Misconfiguration Manager

Overlooked and Overprivileged

Chris Thompson & Duane Michael

SpecterOps

Chris Thompson

- Principal Consultant, Adversary Simulation at SpecterOps
- Speaker at Black Hat USA Arsenal and DEF CON Demo Labs
- Primary author of SharpSCCM
- X: @_Mayyhem

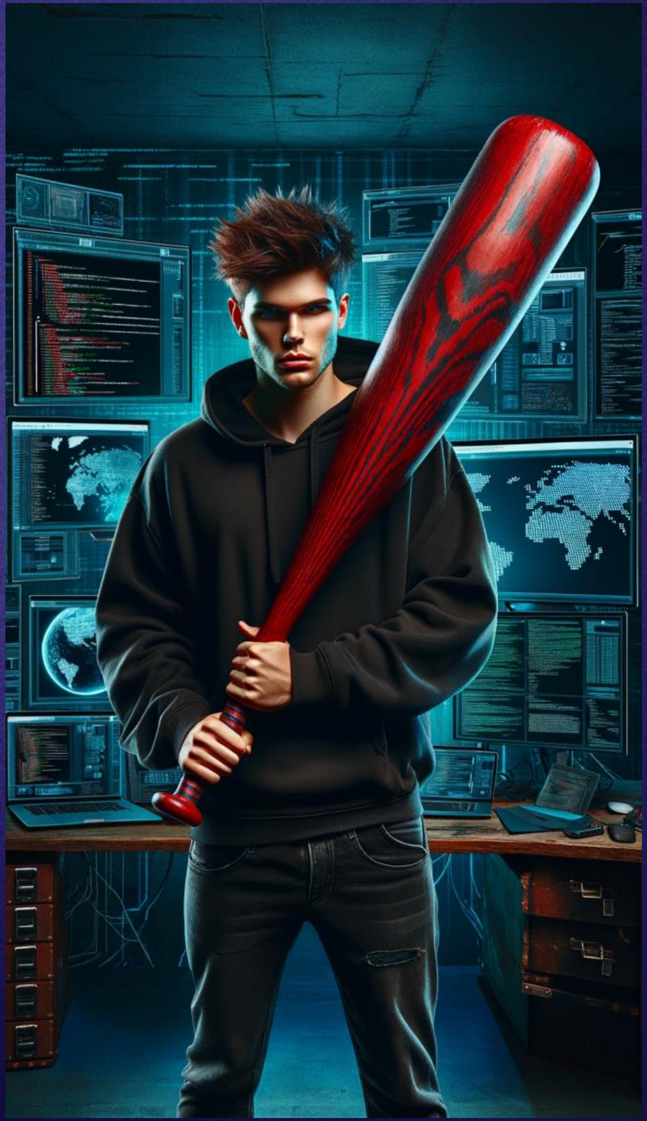
Duane Michael

- Adversary Simulation Operator, Trainer, Manager at SpecterOps
- Speaker at Black Hat USA Arsenal and DEF CON Demo Labs
- Contributor to SharpSCCM
- @subat0mik on all the things

Image credit: Jeff Dimmock

Garrett Foster

- Senior Consultant, Adversary Simulation at SpecterOps
- Speaker at Wild West Hackin' Fest and BSides PDX
- Primary author of SCCMHunter
- X: @garrfoster



Agenda

What this talk is (and is not) about

✓ **This presentation covers:**

- Exposure to common SCCM attack paths
- Stories from the field
- Intro to our SCCM attack path management project

☒ **This presentation does NOT cover:**

- Specific offensive or defensive walkthroughs
- Tool or attack demos
- Comprehensive treatment of topics discussed

SCCM Introduction

Laying the groundwork

- What is Microsoft Configuration Manager?
  - AKA System Center Configuration Manager (SCCM)
  - Used for wide-scale deployment of applications, software updates, operating systems, and compliance settings
  - Real-time management of servers, desktops, and laptops

