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Credential Guard: Say Good Bye to Pass the Hash/Ticket Attacks

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Abstract: **This paper provides important aspects of "Credential Guard" - An awesome mitigation to PtH/T Attacks with just few clicks of Group policy configuration.**

Keywords: **Credential Guard, LSAISO, LSASS, PtH Attack, Secure Kernel, VBS Config, Virtualization Based Security, Windows 10-11, Windows Modern Security.**

I. INTRODUCTION

Introduced in Windows 10 Enterprise and Windows Server 2016, Credential Guard uses virtualization-based security to isolate secrets so that only privileged system software can access them. Unauthorized access to these secrets can lead to credential theft attacks, such as Pass-the-Hash or Pass-The-Ticket.

Kerberos, NTLM, and Credential manager isolate secrets by using virtualization-based security. Previous versions of Windows stored secrets in the Local Security Authority (LSA). Prior to Windows 10, the LSA stored secrets used by the operating system in its process memory. With Windows Defender Credential Guard enabled, the LSA process in the operating system talks to a new component called the isolated LSA process that stores and protects those secrets. Data stored by the isolated LSA process is protected using Virtualization-based security and isn't accessible to the rest of the operating system. LSA uses remote procedure calls to communicate with the isolated LSA process.

For security reasons, the isolated LSA process doesn't host any device drivers. Instead, it only hosts a small subset of operating system binaries that are needed for security and nothing else. All of these binaries are signed with a certificate that is trusted by virtualization-based security and these signatures are validated before launching the file in the protected environment.

When Windows Defender Credential Guard is enabled, NTLMv1, MS-CHAPv2, Digest, and CredSSP can't use the signed-in credentials. Thus, single sign-on doesn't work with these protocols. However, applications can prompt for credentials or use credentials stored in the Windows Vault, which aren't protected by Windows Defender Credential Guard with any of these protocols. It is recommended that valuable credentials, such as the sign-in credentials, aren't to be used with any of these protocols. If these protocols must be used by domain or Azure AD users, secondary credentials should be provisioned for these use cases.

When Windows Defender Credential Guard is enabled, Kerberos doesn't allow unconstrained Kerberos delegation or DES encryption, not only for signed-in credentials, but also prompted or saved credentials.

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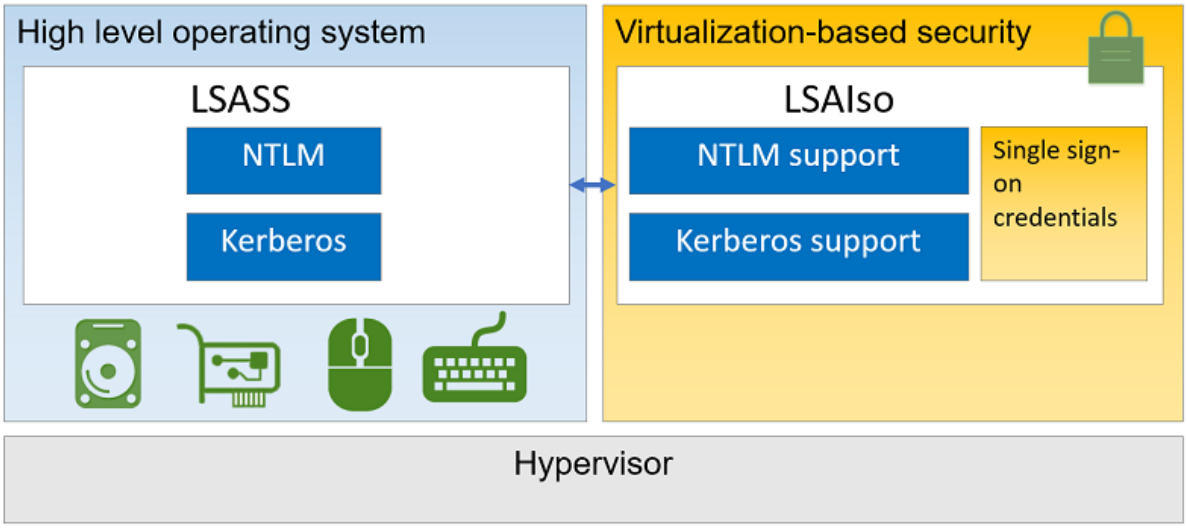
II. OVERVIEW

Here's a high-level overview on how the LSA is isolated by using Virtualization-based security:

Fig. I



https://learn.microsoft.com/en-us/windows/security/identity-protection/credential-guard/credential-guard-how-it-works

III. DEEP DIVE

In this research paper you will see different configurations and associated events and display information.

