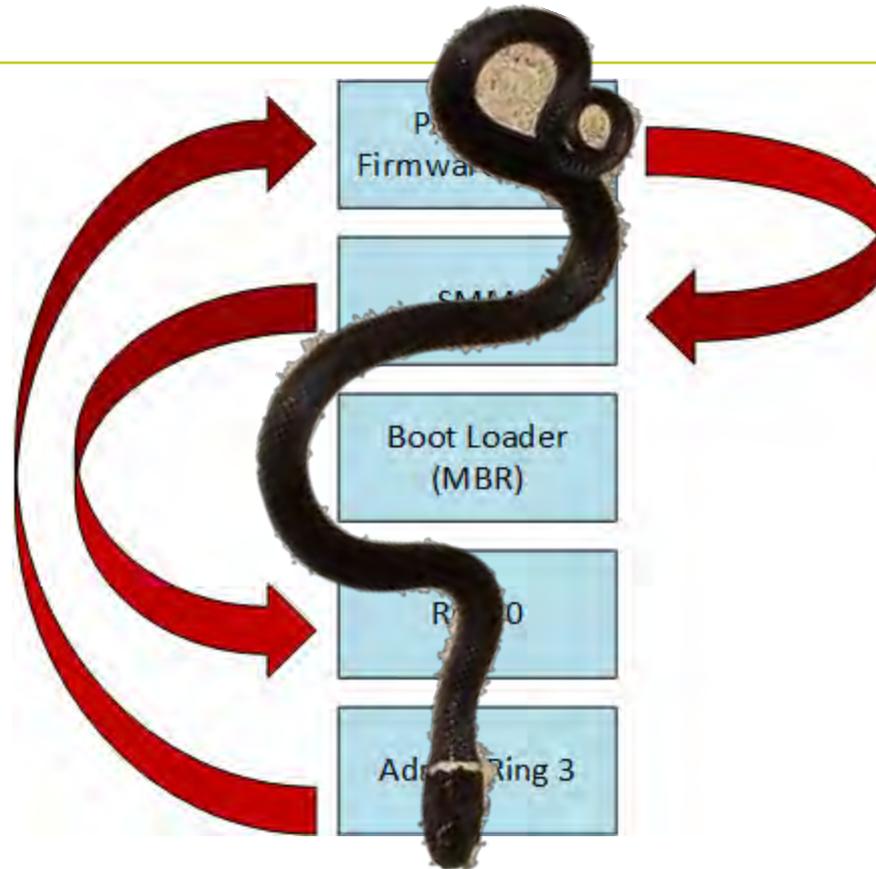
- **Modern platforms contain protections against these more exotic post-exploitation privilege-escalations**
  - Bootkit the system (Prevented by Secure Boot)
  - Install SMM rootkit (SMM is locked on modern systems)
  - Install BIOS rootkit (SPI Flash protected by lockdown mechanisms)

# Extreme Privilege Escalation (1 of 2)



- **This talk presents *extreme* privilege escalation**
  - Administrator userland process exploits the platform firmware (UEFI)
  - Exploit achieved by means of a new API introduced in Windows 8

# Extreme Privilege Escalation (2 of 2)



- **Once the attacker has arbitrary code execution in the context of the platform firmware, he is able to:**
  - Control other "rings" on the platform (SMM, Ring 0)
  - Persist beyond operating system re-installations
  - Permanently "brick" the victim computer

# Target Of Attack



- **Modern Windows 8 systems ship with UEFI firmware**
- **UEFI is designed to replace conventional BIOS and provides a well defined interface to the operating system**

# Windows 8 API

## SetFirmwareEnvironmentVariable function

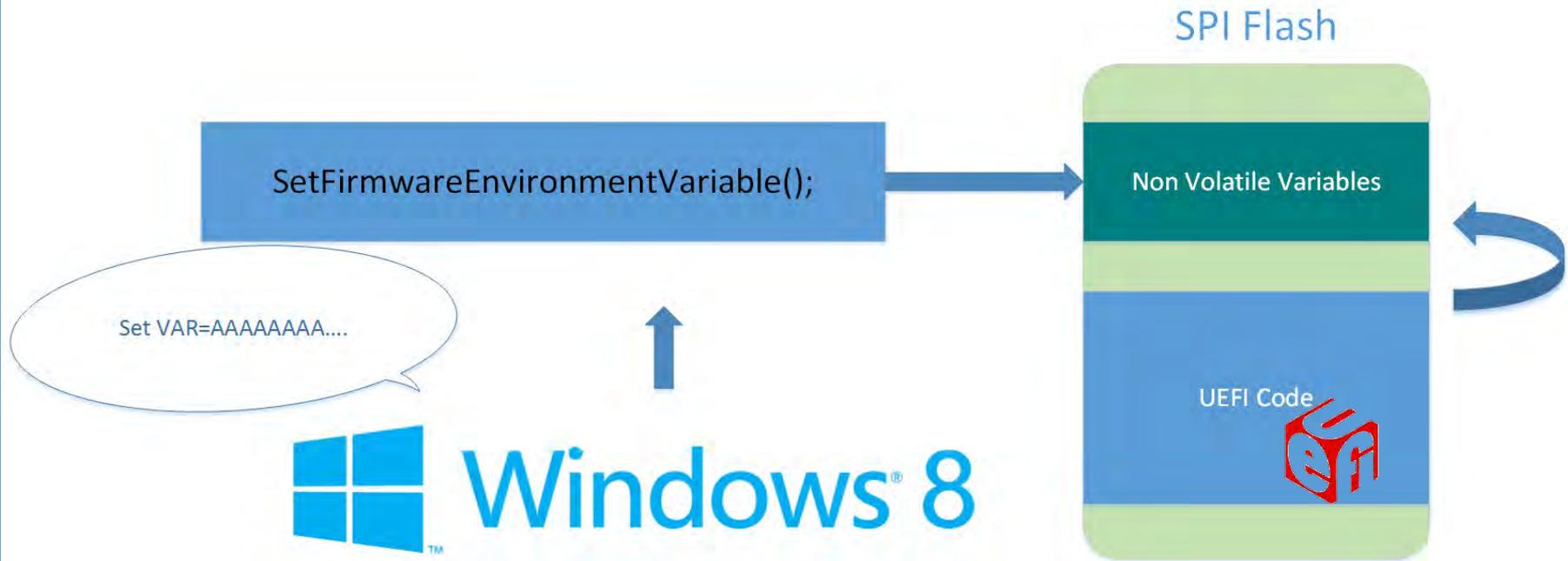
Sets the value of the specified firmware environment variable.

### Syntax

```
C++  
  
BOOL WINAPI SetFirmwareEnvironmentVariable(  
    _In_ LPCTSTR lpName,  
    _In_ LPCTSTR lpGuid,  
    _In_ PVOID pBuffer,  
    _In_ DWORD nSize  
);
```

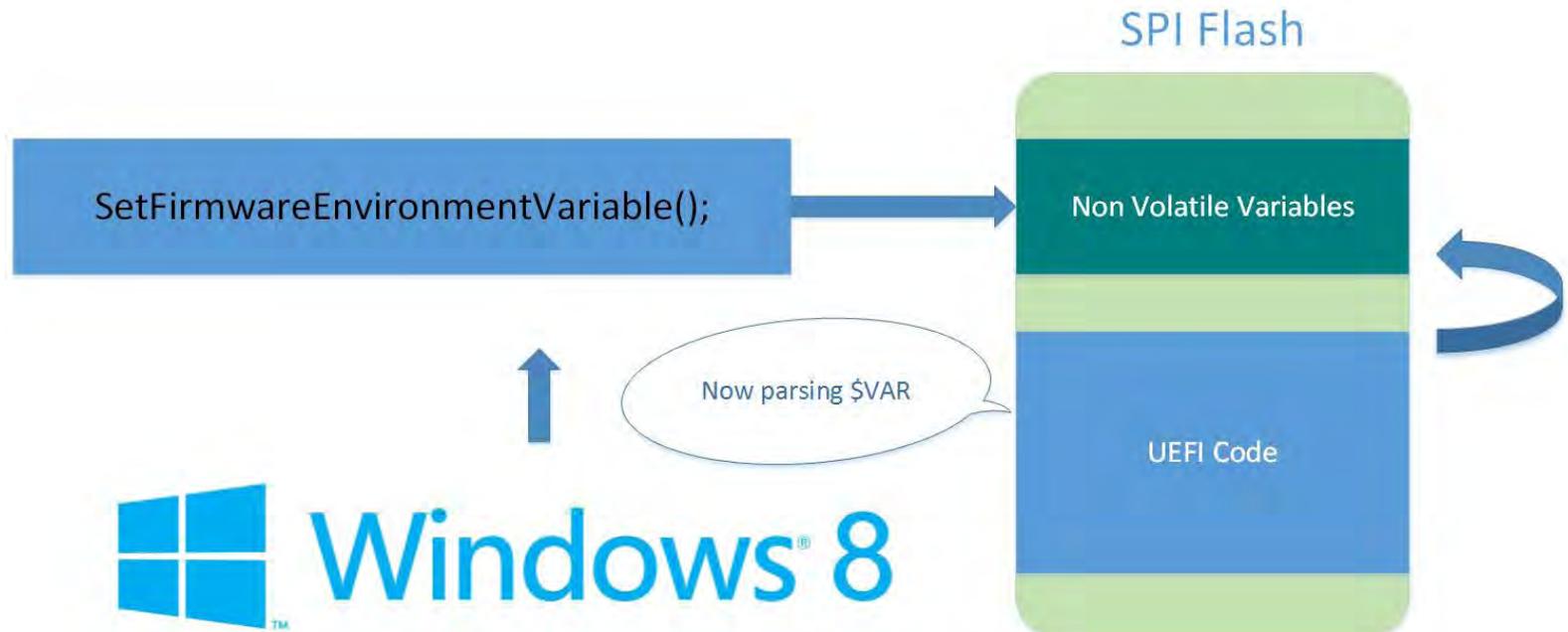
- **Windows 8 has introduced an API that allows a privileged userland process to interface with a subset of the UEFI interface**

# EFI Variable Creation Flow



- **Certain EFI variables can be created/modified/deleted by the operating system**
  - For example, variables that control the boot order and platform language
- **The firmware can also use EFI variables to communicate information to the operating system**

# EFI Variable Consumption



- The UEFI variable interface is a conduit by which a less privileged entity (admin Ring 3) can produce data for a more complicated entity (the firmware) to consume
- This is roughly similar to environment variable parsing attack surface on \*nix systems

# Previous EFI Variable Issues (1 of 2)

## Vulnerability Note VU#758382

### Unauthorized modification of UEFI variables in UEFI systems

Original Release date: 09 Jun 2014 | Last revised: 19 Jun 2014



#### Overview

Certain firmware implementations may not correctly protect and validate information contained in certain UEFI variables. Exploitation of such vulnerabilities could potentially lead to bypass of security features and/or denial of service for the platform.

#### Description

As discussed in recent conference publications ([CanSecWest 2014](#), [Syscan 2014](#), and [Hack-in-the-Box 2014](#)) certain UEFI implementations do not correctly protect and validate information contained in the 'Setup' UEFI variable. On some systems, this variable can be overwritten using operating system APIs. Exploitation of this vulnerability could potentially lead to bypass of security features, such as secure boot, and/or denial of service for the platform. Please refer to the conference publications for further details.

#### Impact

A local attacker that obtains administrator access to the operating system may be able to modify UEFI variables. Exploitation of such vulnerabilities could potentially lead to bypass of security features and/or denial of service for the platform.