SCCM Introduction

Know your target

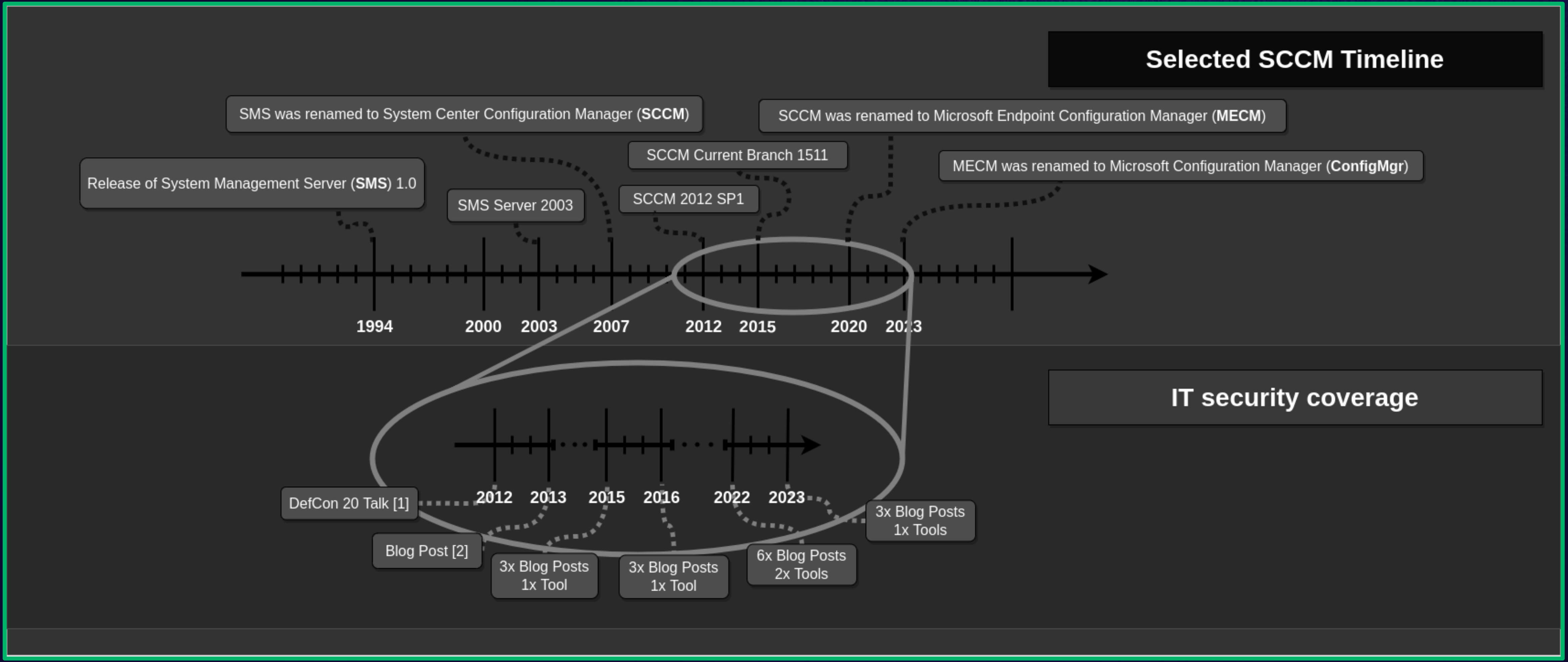
- As an attacker, why should I care?
  - Used by many organizations that use Windows workstations, so you're likely to encounter it
  - Often used to manage clients in multiple AD domains and networks, bypassing segmentation
  - Commonly misconfigured due to some insecure default settings and poor community advice

SCCM Introduction

Know your attack surface

- As a defender or administrator, why should I care?
  - If you work in a Windows/Active Directory enterprise environment, you're likely using SCCM
  - Misconfigurations cause dangerous vulnerabilities that may lead to domain compromise

A Brief History of SCCM Security Research



Selected SCCM Timeline

Release of System Management Server (**SMS**) 1.0

SMS Server 2003

SMS was renamed to System Center Configuration Manager (**SCCM**)

SCCM 2012 SP1

SCCM Current Branch 1511

SCCM was renamed to Microsoft Endpoint Configuration Manager (**MECM**)

MECM was renamed to Microsoft Configuration Manager (**ConfigMgr**)

IT security coverage

DefCon 20 Talk [1]

Blog Post [2]

3x Blog Posts
1x Tool

3x Blog Posts
1x Tool

6x Blog Posts
2x Tools

3x Blog Posts
1x Tools

https://www.securesystems.de/images/blog/active-directory-spotlight-attacking-the-microsoft-configuration-manager/SCCM-History-Overview.png