Firstly, lets us examine a machine without credential guard enabled and see what we can derive from

LSASS on Windows 10 domain joined machine.

On my lab client machine I am using **mimikatz** tool (BY Benjamin Deply - https://github.com/gentilkiwi)to extract **hashes** from memory (LSASS) :

Fig. II

```
Authentication Id : 0 ; 233728 (00000000:00039100)
Session           : Interactive from 1
User Name         : administrator
Domain            : CONTOSO
Logon Server      : DC
Logon Time        : 5/24/2017 1:18:59 AM
SID               : S-1-5-21-1469689841-4213604591-3442953207-500
        msv :
         [00000003] Primary
         * Username : Administrator
         * Domain   : CONTOSO
         * NTLM     : eaa4bb35b0e582b247335bcbb5dea412
         * SHA1     : e3d927ff20f3b587df63b8388122d49b59d1b36e
         * DPAPI    : 1e19849f813cebb2e907762030a999b2
        tspkg :
        wdigest :
         * Username : Administrator
         * Domain   : CONTOSO
         * Password : (null)
        kerberos :
         * Username : Administrator
         * Domain   : CONTOSO.COM
         * Password : (null)
        ssp :
        credman :
```

In Fig. II we can see NTLM Hash is being displayed and can be utilized for PtH/T attacks.

If you will check **msinfo32** (Start > Run - msinfo32) report you will see following configuration being displayed:

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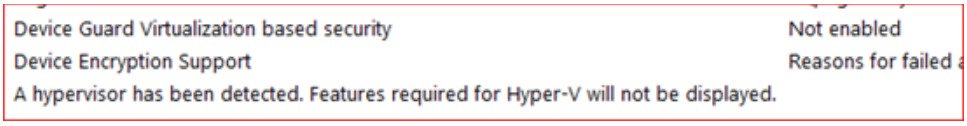
Fig. IV



Device Guard Virtualization based security: Not Enabled

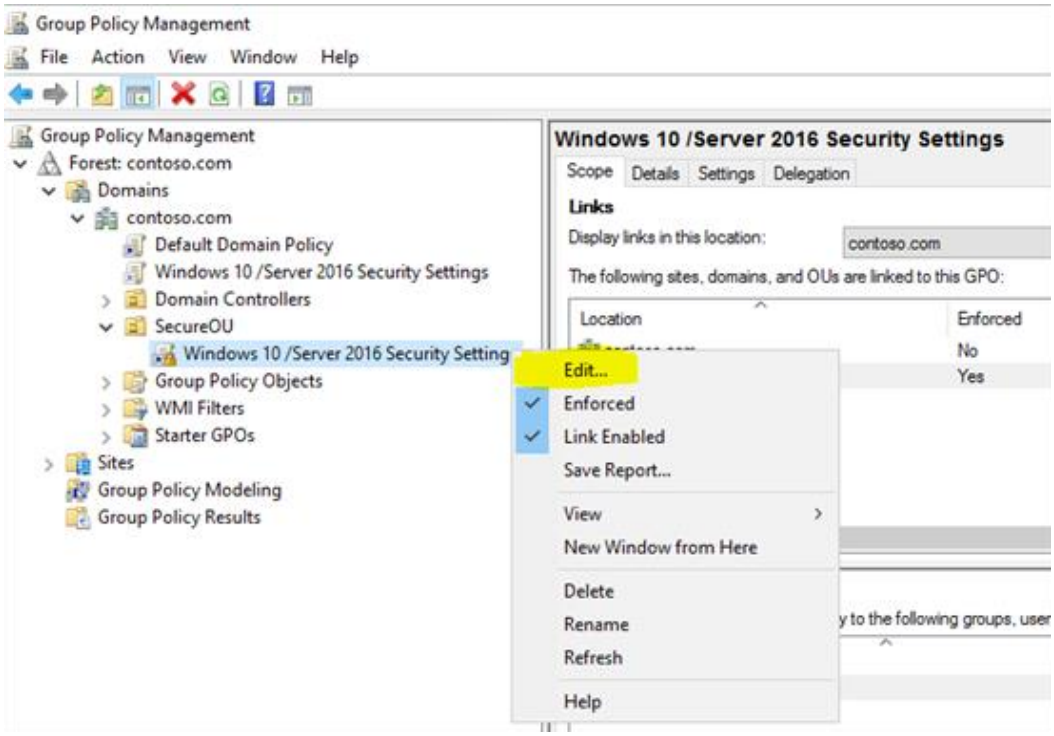
Virtualization -based security services configured: Credential Guard will not show up