- **We've already co-discovered[13] with Intel some vulnerabilities associated with EFI Variables that allowed bypassing secure boot and/or bricking the platform**

# Previous EFI Variable Issues (2 of 2)

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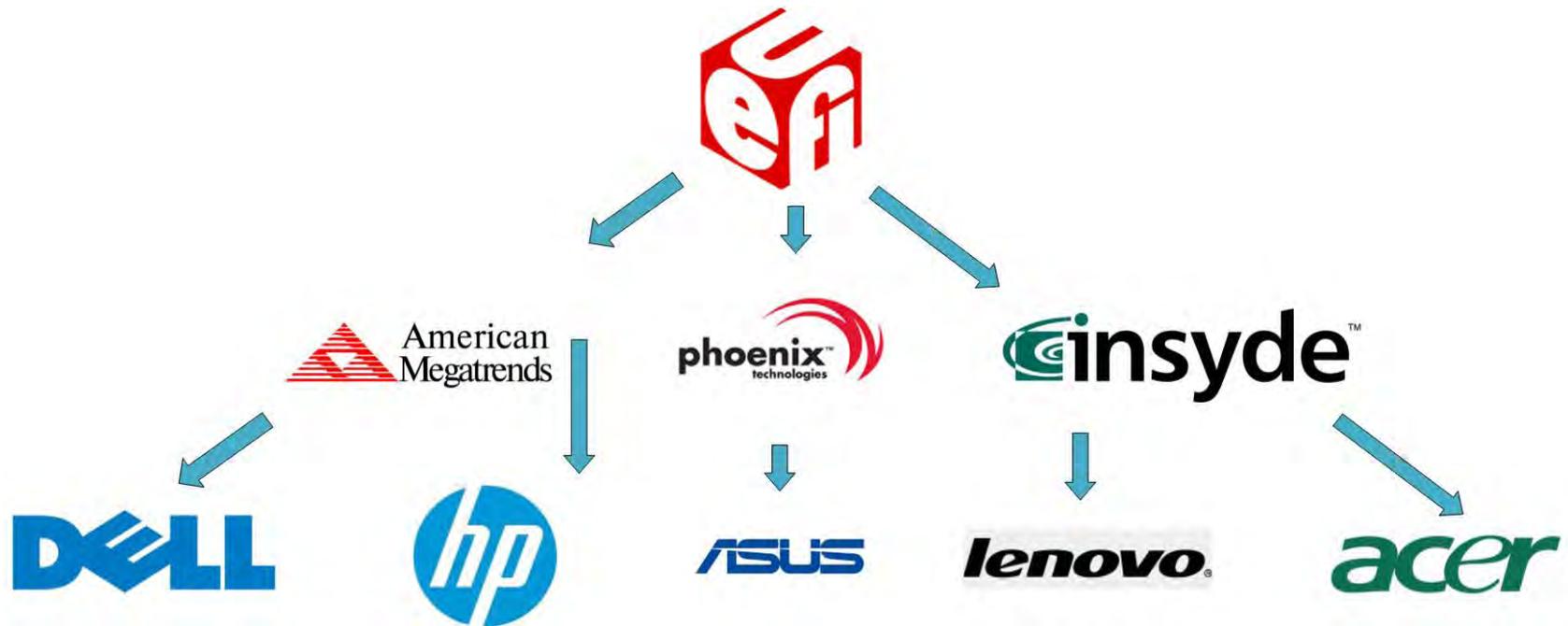
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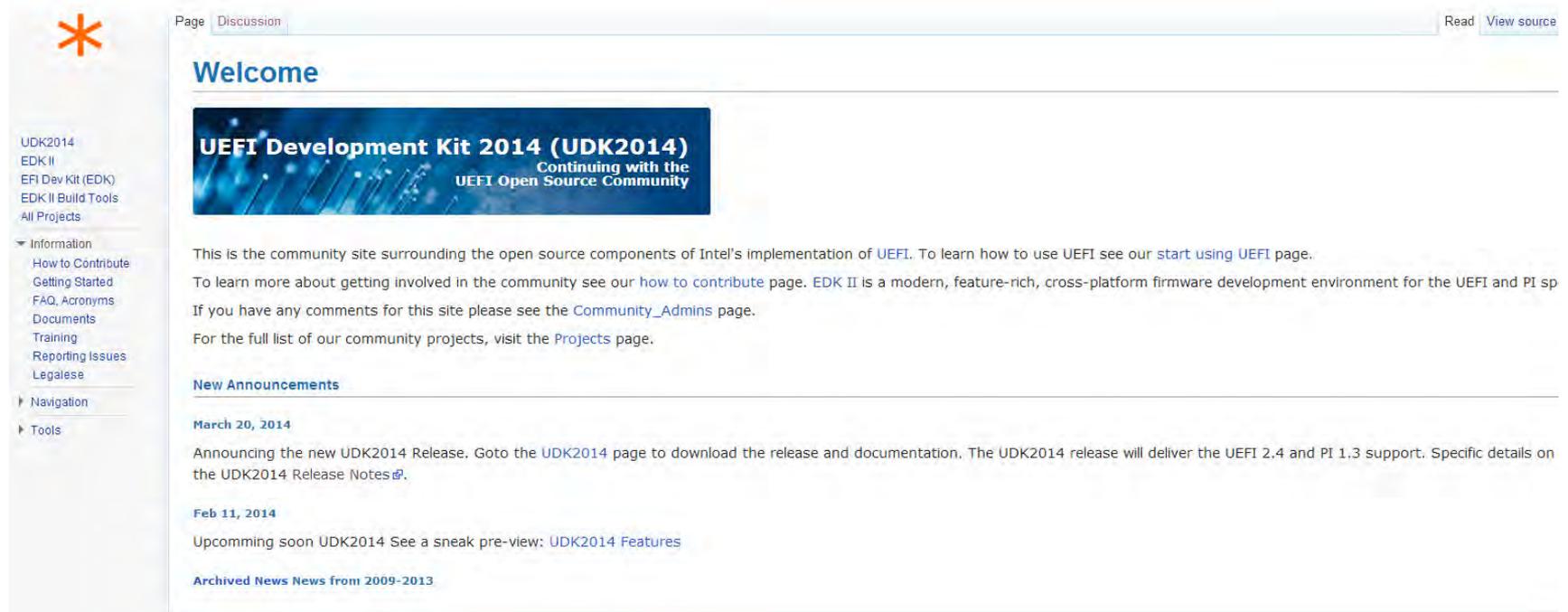
- **However, VU #758382 was leveraging a proprietary Independent BIOS Vendor (IBV) implementation mistake, it would be more interesting if we could find a variable vulnerability more generic to UEFI**

# UEFI Vulnerability Proliferation



- If an attacker finds a vulnerability in the UEFI "reference implementation," its proliferation across IBVs and OEMs would potentially be wide spread.
  - More on how this theory works "in practice" later...

# Auditing UEFI



The screenshot shows the 'Welcome' page of the UEFI Open Source Community. The page features a navigation menu on the left with categories like 'Information', 'Navigation', and 'Tools'. The main content area includes a 'Welcome' heading, a banner for 'UEFI Development Kit 2014 (UDK2014)' with the tagline 'Continuing with the UEFI Open Source Community', and several paragraphs of introductory text. A 'New Announcements' section lists recent updates, including the UDK2014 release and upcoming features.

Page Discussion Read View source

## Welcome

**UEFI Development Kit 2014 (UDK2014)**  
Continuing with the  
UEFI Open Source Community

This is the community site surrounding the open source components of Intel's implementation of UEFI. To learn how to use UEFI see our [start using UEFI](#) page.

To learn more about getting involved in the community see our [how to contribute](#) page. EDK II is a modern, feature-rich, cross-platform firmware development environment for the UEFI and PI sp

If you have any comments for this site please see the [Community\\_Admins](#) page.

For the full list of our community projects, visit the [Projects](#) page.

### New Announcements

**March 20, 2014**

Announcing the new UDK2014 Release. Goto the [UDK2014](#) page to download the release and documentation. The UDK2014 release will deliver the UEFI 2.4 and PI 1.3 support. Specific details on the UDK2014 Release Notes [@](#).

**Feb 11, 2014**

Upcomming soon UDK2014 See a sneak pre-view: [UDK2014 Features](#)

[Archived News News from 2009-2013](#)

<http://tianocore.sourceforge.net/wiki/Welcome>

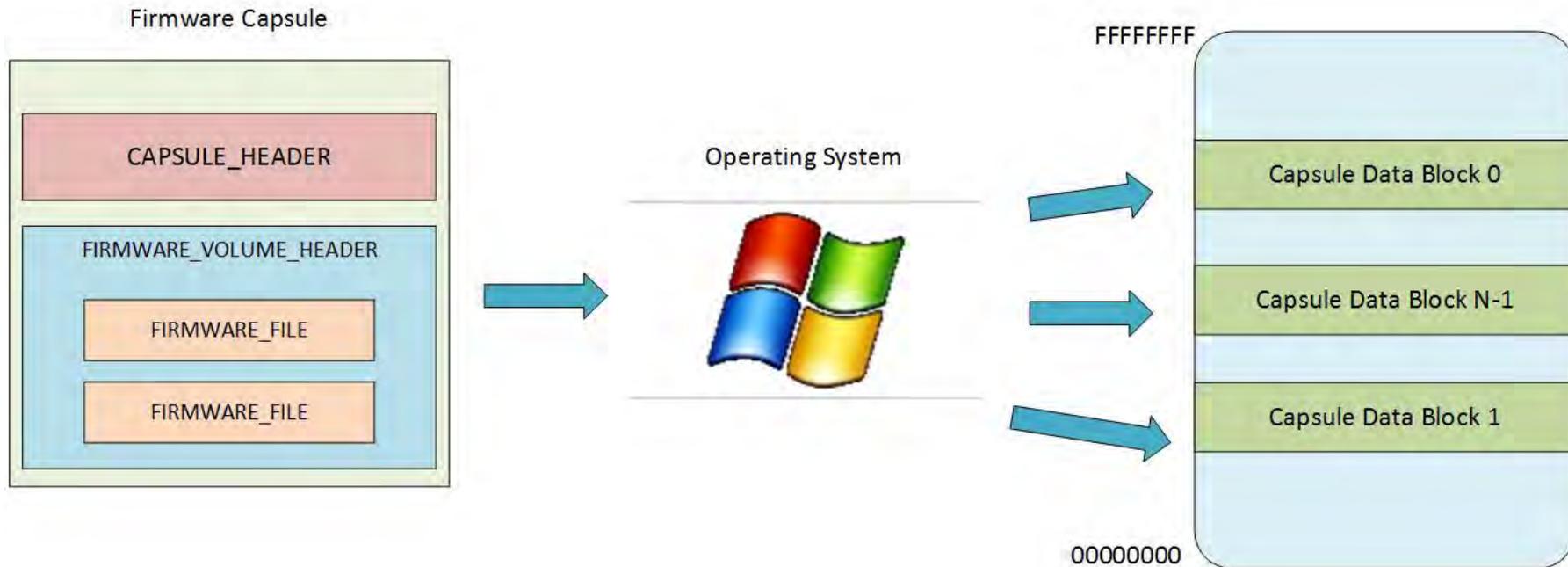
- UEFI reference implementation is open source, making it easy to audit
- Let the games begin:
  - Svn checkout <https://svn.code.sf.net/p/edk2/code/trunk/edk2/>

# Where to start looking for problems?

- Always start with wherever there is attacker-controlled input
- We had good success last year exploiting Dell systems by passing an specially-crafted fake BIOS update...
- So let's see if UEFI has some of the same issues
- The UEFI spec has outlined a "Capsule update" mechanism
  - Capsule Update is initiated and guided by EFI variable contents that are controllable by the operating system