SCCM Primer

The building blocks

- ***Hierarchy***: One instance of SCCM, consisting of one or more sites

- ***Site***: An environment that provides services to a scope of clients, identified by a three-character site code (e.g., PS1)

- ***Client/Device***: Systems joined to, managed by, and that receive content from an SCCM site through installation of the SCCM client software (think C2 agent)

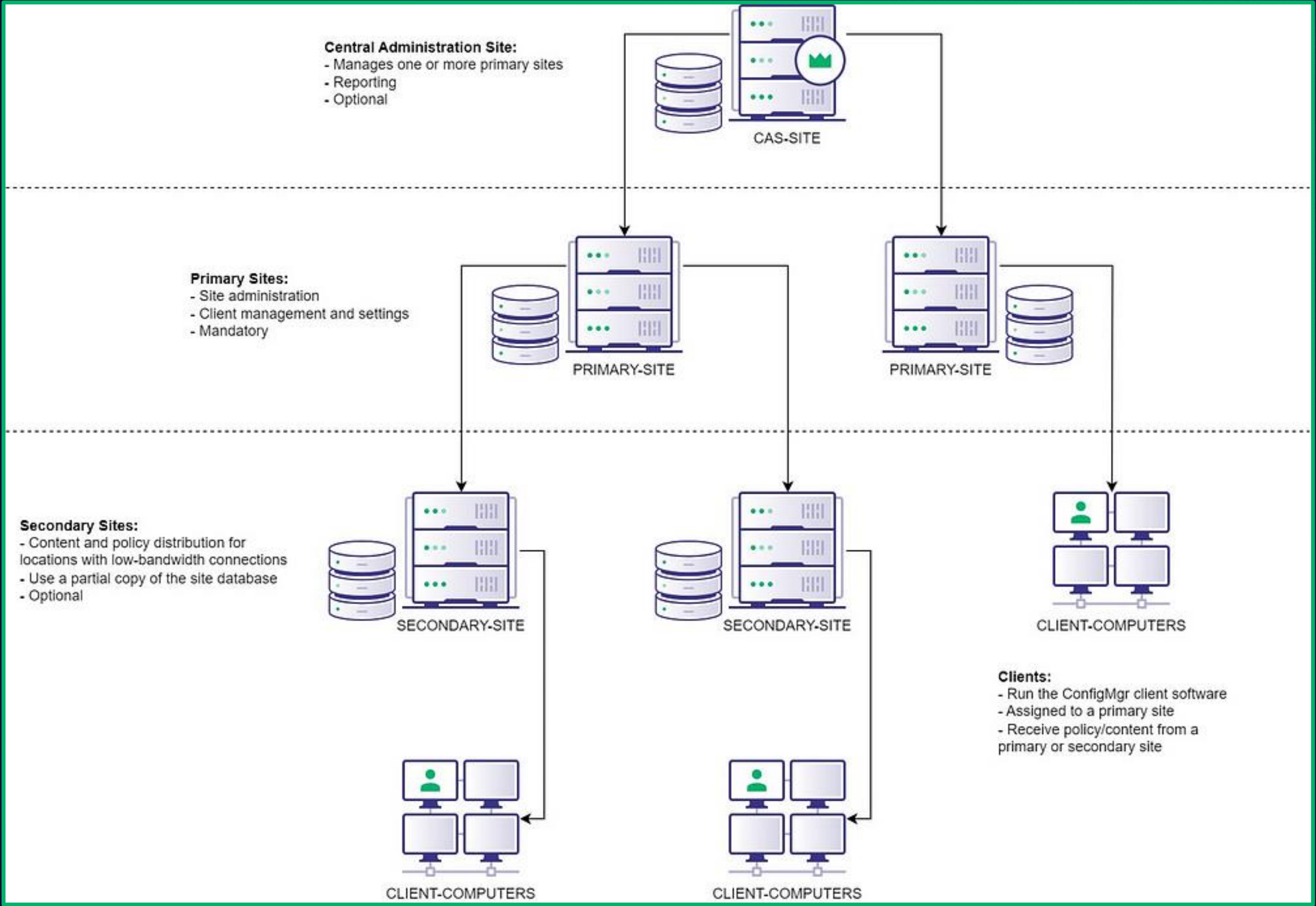
SCCM Primer

The building blocks

- ***Primary Site:*** A site that clients can be assigned to and that is administered using the Configuration Manager console