Let's now configure credential guard using active directory group policy (In lab setup - Domain Controller is on Windows Server 2016):

Open GPMC - Group Policy Management Configuration Management Console or AGPM - Advanced Group Policy Management MMC (Whatever you are using). Even for testing you can use local GPMC on Windows 10 or Server machine.

Edit the GPO which is used for configuring Credential Guard

Fig. V



- Configure the configuration for Credential Guard

Policy Path: Computer Configuration\Administrative Templates\System\Device Guard

Policy Name	Value
Turn On Virtualization Based Security	Enabled

* Configurations:

Option	Value
Select Platform Security Level	Secure Boot and DMA protection
Virtualization Based Protection of Code Integrity	Enabled without UEFI Lock
Credential Guard Configuration	Enabled without UEFI Lock

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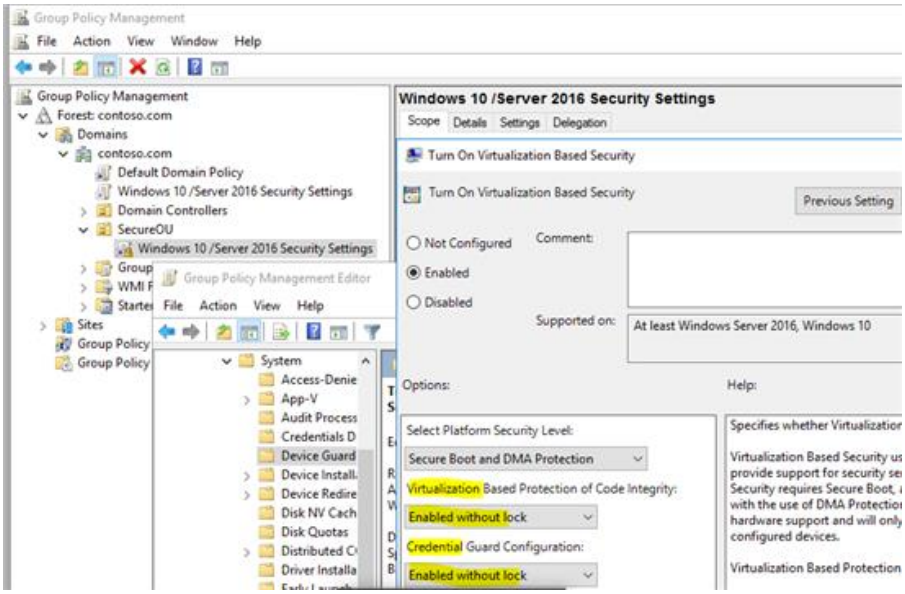
We will discuss UEFI lock later in this post-

Fig. VI



- After restarting client machine we will see "Running configuration" in msinfo32 summary:

Fig. VII

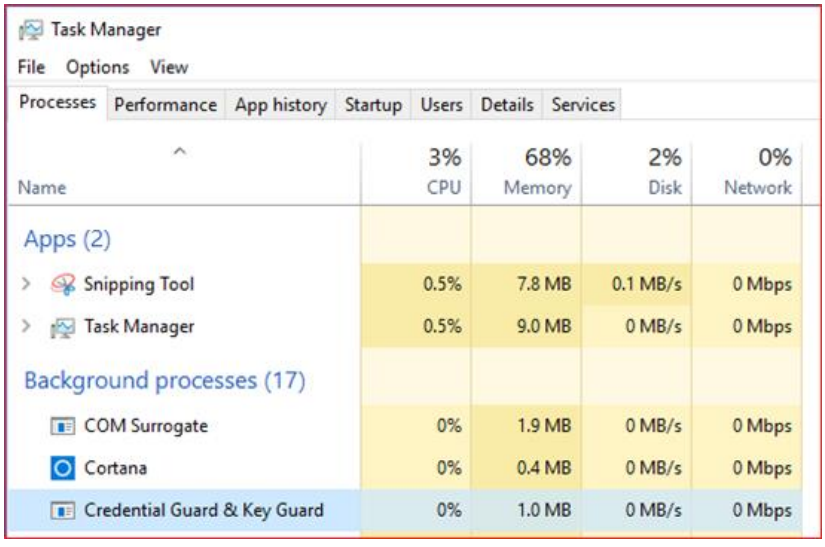
Device Guard Virtualization based security	Running
Device Guard Required Security Properties	Base Virtualization Support, Secure Boot, DMA Protection
Device Guard Available Security Properties	Base Virtualization Support, Secure Boot, DMA Protection,
Device Guard Security Services Configured	Credential Guard, Hypervisor enforced Code Integrity
Device Guard Security Services Running	Credential Guard, Hypervisor enforced Code Integrity