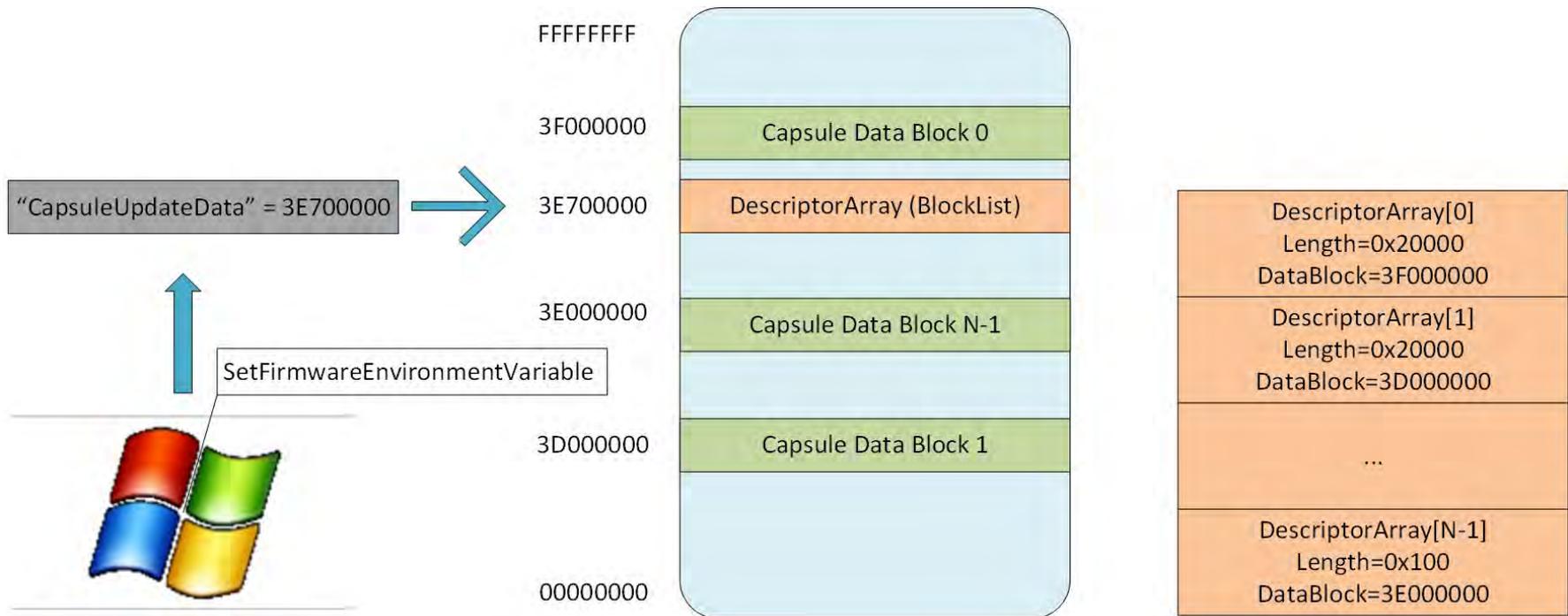


# Capsule Scatter Write



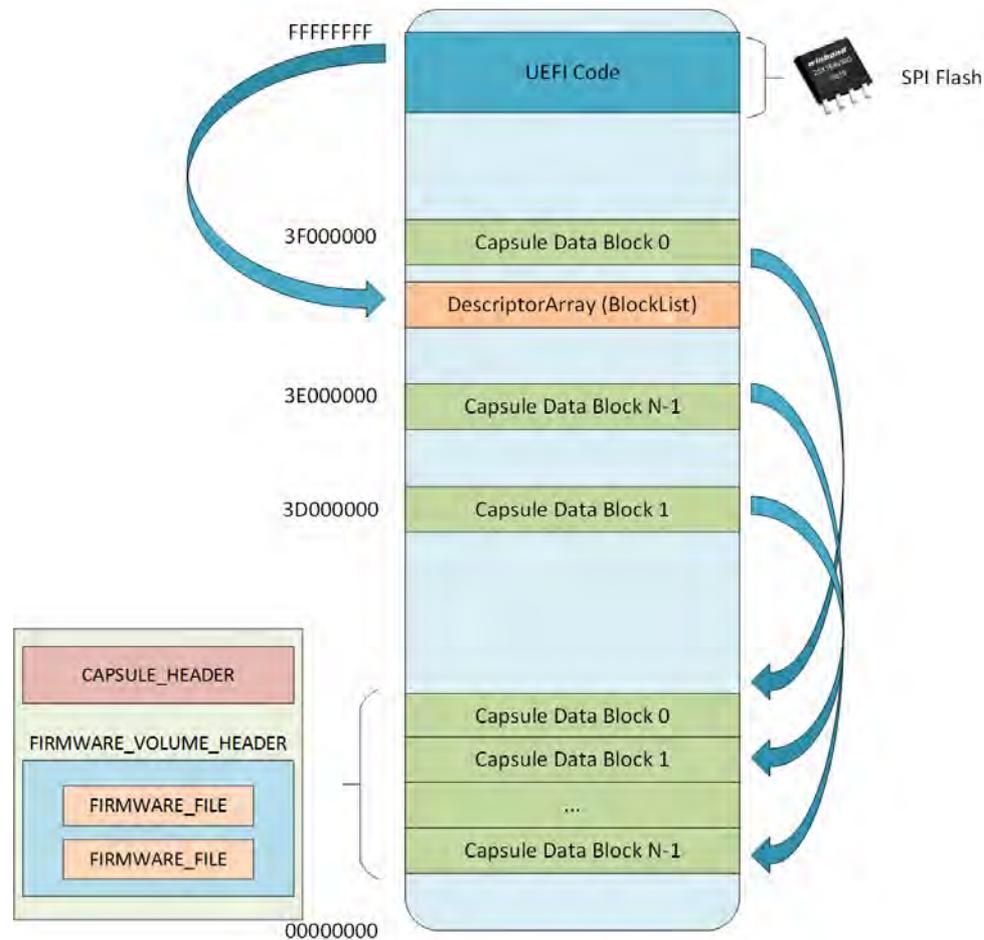
- To begin the process of sending a Capsule update for processing, the operating system takes a firmware capsule and fragments it across the address space

# Capsule Processing Initiation



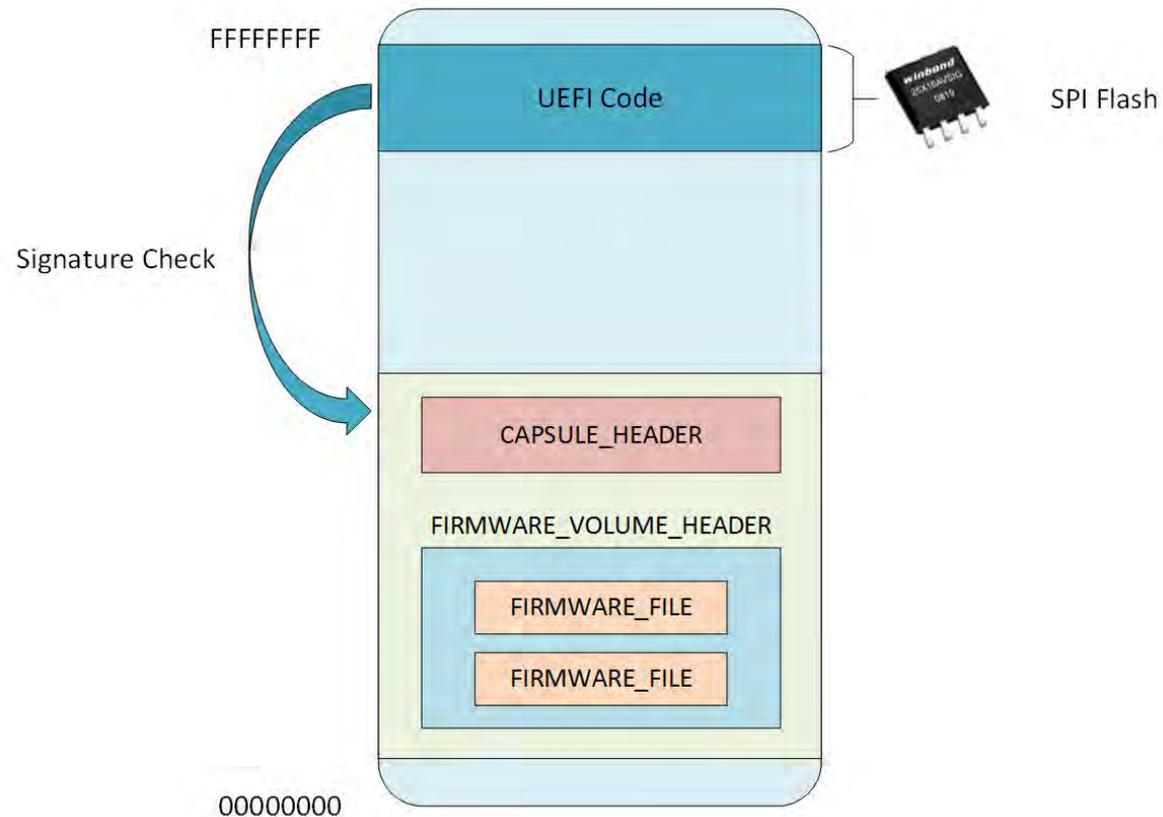
- The operating system creates an EFI variable that describes the location of the fragmented firmware capsule
- A "warm reset" then occurs to transition control back to the firmware

# Capsule Coalescing



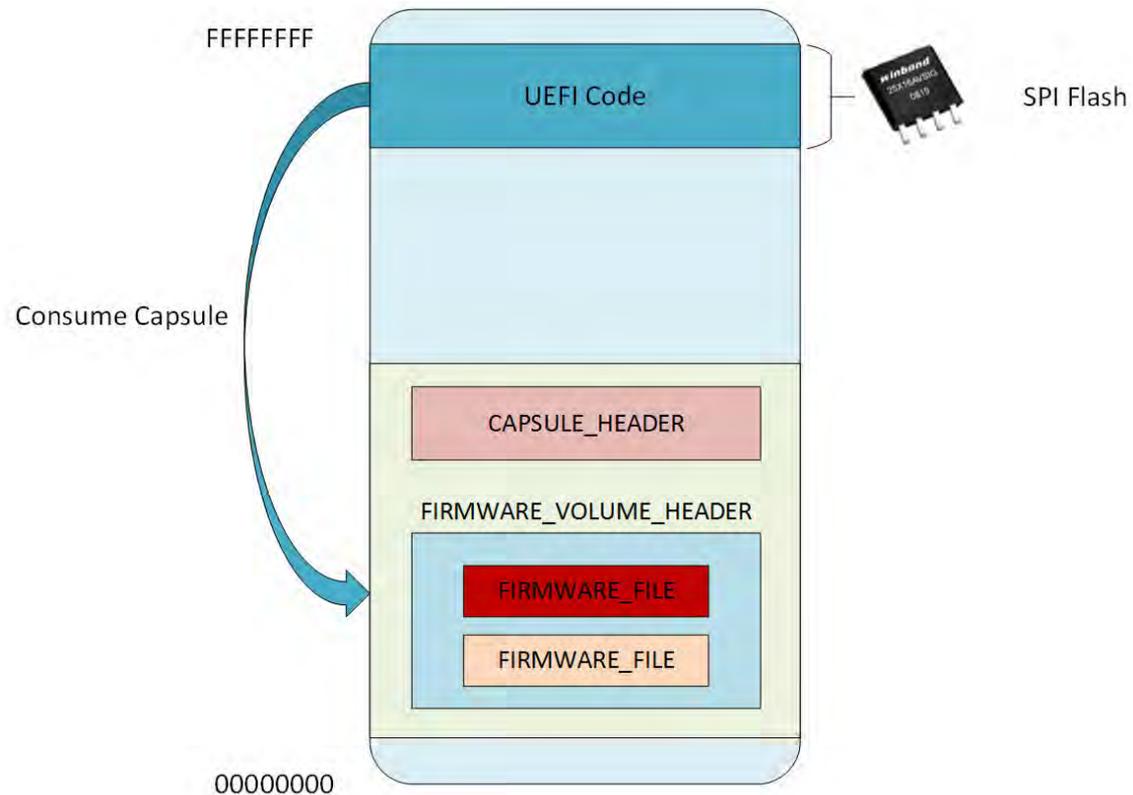
- The UEFI code "coalesces" the firmware capsule back into its original form.

# Capsule Verification



- **UEFI parses the envelope of the firmware capsule and verifies that it is signed by the OEM**

# Capsule Consumption



- **Contents of the capsule are then consumed....**
  - Flash contents to the SPI flash
  - Run malware detection independent of the operating system
  - Etc...

# Opportunities For Vulnerabilities

- **There are 3 main opportunities for memory corruption vulnerabilities in the firmware capsule processing code**
  1. The coalescing phase
  2. Parsing of the capsule envelope
  3. Parsing of unsigned content within the capsule
- **Our audit of the UEFI capsule processing code yielded multiple vulnerabilities in the coalescing and envelope parsing code**
  - The first "BIOS reflash" exploit was presented by Wojtczuk and Tereshkin. They found it by reading the UEFI code which handled BMP processing and exploiting an unsigned splash screen image embedded in a firmware[1]

# Coalescing Bug #1

```

EFI_STATUS
EFIAPI
CapsuleDataCoalesce (
    IN EFI_PEI_SERVICES                **PeiServices,
    IN EFI_PHYSICAL_ADDRESS            *BlockListBuffer,
    IN OUT VOID                        **MemoryBase,
    IN OUT UINTN                       *MemorySize
)
{
    ...
    //
    // Get the size of our descriptors and the capsule size. GetCapsuleInfo()
    // returns the number of descriptors that actually point to data, so add
    // one for a terminator. Do that below.
    //
    GetCapsuleInfo (BlockList, &NumDescriptors, &CapsuleSize);
    if ((CapsuleSize == 0) || (NumDescriptors == 0)) {
        return EFI_NOT_FOUND;
    }
    ...
    DescriptorsSize = NumDescriptors * sizeof (EFI_CAPSULE_BLOCK_DESCRIPTOR);
    ...
    if (*MemorySize <= (CapsuleSize + DescriptorsSize)) { <= Bug 1
        return EFI_BUFFER_TOO_SMALL;
    }
}

```

Edk2/MdeModulePkg/Universal/CapsulePei/Common/CapsuleCoalesce.c

- **Bug 1: Integer overflow in capsule size sanity check**
  - Huge CapsuleSize may erroneously pass sanity check

# Coalescing Bug #2

```

EFI_STATUS
GetCapsuleInfo (
    IN EFI_CAPSULE_BLOCK_DESCRIPTOR *Desc,
    IN OUT UINTN                    *NumDescriptors OPTIONAL,
    IN OUT UINTN                    *CapsuleSize OPTIONAL
)
{
    UINTN Count;
    UINTN Size;
    ...
    while (Desc->Union.ContinuationPointer != (EFI_PHYSICAL_ADDRESS) (UINTN) NULL) {
        if (Desc->Length == 0) {
            //
            // Descriptor points to another list of block descriptors somewhere
            //
            Desc = (EFI_CAPSULE_BLOCK_DESCRIPTOR *) (UINTN) Desc->Union.ContinuationPointer;
        } else {
            Size += (UINTN) Desc->Length; <= Bug 2
            Count++;
            Desc++;
        }
    }

    if (NumDescriptors != NULL) {
        *NumDescriptors = Count;
    }

    if (CapsuleSize != NULL) {
        *CapsuleSize = Size;
    }
}