- ***Primary Site Server:*** The system that handles processing of all client data in a primary site, also referred to as just the “site server”

- ***Site Database Server:*** The server(s) that host the database where client and server data is stored for the primary site



Central Administration Site:
- Manages one or more primary sites
- Reporting
- Optional

Primary Sites:
- Site administration
- Client management and settings
- Mandatory

Secondary Sites:
- Content and policy distribution for locations with low-bandwidth connections
- Use a partial copy of the site database
- Optional

Clients:
- Run the ConfigMgr client software
- Assigned to a primary site
- Receive policy/content from a primary or secondary site

SCCM Primer

The tools

SMS Provider

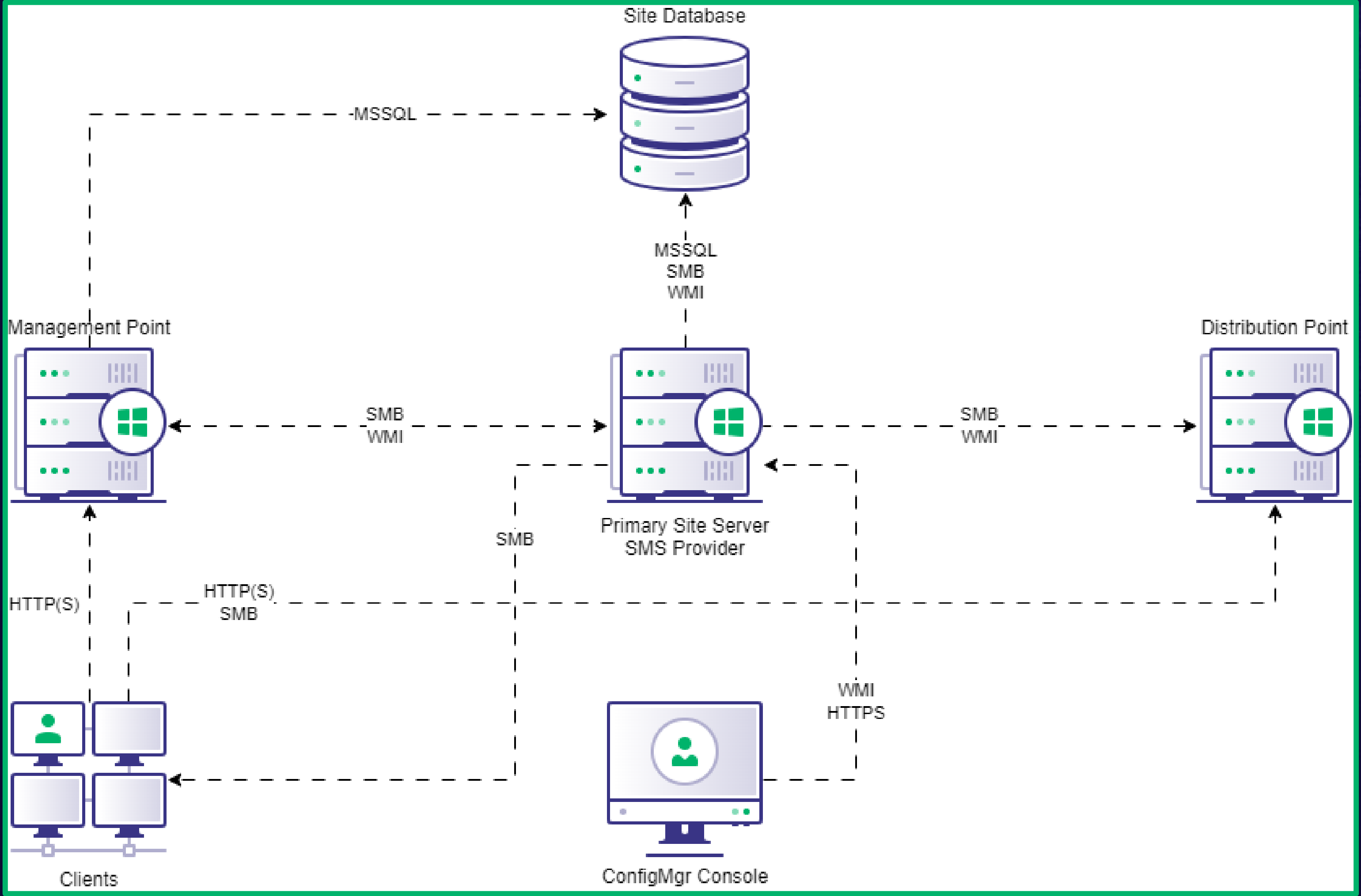
- Interface for the console to interact with the site database via WMI or REST API
- Allows indirect access to the site database
- Installed on the primary site server by default but can also be installed elsewhere