Also we can see one additional process called *LSAISO* under details TAB of Task manager and also as ***Credential Guard & Key Guard*** under Processes Tab:

Fig. VIII

Lsaiso.exe	912	Running	SYSTEM	00	1,25...	Credential Guard & Key Guard
lsass.exe	920	Running	SYSTEM	00	4,29...	Local Security Authority Process

Fig. IX



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- After running **mimikatz** tool again and this is what we will get from memory:

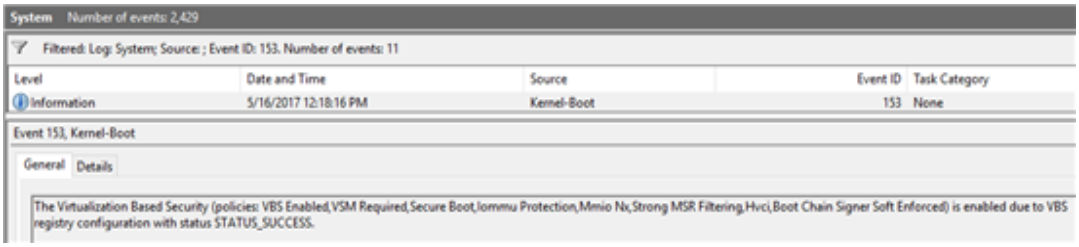
Fig, X

As we can see in Fig. X there is no hash displayed and we can see an Encrypted Blob. Hence "ENDGAME" for Pass the Hash/Ticket (PtH/T) Attacks.

A peek at Event Viewer will show following informational Events:

SYSTEM **Event ID 153** :

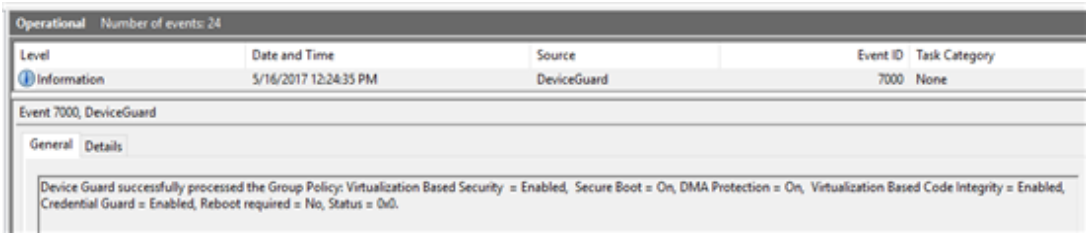
Fig. XI



The Virtualization Based Security (policies: VBS Enabled,VSM Required,Secure Boot,Iommu Protection,Mmio Nx,Strong MSR Filtering,Hvci,Boot Chain Signer Soft Enforced) is enabled due to ***VBS registry configuration*** *with status STATUS_SUCCESS.*

Application and Services Logs > Microsoft > Windows > DeviceGuard- **Event ID 7000**