```

Edk2/MdeModulePkg/Universal/CapsulePei/Common/CapsuleCoalesce.c

- **Bug 2: Integer overflow in fragment length summation**
  - CapsuleSize may be less than true summation of fragment lengths

# Envelope Parsing Bug (Bug #3)

```

EFI_STATUS
ProduceFVBProtocolOnBuffer (
    IN EFI_PHYSICAL_ADDRESS BaseAddress,
    IN UINT64 Length,
    IN EFI_HANDLE ParentHandle,
    IN UINT32 AuthenticationStatus,
    OUT EFI_HANDLE *FvProtocol OPTIONAL
)
{
    EFI_STATUS Status;
    EFI_FW_VOL_BLOCK_DEVICE *FvbDev;
    EFI_FIRMWARE_VOLUME_HEADER *FwVolHeader;
    UINTN BlockIndex;
    UINTN BlockIndex2;
    UINTN LinearOffset;
    UINT32 FvAlignment;
    EFI_FV_BLOCK_MAP_ENTRY *PtrBlockMapEntry;

    FwVolHeader = (EFI_FIRMWARE_VOLUME_HEADER *) (UINTN) BaseAddress;
    ...
    //
    // Init the block caching fields of the device
    // First, count the number of blocks
    //
    FvbDev->NumBlocks = 0;
    for (PtrBlockMapEntry = FwVolHeader->BlockMap;
        PtrBlockMapEntry->NumBlocks != 0;
        PtrBlockMapEntry++) {
        FvbDev->NumBlocks += PtrBlockMapEntry->NumBlocks;
    }
    //
    // Second, allocate the cache
    //
    FvbDev->LbaCache = AllocatePool (FvbDev->NumBlocks * sizeof (LBA_CACHE)); <= Bug 3
}

```

Edk2/MdeModulePkg/Core/Dxe/FwVolBlock/FwVolBlock.c

- **Bug 3: Integer overflow in multiplication before allocation**
  - LbaCache may be unexpectedly small if NumBlocks is huge

# Miscellaneous Coalescing Bug (Bug #4)

```
BOOLEAN
IsOverlapped (
    UINT8    *Buff1,
    UINTN    Size1,
    UINT8    *Buff2,
    UINTN    Size2
)
{
    //
    // If buff1's end is less than the start of buff2, then it's ok.
    // Also, if buff1's start is beyond buff2's end, then it's ok.
    //
    if (((Buff1 + Size1) <= Buff2) || (Buff1 >= (Buff2 + Size2))) { <= Bug 4
        return FALSE;
    }

    return TRUE;
}
```

Edk2/MdeModulePkg/Universal/CapsulePei/Common/CapsuleCoalesce.c

- **Bug 4: Integer overflow in IsOverlapped**
  - Can erroneously return False if Buff1+Size1 overflows
  - This didn't directly lead to a vulnerability but we had to abuse it to successfully exploit the other bugs

# Vulnerabilities Summary

```
} else {  
    //  
    //To enhance the reliability of check-up, the first capsule's header is checked here.  
    //More reliabilities check-up will do later.  
    if (CapsuleSize == 0) {  
        //  
        //Move to the first capsule to check its header.  
        //  
        CapsuleHeader = (EFI_CAPSULE_HEADER*)((UINTN)Ptr->Union.DataBlock);  
        if (IsCapsuleCorrupted (CapsuleHeader)) {  
            return NULL;  
        }  
        CapsuleCount ++;  
        CapsuleSize = CapsuleHeader->CapsuleImageSize;  
    }  
}
```

ValidateCapsuleIntegrity: Edk2/MdeModulePkg/Universal/CapsulePei/Common/CapsuleCoalesce.c

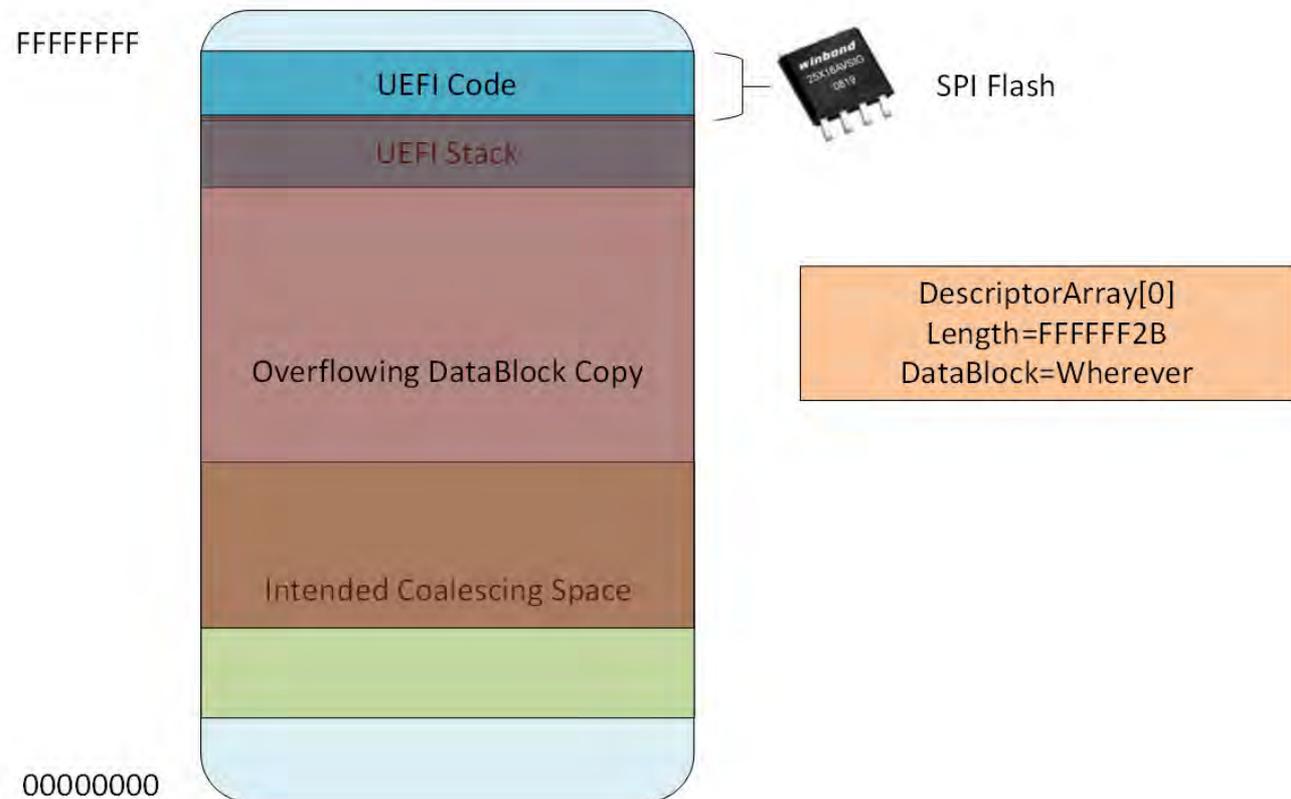
- **We spent ~1 week looking at the UEFI reference implementation and discovered vulnerabilities in security critical code**
  - The identified vulnerabilities occur before the update is cryptographically verified
- **The presence of easy to spot integer overflows in open source and security critical code is... *disturbing***
  - Is no one else looking here?

# Onward To Exploitation



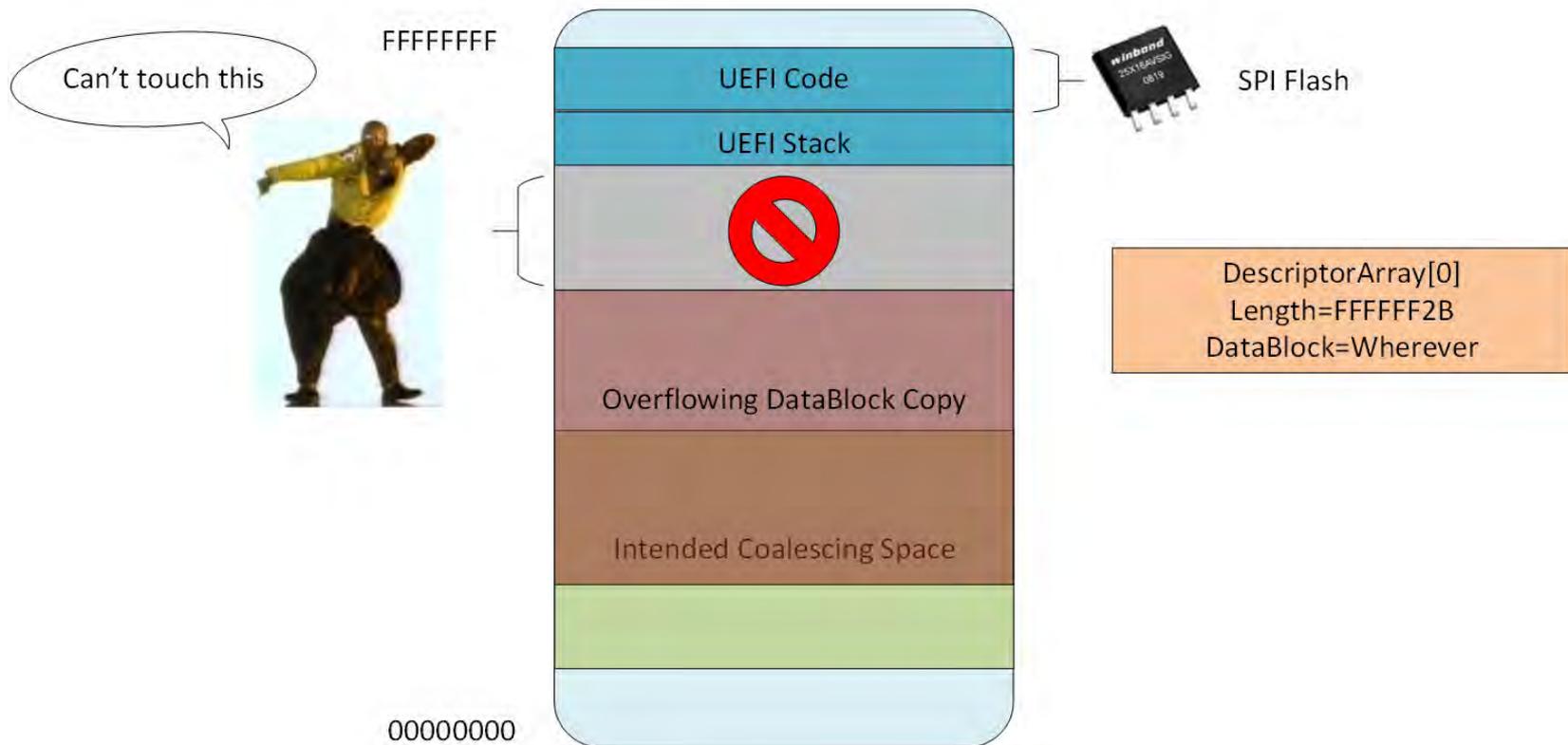
- **The aforementioned code runs with read-write-execute permissions**
  - Flat protected mode with paging disabled
  - No mitigations whatsoever
- **However, successful exploitation in this unusual environment was non-trivial**