Configuration Manager console

- The software that administrators use to manage a site via an SMS Provider

Site Communication Protocols

The blueprint



SCCM has *many* accounts…

Many accounts are used for many things, most are abusable…

Client Push Installation

- Used to install the client software on computers
- Must be admin on every target computer
- Results in many overprivileged scenarios

Network Access

- Used to retrieve software from DPs
- (Sometimes) optional but still wide-spread
- Stored on clients (DPAPI) and transmitted via computer policy (obfuscated, not encrypted)

Task Sequence

Various accounts:

- Domain join account
- RunAs account
- Network folder connection account
- Collection variables

https://learn.microsoft.com/en-us/mem/configmgr/core/plan-design/hierarchy/accounts

Client Push Installation

How computers become clients

- Used to deploy the SCCM client software remotely from the site server
- Copies installation files to the ADMIN$ share and executes ccmsetup.exe
- Uses configured accounts and the site server domain computer account, which must be a local admin to successfully install or reinstall the client software

Automatic site-wide client push installation

How computers become clients

- The site server automatically tries client push installation on any computers it discovers in the domain or network
- Can be abused by creating fake device records, which cause the site server to connect to the ADMIN$ share at an arbitrary IP address
- Incoming NTLM authentication to the IP address can be relayed to other workstations or SCCM servers (where the site server has admin privileges)

Network Access Accounts

What are they and why do they exist?

- Domain account used to retrieve software from distribution points (DP)
- (Mostly) optional, required for specific actions / scenarios
- Requires minimal privileges: read the network share on the DP

The Worst (and Most Common) Misconfiguration

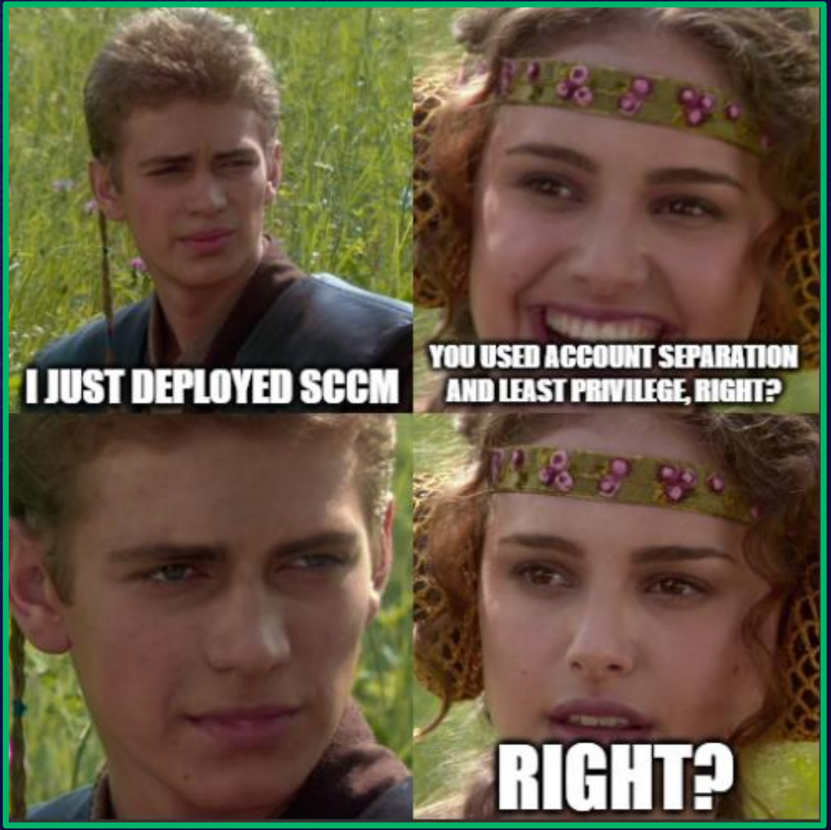
Overprivileged Network Access Accounts

- Included in computer policy sent to all clients
- Policy can be requested with control of a computer object
- Credentials are obfuscated on the wire (no encryption)
- Protected by DPAPI on the client, recoverable as admin