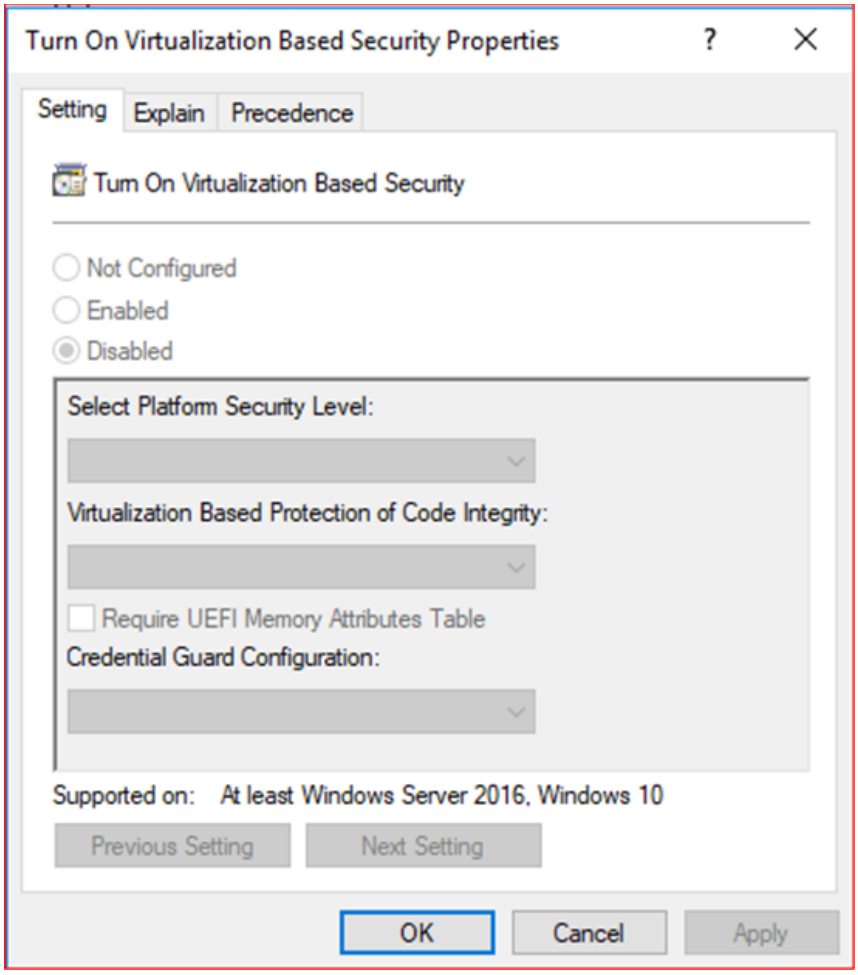
Fig. XII



Device Guard successfully processed the Group Policy: Virtualization Based Security = Enabled, Secure Boot = On, DMA Protection = On, Virtualization Based Code Integrity = Enabled, Credential Guard = Enabled, Reboot required = No, Status = 0x0.

- In order to disable the setting, just configure GPO and choose option Disabled (Do not use Not Configured)

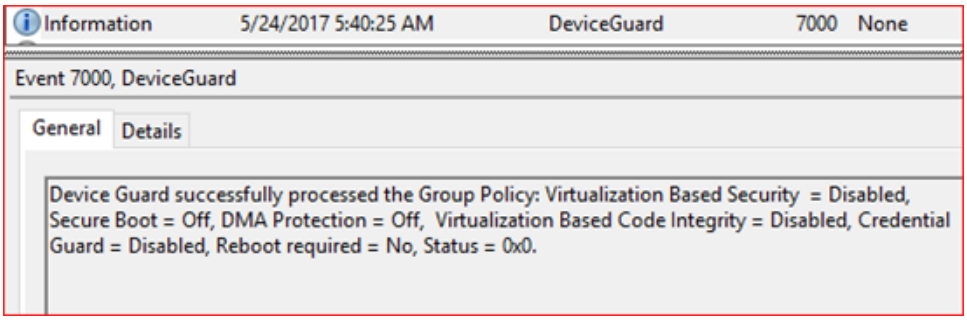
Fig. XIII



- Run **gpupdate/force** command or reboot the Client

After reboot you will see corresponding Event on Machine - *Application and Services Logs > Microsoft > Windows > DeviceGuard-* ***Event ID 7000***

Fig. XIV



Configuration 2 : With UEFI Lock

Systems which support UEFI Secure Boot maintain an internal security database within UEFI Authenticated Variables. These variables are typically stored in erasable read/write memory with hardware protection against modification by unauthorized parties

http://apps.insyde.com/app/HELP/SecureBootCheckup/UEFI%20Secure%20Boot%20Checkup.html?GeneralUEFIVariables.html