# Coalescing Exploit Attempt



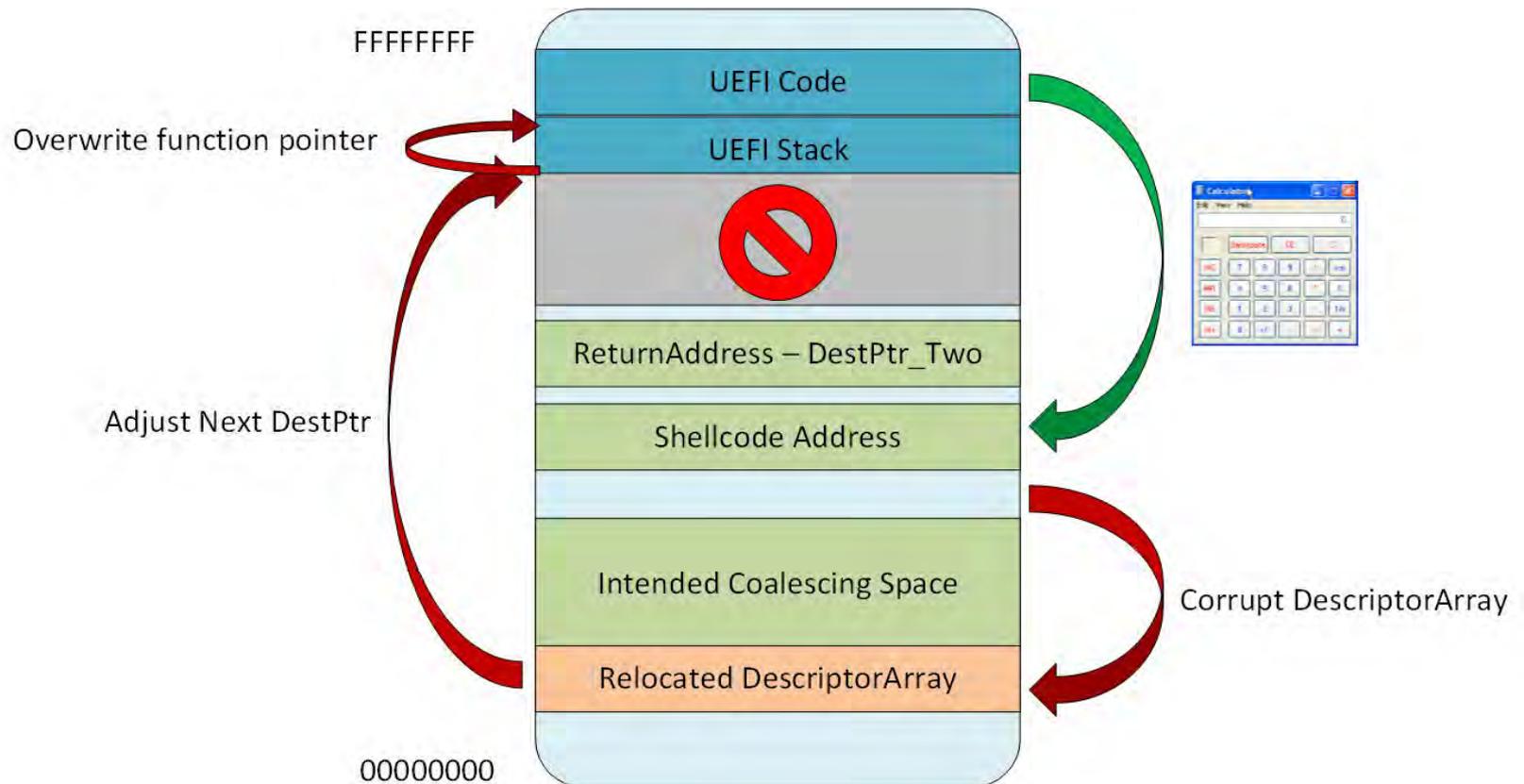
- Attempt #1: Provide a huge capsule size and clobber our way across the address space to some function pointer on the stack area**

# Coalescing Exploit Fail



- **Overwriting certain regions of the address space had undesirable results**
- **We had to come up with an approach that skipped past the forbidden region**

# Coalescing Exploit Success



- **Came up with a multistage approach that involved corrupting the descriptor array**
  - Achieve surgical write-what-where primitive
  - Combined bugs #1, #2, #4 and abused a CopyMem optimization

See whitepaper for full details on the exploitation technique

# Envelope Parsing Exploitation

```

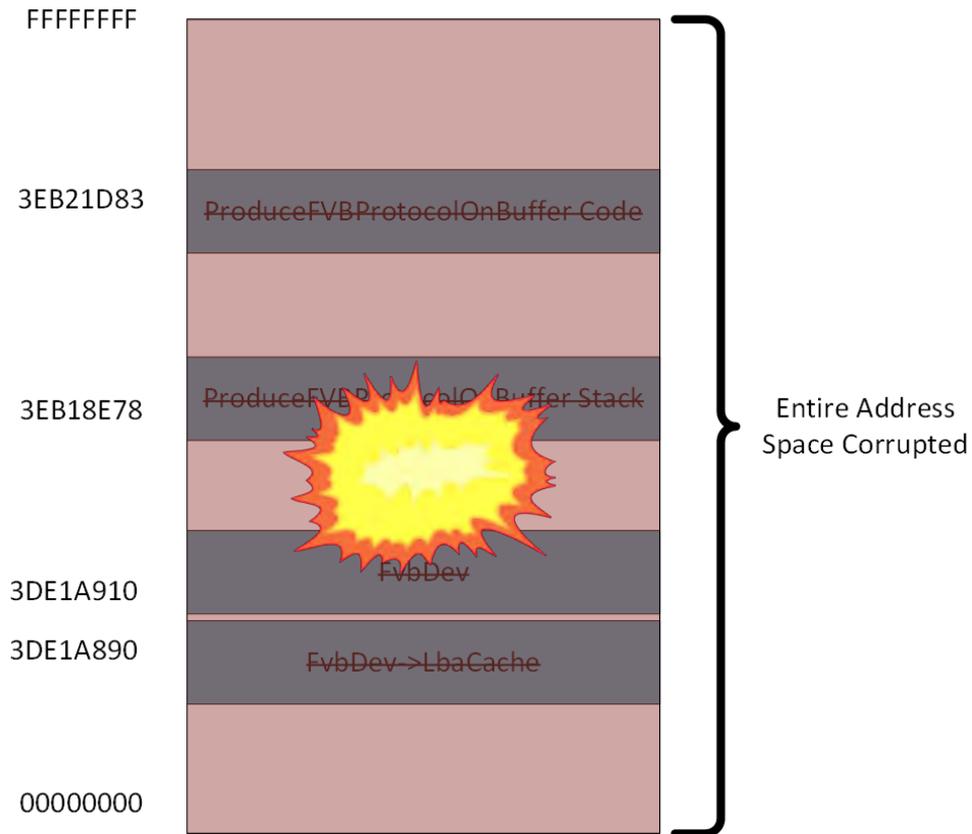
FvbDev->LbaCache = AllocatePool (FvbDev->NumBlocks * sizeof (LBA_CACHE)); <= Bug 3
...
//
// Last, fill in the cache with the linear address of the blocks
//
BlockIndex = 0;
LinearOffset = 0;
for (PtrBlockMapEntry = FwVolHeader->BlockMap;
     PtrBlockMapEntry->NumBlocks != 0; PtrBlockMapEntry++) {
    for (BlockIndex2 = 0; BlockIndex2 < PtrBlockMapEntry->NumBlocks; BlockIndex2++) {
        FvbDev->LbaCache[BlockIndex].Base = LinearOffset;
        FvbDev->LbaCache[BlockIndex].Length = PtrBlockMapEntry->Length;
        LinearOffset += PtrBlockMapEntry->Length;
        BlockIndex++;
    }
}

```

Edk2/MdeModulePkg/Core/Dxe/FwVolBlock/FwVolBlock.c

- **Exploitation of the "envelope parsing" bug was complicated for several reasons**
- **Note that in order to trigger the undersized LbaCache allocation, the NumBlocks value must be huge**
  - This effectively means that the corrupting for() loops will never terminate

# Total Address Space Annihilation



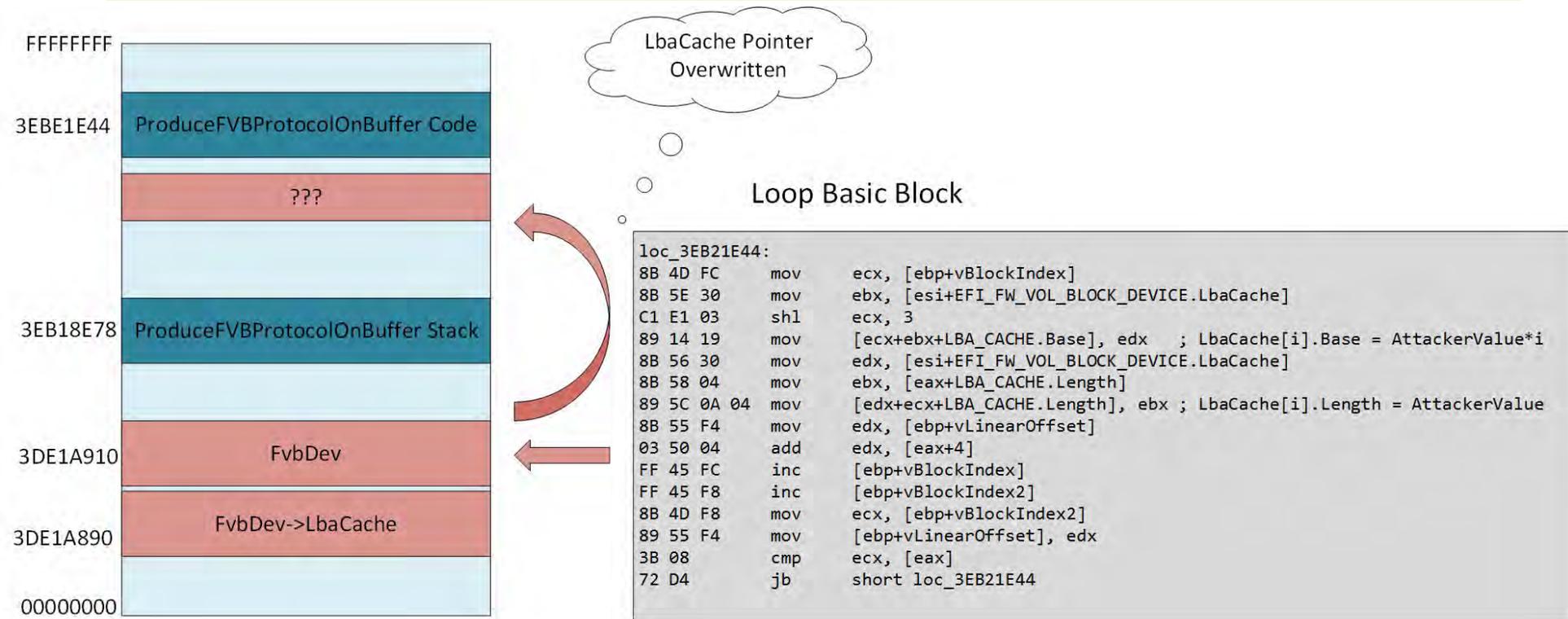
- Loop will corrupt entire address space and hang the system

# Other Complications

...	...	...
3DE1A944	Other FvbDev Members	???
3DE1A940	FvbDev->LbaCache (pointer)	AttackerValue x 16
...	...	...
3DE1A910	FvbDev->Signature	AttackerValue x 10
...	...	...
3DE1A89C	FvbDev->LbaCache[1].Length	AttackerValue
3DE1A898	FvbDev->LbaCache[1].Base	AttackerValue x 1
3DE1A894	FvbDev->LbaCache[0].Length	AttackerValue
3DE1A890	FvbDev->LbaCache[0].Base	AttackerValue x 0

- **LbaCache pointer is overwritten by the corruption, further complicating things**
- **Values being written during the corruption are not entirely attacker controller**

# Corruption Direction Change



- Overwriting the LbaCache pointer changes the location the corruption continues at

# Difficulties Recap



- **An attacker has some serious hoops to jump through to successfully exploit the envelope parsing vulnerability**
  - Corrupting of base pointer for corruption (LbaCache)
  - Only partially controlled values being written
  - Corrupting loop will never terminate

# Self-overwriting Code

We are now corrupting the loop code itself..

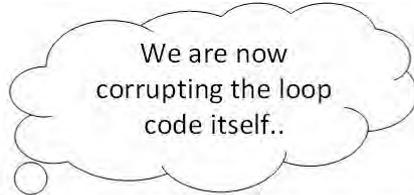
- AttackerValue = 2D98BB8.
- Overwrites top of loop code on iteration=38E
- \*(DWORD \*)3EB21E44 = AttackerValue (B8 8B D9 02) [endianness]

```

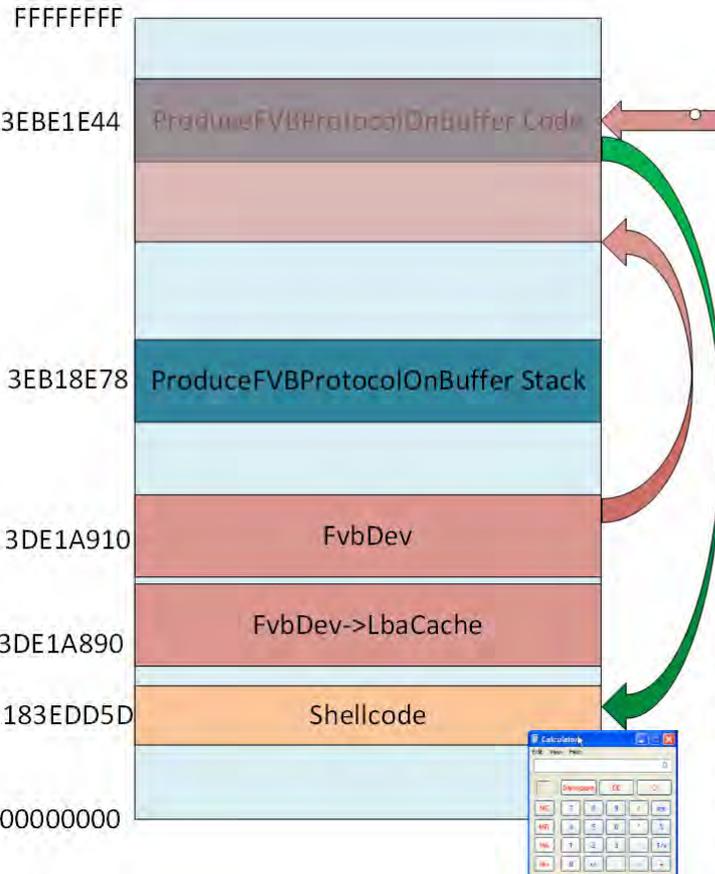
loc_3EB21E44:
B8 8B D9 02 5E      mov     eax, 5E02D98Bh
8B 5E 30           mov     ebx, [esi+EFI_FW_VOL_BLOCK_DEVICE.LbaCache]
C1 E1 03           shl     ecx, 3
89 14 19           mov     [ecx+ebx+LBA_CACHE.Base], edx ; LbaCache[i].Base = AttackerValue*i
8B 56 30           mov     edx, [esi+EFI_FW_VOL_BLOCK_DEVICE.LbaCache]
8B 58 04           mov     ebx, [eax+LBA_CACHE.Length]
89 5C 0A 04       mov     [edx+ecx+LBA_CACHE.Length], ebx ; *(DWORD *)3EB21E44 = AttackerValue
8B 55 F4           mov     edx, [ebp+vLinearOffset]
03 50 04           add     edx, [eax+4]
FF 45 FC           inc     [ebp+vBlockIndex]
FF 45 F8           inc     [ebp+vBlockIndex2]
8B 4D F8           mov     ecx, [ebp+vBlockIndex2]
89 55 F4           mov     [ebp+vLinearOffset], edx
3B 08             cmp     ecx, [eax]
72 D4             jb     short loc_3EB21E44
  
```

- Our approach to escaping the non-terminating for loop was to massage the corruption so the loop would self-overwrite
- In this case, we overwrite the top of the basic block with non-advantageous x86 instructions
  - Overwritten values only "semi-controlled"

# Self-overwriting Success



- AttackerValue = 2D98CBF.
- Overwrites top of loop code on iteration=BB
- $*(\text{DWORD } *)3\text{EB}21\text{E}42 = (\text{AttackerValue} * 0\text{xBB}) \% 0\text{x}100000000$   
 $= 14\text{E}9\text{C}\text{F}8\text{F}$   
 $= 85 \text{ CF } \text{E}9 \text{ 14 [endianness]}$
- $*(\text{DWORD } *)3\text{EB}21\text{E}46 = \text{BF } 8\text{C } \text{D}9 \text{ 02 [endianness]}$



```

loc_3EB21E44:
E9 14 BF 8C D9      jmp     183EDD5Dh
2D 5E 30          mov     ebx, [esi+EFI_FW_VOL_BLOCK_DEVICE.LbaCache]
C1 E1 03          shl     ecx, 3
89 14 19          mov     [ecx+ebx+LBA_CACHE.Base], edx ; *(DWORD *)3EB21E42 = AttackerValue*i
8B 56 30          mov     edx, [esi+EFI_FW_VOL_BLOCK_DEVICE.LbaCache]
8B 58 04          mov     ebx, [eax+LBA_CACHE.Length]
89 5C 0A 04       mov     [edx+ecx+LBA_CACHE.Length], ebx ; *(DWORD *)3EB21E46 = AttackerValue
8B 55 F4          mov     edx, [ebp+vLinearOffset]
03 50 04          add     edx, [eax+4]
FF 45 FC          inc     [ebp+vBlockIndex]
FF 45 F8          inc     [ebp+vBlockIndex2]
8B 4D F8          mov     ecx, [ebp+vBlockIndex2]
89 55 F4          mov     [ebp+vLinearOffset], edx
3B 08            cmp     ecx, [eax]
72 D4            jb     short loc_3EB21E44
    
```

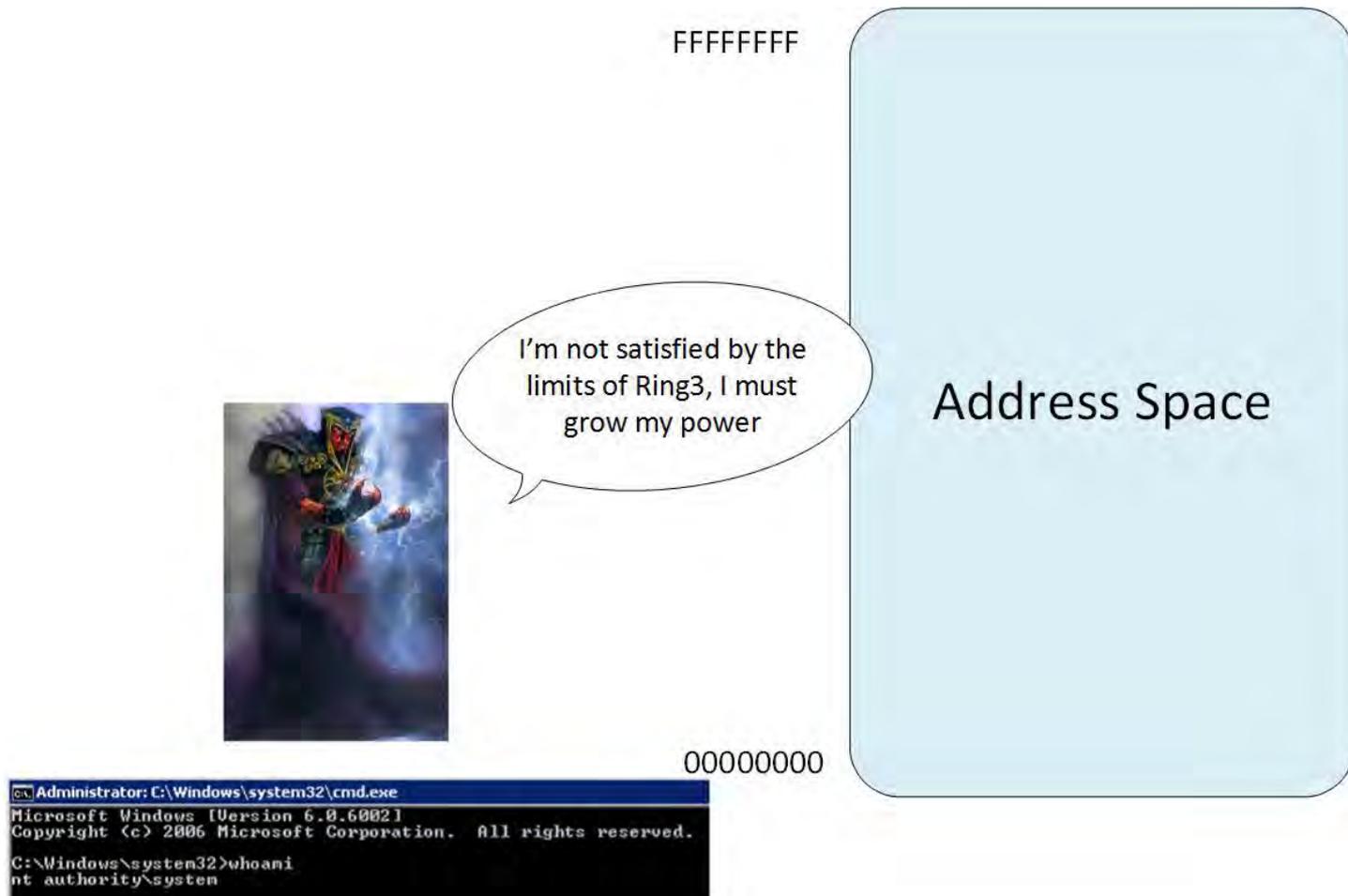
- With some brute force we discovered a way to overwrite the looping basic block with advantageous attacker instructions
  - Jump to uncorrupted shellcode

# Exploitation Mechanics Summary

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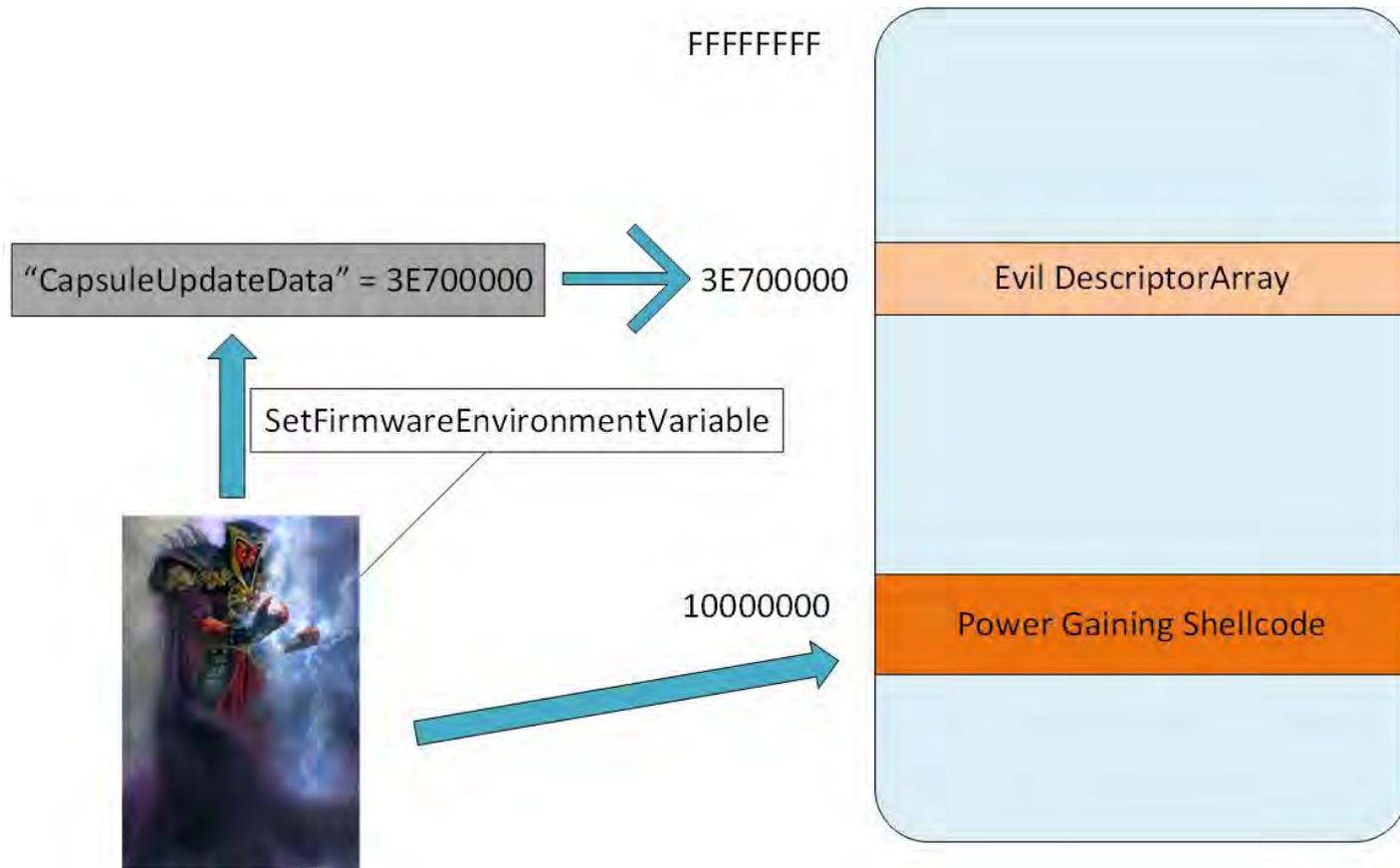
- **Vulnerable code runs with read-write-execute permissions and no mitigations**
- **However, successful exploitation was still complicated**
- **Capsule coalescing exploit allows for surgical write-what-where primitive resulting in reliable exploitation of the UEFI firmware**
  - Address space is almost entirely uncorrupted so system remains stable
- **Capsule envelope parsing vulnerability can be exploited but corrupts a lot of the address space**
  - System probably in an unstable state
- **In both cases, attacker ends up with control of EIP in the early boot environment**