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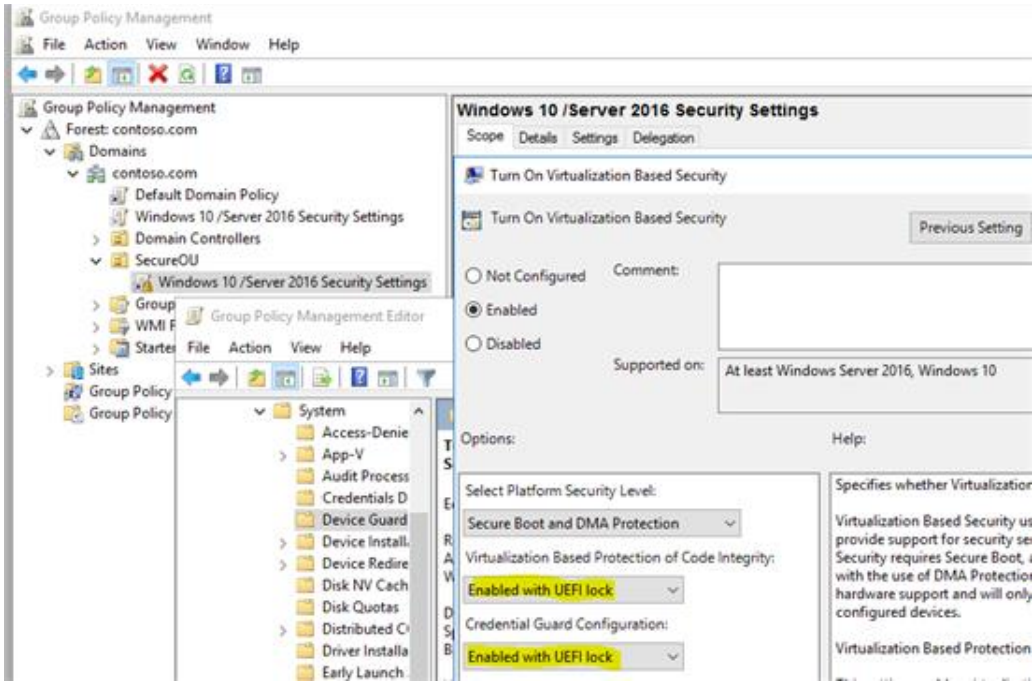
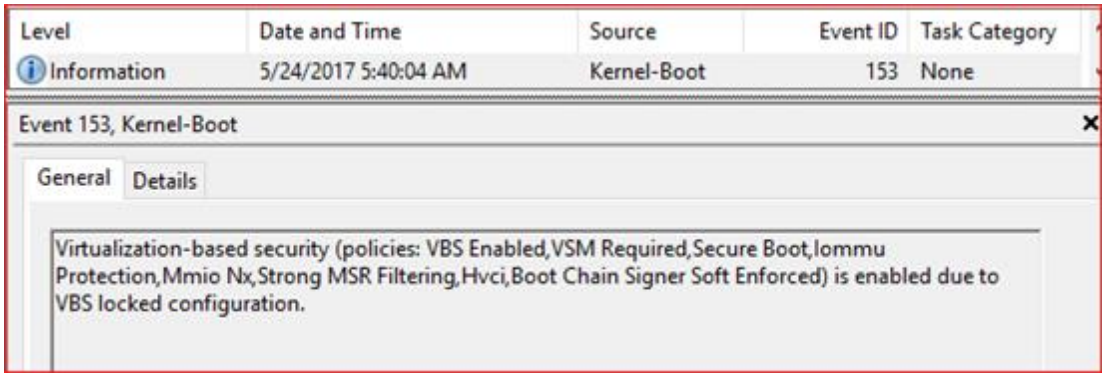
Fig. XV



In Event Viewer we will see System ***Event ID 153.*** However here we can see some difference:

Fig. XVI



Virtualization-based security (policies: VBS Enabled,VSM Required,Secure Boot,Iommu Protection,Mmio Nx,Strong MSR Filtering,Hvci,Boot Chain Signer Soft Enforced) is enabled due to VBS locked configuration.