# Exploitation Flow (1 of 8)



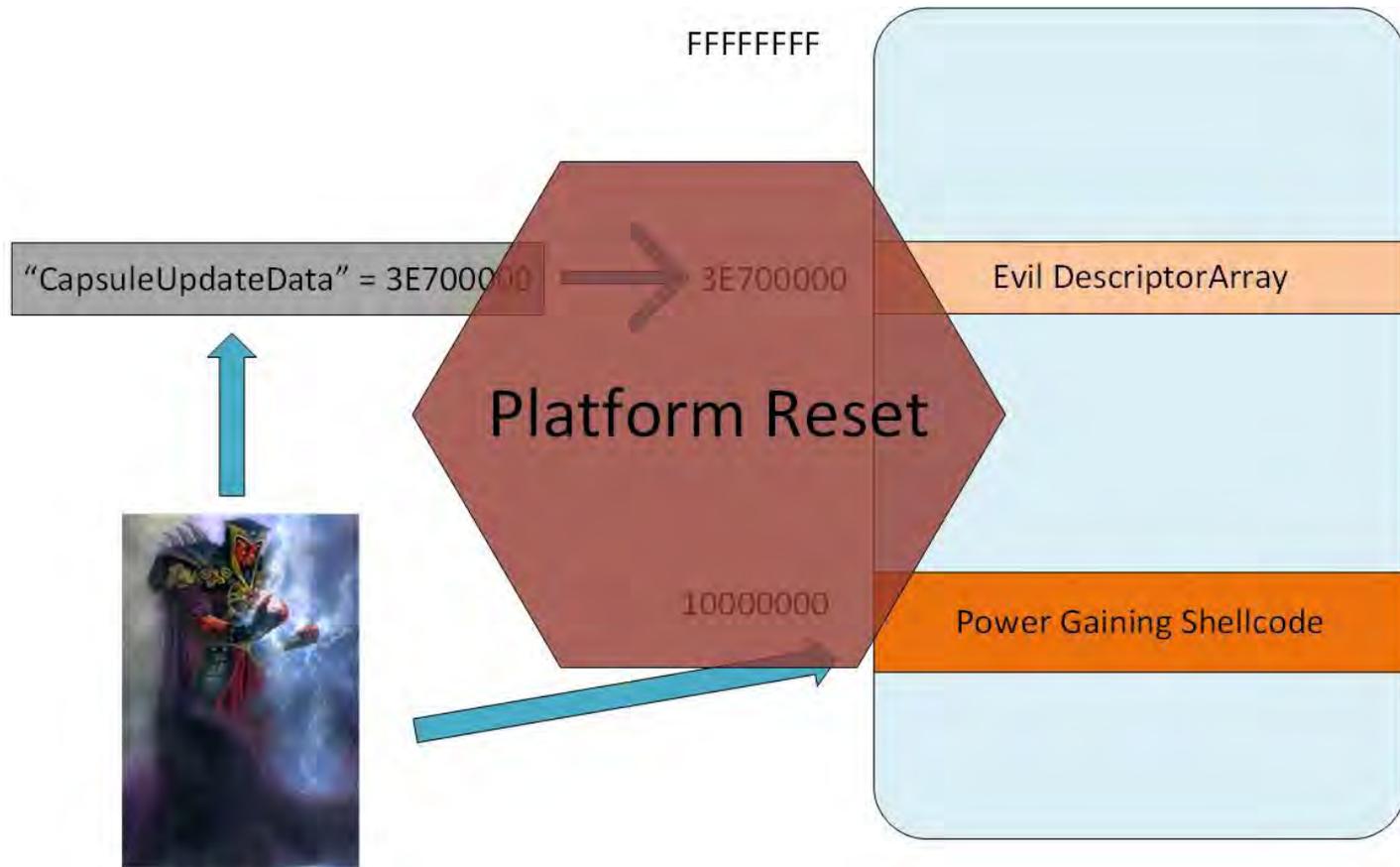
- Our Sith attacker is unimpressed with his ring 3 admin privileges and seeks to grow his power through the dark side of the force

# Exploitation Flow (2 of 8)



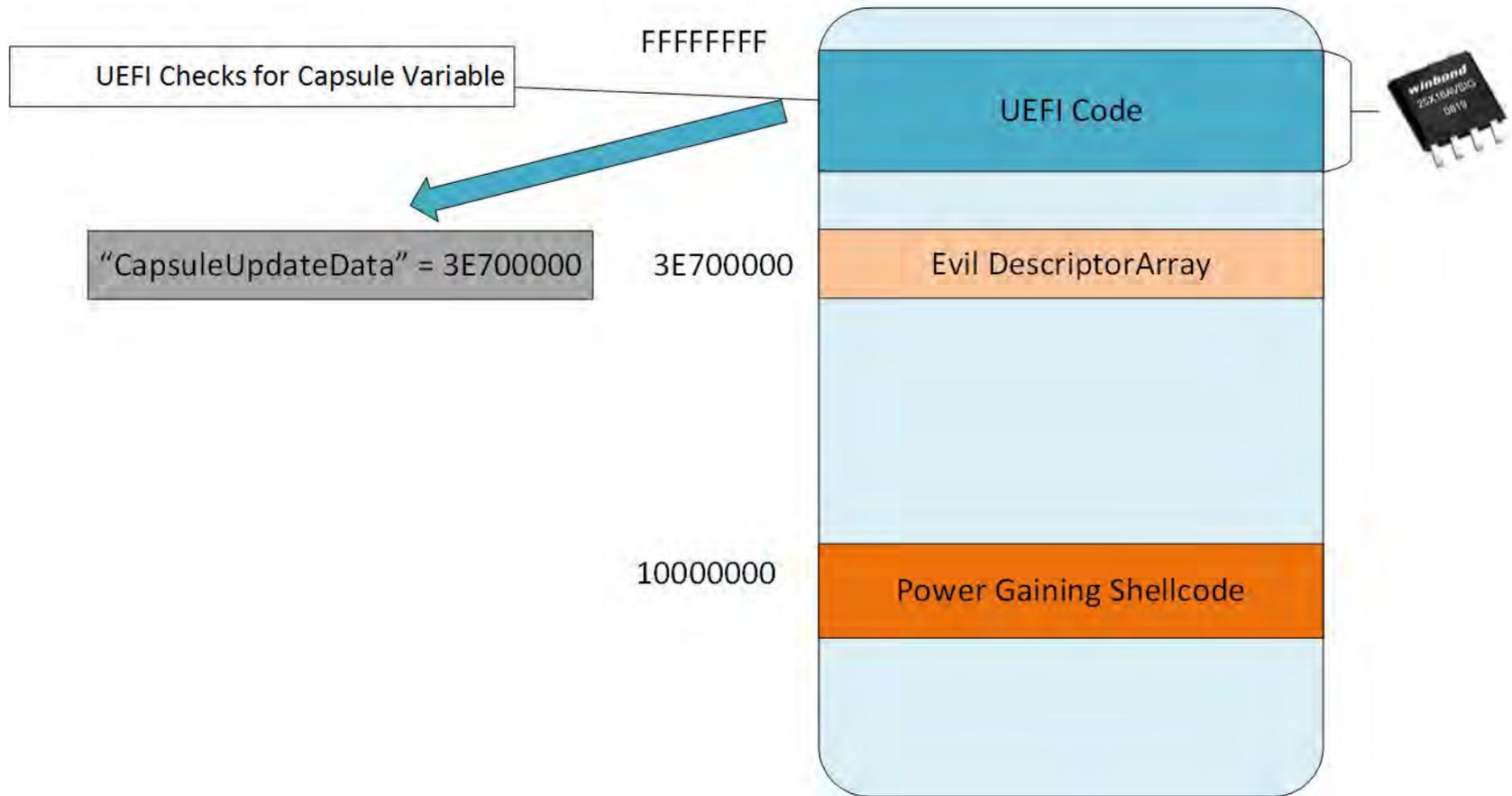
- Attacker seeds an evil capsule update into memory
- Attacker then uses SetFirmwareEnvironmentVariable to prepare the firmware to consume the evil capsule
- Shellcode to be executed in the early boot environment is staged in memory

# Exploitation Flow (3 of 8)



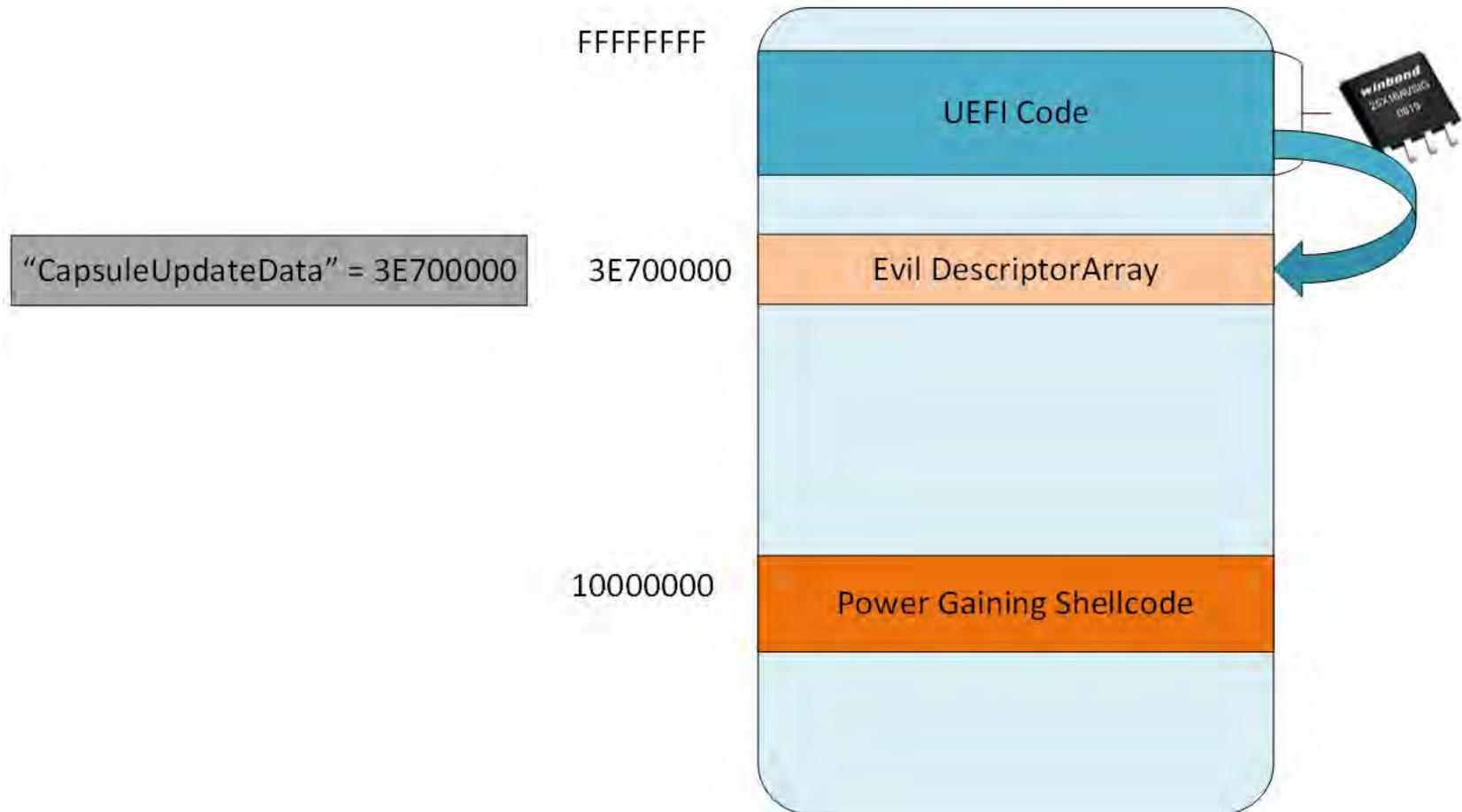
- Warm reset is performed to transfer context back to UEFI

# Exploitation Flow (4 of 8)



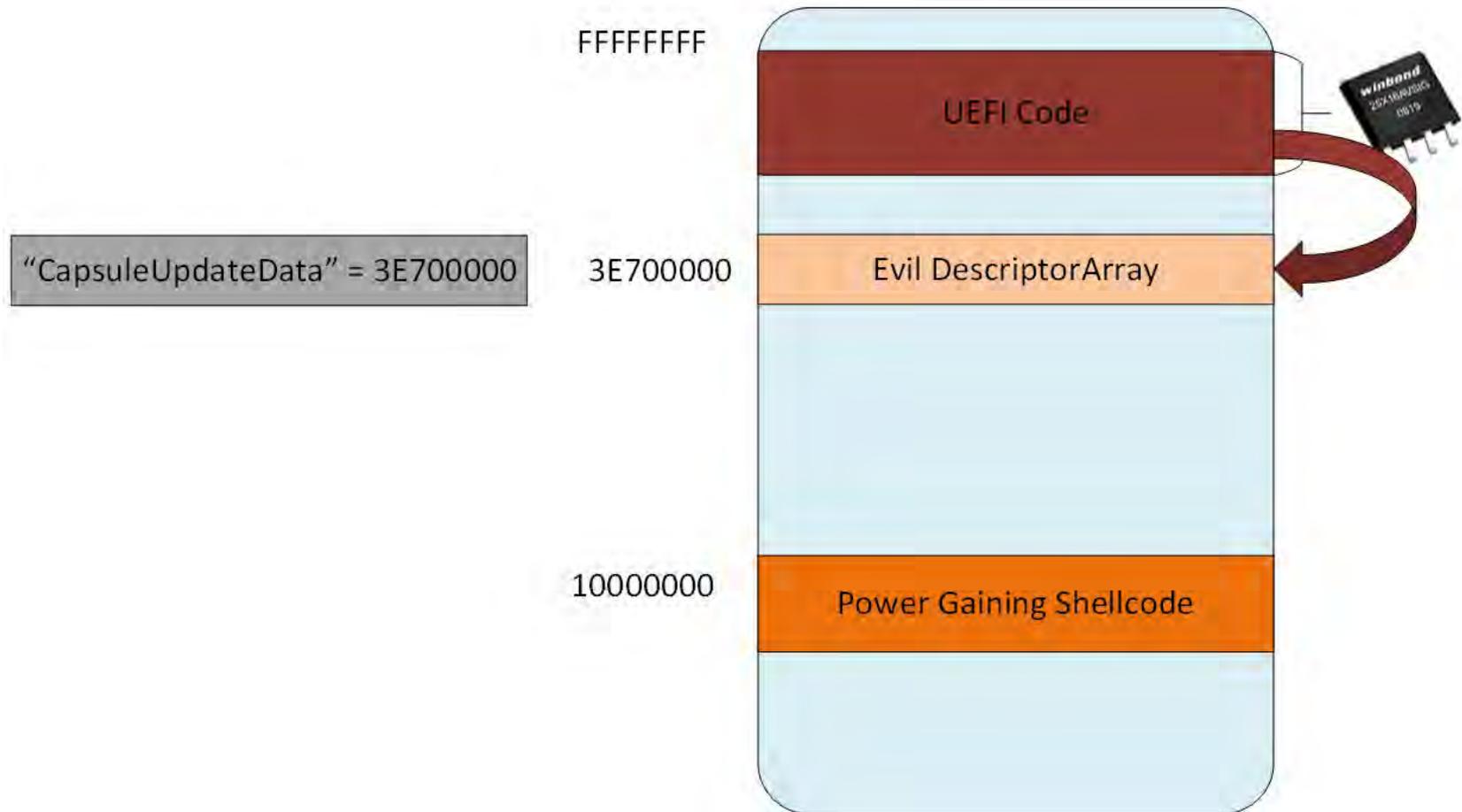
- Capsule processing is initiated by the existence of the "CapsuleUpdateData" UEFI variable