As we can see configuration is set as "***Enabled due to VBS locked configuration***" and in earlier confirulation (Without UEFI lock) it was *enabled due to* "**VBS registry configuration "**

- In MSINFO32 summary following will be displayed:

Fig. XVII

Device Guard Virtualization based security	Running
Device Guard Required Security Properties	Base Virtualization Support, Secure Boot, DMA Protection
Device Guard Available Security Properties	Base Virtualization Support, Secure Boot, DMA Protection, UEFI Code Readonly
Device Guard Security Services Configured	Credential Guard, Hypervisor enforced Code Integrity
Device Guard Security Services Running	Credential Guard, Hypervisor enforced Code Integrity

So that means if we disable configuration using Group Policy as we did earlier that is not going to work and in this case we need to do following:

- Disable using GPO - choose option Disabled (Do not use Not Configured)

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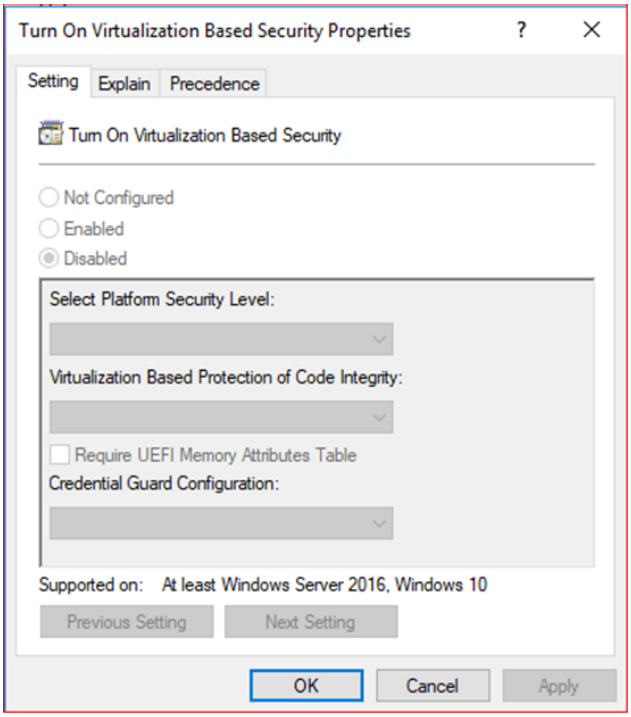
Fig. XVIII



- We need to run following commands on elevated command prompt :

mountvol X: /s

copy %WINDIR%\System32\SecConfig.efi X:\EFI\Microsoft\Boot\SecConfig.efi /Y

bcdedit /create {0cb3b571-2f2e-4343-a879-d86a476d7215} /d "DebugTool" /application osloader

bcdedit /set {0cb3b571-2f2e-4343-a879-d86a476d7215} path "\EFI\Microsoft\Boot\SecConfig.efi"

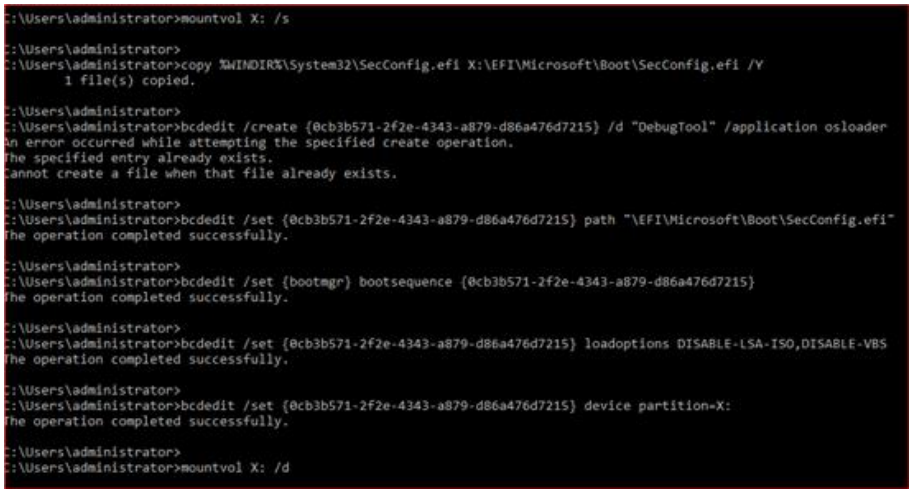
bcdedit /set {bootmgr} bootsequence {0cb3b571-2f2e-4343-a879-d86a476d7215}

bcdedit /set {0cb3b571-2f2e-4343-a879-d86a476d7215} loadoptions DISABLE-LSA-ISO,DISABLE-VBS

bcdedit /set {0cb3b571-2f2e-4343-a879-d86a476d7215} device partition=X:

mountvol X: /d

Fig. XIX



Link : https://docs.microsoft.com/en-us/windows/access-protection/credential-guard/credential-guard-manage

Here we need to make sure we have both "DISABLE-LSA-ISO,DISABLE-VBS" added in command as GPO configuration which we used had both VBS Protection and Credential selected.