# Exploitation Flow (5 of 8)



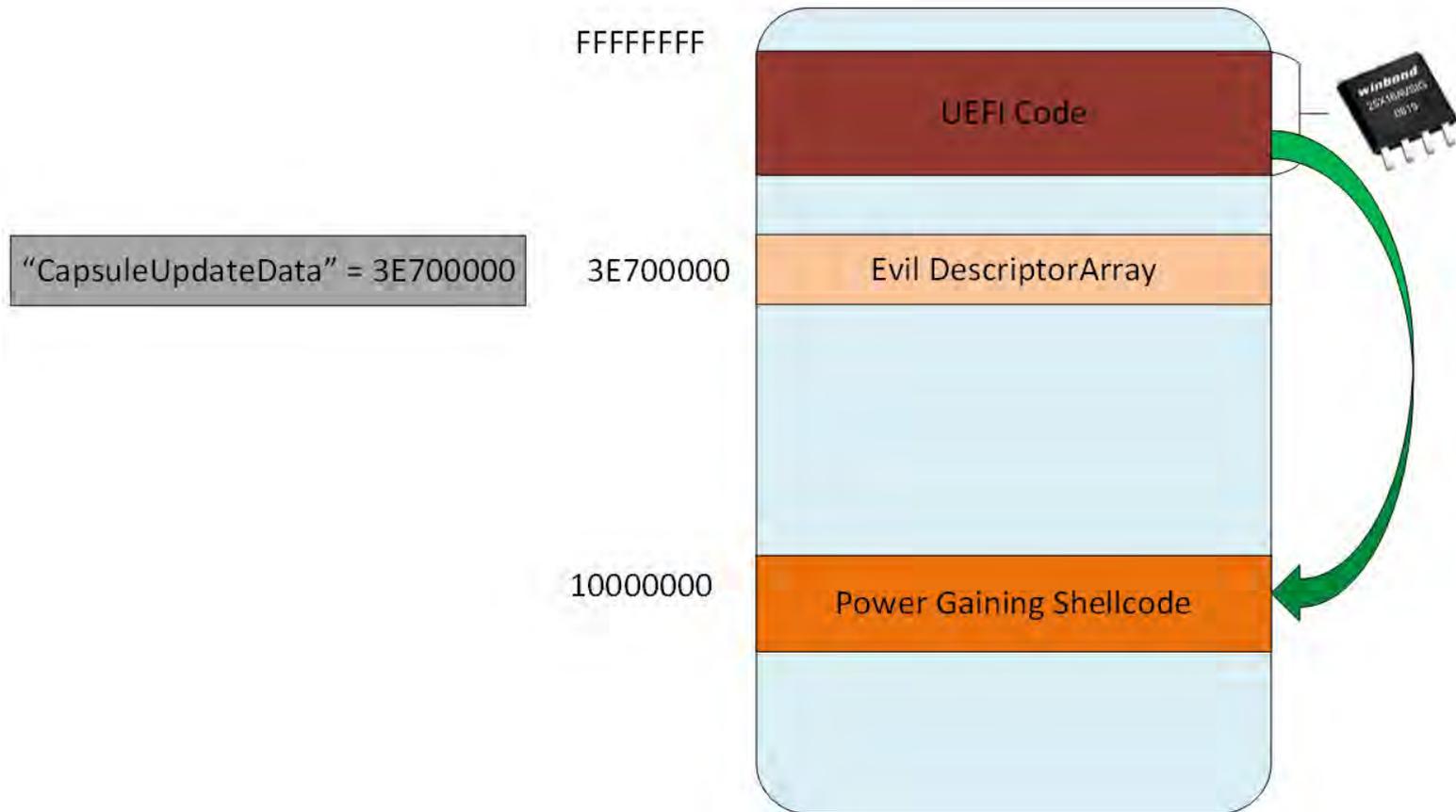
- **UEFI begins to coalesce the evil capsule**

# Exploitation Flow (6 of 8)



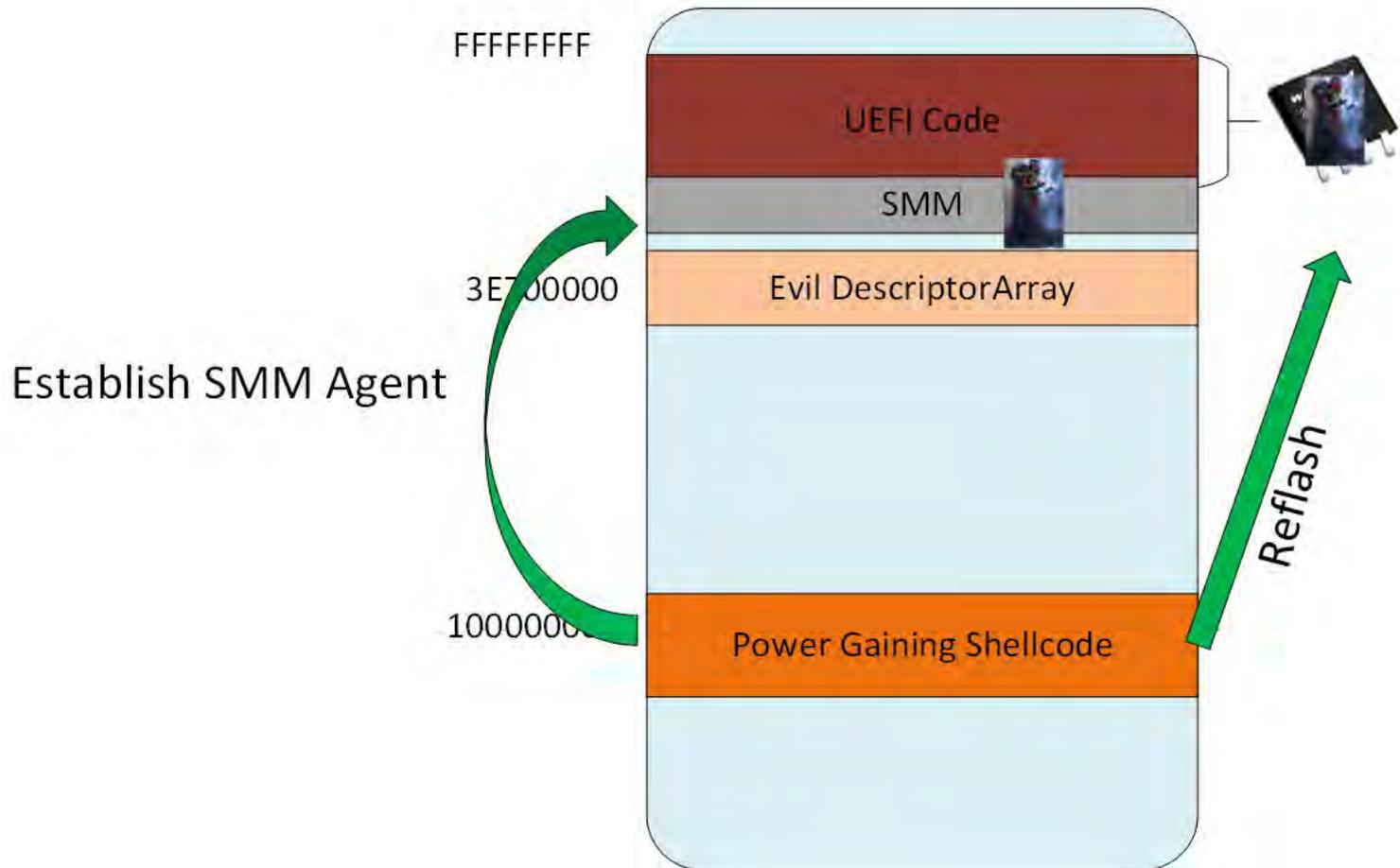
- UEFI becomes corrupted while parsing evil capsule

# Exploitation Flow (7 of 8)



- **Attacker gains arbitrary code execution in the context of the early boot environment**
  - Platform is unlocked at this point

# Exploitation Flow (8 of 8)



- **Attacker can now establish agents in SMM and/or the platform firmware to do their bidding**

# Unnatural Powers

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- **With these new powers, our attacker can:**
  - Brick the platform
  - Defeat Secure Boot[2]
  - Establish an undetectable SMM rootkit[8][5]
  - Subvert hypervisors[9]
  - Subvert TXT launched hypervisors[3]
  - Circumvent operating system security functions[11]
  - Survive operating system reinstallation attempts
  - Other?

# Demo Time

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# Vendor Response

- **We told Intel & CERT about the bugs we found on Nov 22<sup>nd</sup> and Dec 4<sup>th</sup> 2013**
  - We conveyed that we would extend our typical 6 month responsible disclosure deadline, and we would be targeting public disclosure in the summer at BlackHat/Defcon
  - We also directly contacted some of the OEMs that we already had the capability to send encrypted email to
- **Intel queried UEFI partners to ask if they were using the affected code**
- **If the vendors said they thought they would be affected, then Intel sent them the details**
- **Then we didn't hear anything for a while**
- **Eventually Intel indicated which vendors said they were vulnerable, and which systems would be patched.**
- **This information is conveyed in CERT VU #552286**
- **The UEFI forum is in the process of setting up a UEFI Security Response Team to better coordinate these sort of disclosures in the future. Shooting to go live by Sept 1.**

# What can you do about it?

- **Run Copernicus.** It has been updated to automatically report if your system is on the VU # 552286 affected list
  - <http://www.mitre.org/capabilities/cybersecurity/overview/cybersecurity-blog/copernicus-question-your-assumptions-about> or just search for "MITRE Copernicus"
- **We also have a binary integrity checking capability for Copernicus. This can help you detect if your BIOS has been backdoored**
  - The capability is freely available, but it's not as simple and foolproof as the public Copernicus (it will have false positives/negatives). And we don't really have the resources to support it for everyone. Therefore we prioritize who we work with to use it, based on the number of systems that will be checked. So if you're serious about checking your BIOSes, email [copernicus@mitre.org](mailto:copernicus@mitre.org)
    - We also need this data to feed further research results on the state of BIOS security in the wild on deployed systems. Unlike the IPMI people, we can't just portscan networks to get 100k research results :P

# What can you do about it?

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- **If you're a security vendor, start including BIOS checks**
  - If you're a customer, start asking for BIOS checks
- **We are happy to freely give away our Copernicus code to get vendors started with incorporating checking BIOSes. All we ask for in return is some data to help further our research.**
- **We want BIOS configuration & integrity checking to become standard capabilities which are widely available from as many vendors as possible.**
  - No more massive blind spot please!

# Conclusion

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- **UEFI has more tightly coupled the bonds of the operating system and the platform firmware**
- **Specifically, the EFI variable interface acts as a conduit by which a less privileged entity (the operating system) can pass information for consumption by a more privileged entity (the platform firmware)**
  - We have demonstrated how a vulnerability in this interface can allow an attacker to gain control of the firmware
- **Although the authors believe UEFI to ultimately be a good thing for the state of platform security, a more thorough audit of the UEFI code and its new features is needed**
- **Copernicus continues to be updated to give the latest information about whether vulnerabilities affect your BIOS**

# Questions & Contact

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- {ckallenberg, xkovah, jbutterworth, scornwell} @ mitre . org
- Copernicus @ mitre . org
- @coreykal, @xenokovah, @jwbutterworth3, @ssc0rnwell
- @MITREcorp
  
- P.s., go check out [OpenSecurityTraining.info](http://OpenSecurityTraining.info)!
- @OpenSecTraining

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