Above step is very Important in case of UEFI lock because of following:

Systems which support UEFI Secure Boot maintain an internal security database within UEFI Authenticated Variables. T*hese variables are typically stored in erasable read/write memory with hardware protection against modification by unauthorized parties*

Even if we will format the OS drive or use new hard drive this setting will still be there as it is in stored in UEFI memory and only way to delete is to physically attend the machine and follow the steps that are in this paper-

- After commands are executed successfully then Restart PC

- Press **F3** on ***Opt-Out Screen for Credential Guard*** and then Any key to continue:

Fig. XX

Fig. XXI

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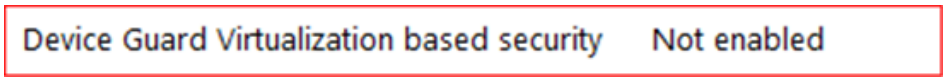
- Now press **F3** again for ***Opt-Out for Virtualization Based Security*** and Any key to continue

Fig. XXII

Fig. XXII

- After reboot, MSINFO Summary will show following:

Fig. XXIII



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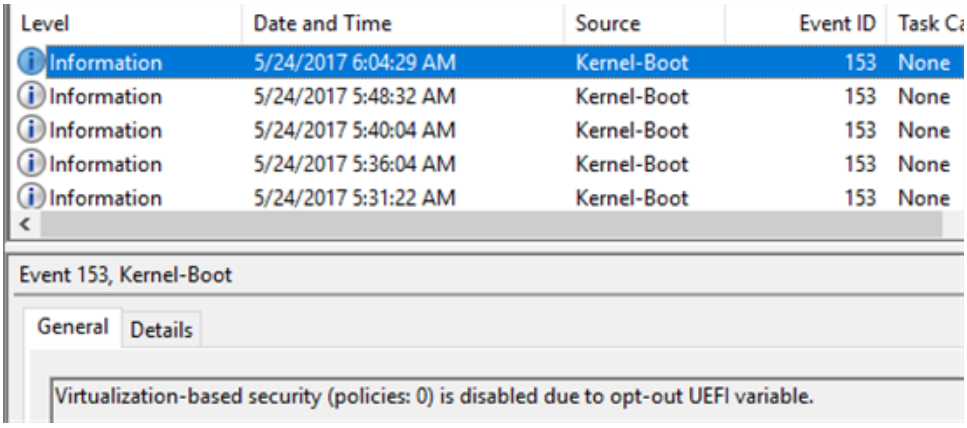
- Event will also show an event related to Opt-Out UEFI (System **Event ID 153)**

Fig. XXIV



Virtualization-based security (policies: 0) is disabled due to opt-out UEFI variable.

- For Disabling VBS in ***Virtual Machine,*** following PowerShell command needs to executed on Host machine:

Set-VMSecurity -VMName <VMName> -VirtualizationBasedSecurityOptOut $true

IV. CONCLUSION

This research paper is intended to provide high level summary of Credential Guard the one of the important security features of modern Windows Operating systems. Credential Guard provides robust protection against Pass the Hash attacks.

REFERENCES

[1] Credential Guard - https://learn.microsoft.com/en-us/windows/security/identity-protection/credential-guard/credential-guard-how-it-works

[2] Prerequisites for Credential Guard: https://learn.microsoft.com/en-us/windows/security/identity-protection/credential-guard/credential-guard-requirements?source=recommendations

[3] Security Subsystem Architecture:https://learn.microsoft.com/en-us/previous-versions/windows/it-pro/windows-2000-server/cc961760(v=technet.10)?redirectedfrom=MSDN

[4] Secure Boot : https://learn.microsoft.com/en-us/windows-hardware/design/device-experiences/oem-secure-boot

[5] PtH Mitigation: https://download.microsoft.com/download/7/7/a/77abc5bd-8320-41af-863c-6ecfb10cb4b9/mitigating-pass-the-hash-attacks-and-other-credential-theft-version-2.pdf