The Worst (and Most Common) Misconfiguration

Overprivileged Network Access Accounts

- Due to so many different accounts, the same god-mode account is often used
- E.g., Domain Admin, SCCM Admin, client push installation (local admin on all clients)
- **We find this *All. The. Time.***
- Creds may persist beyond account rotation



NTLM Relay Primer

Connecting the dots

If an account authenticates (NTLM) to an attacker-controlled machine, the attacker can forward the authentication to another system to access it using the relayed account's privileges

- E.g., to launch a C2 agent, add a user account, modify permissions/configurations, etc.

Several bugs that Microsoft won't fix can be abused to force a computer to authenticate to an arbitrary IP address using NTLM (a.k.a. coercion)

- Printerbug
- PetitPotam

Hierarchy Takeover

Assuming full control of all systems in the SCCM hierarchy

How can attackers take over a hierarchy?

- Obtain the **Full Administrator** role in **ANY** site
- The site database is shared by all sites
- Own one primary site, *own them all*

Hierarchy Takeover

Assuming full control of all systems in the SCCM hierarchy

Why do we care?

- Allows arbitrary *command execution on all clients*
- Allows access to features like CMPivot, Run Script
- Allows ability to impact availability of software

Hierarchy Takeover

Key concepts

- The primary site server's computer account ***must*** be:
    - Local admin on the site database server
    - Sysadmin on the site database
    - Local admin on every other site system role

If we can ***coerce authentication from this account*** and relay the authentication to certain SCCM servers, we ***gain control of SCCM.***

Hierarchy Takeover Attack Paths

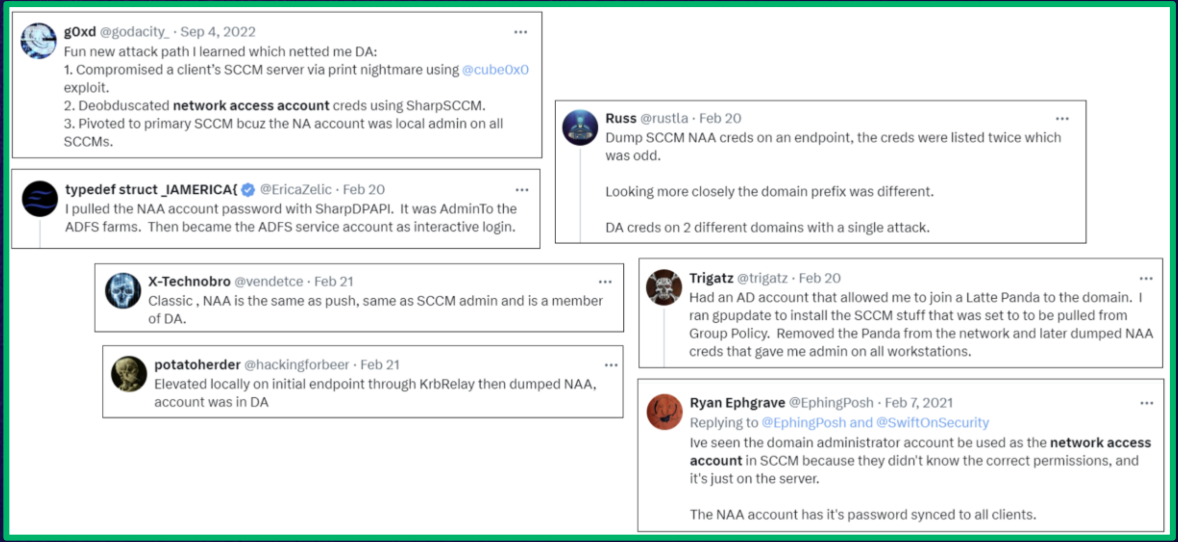
Just a few examples…

- Coerce NTLM from site server or SMS Provider → Relay to MSSQL on remote site DB
  → Grant Full Admin
- Coerce NTLM from site server → Relay to SMB on remote site DB server
  → Compromise/impersonate DBA, Grant Full Admin
- Coerce NTLM from site server → Relay to HTTPS on remote SMS Provider
  → Grant Full Admin
- Coerce NTLM from site server → Relay to SMB on remote SMS Provider server
  → Grant Full Admin via WMI
- ***And many, many more...***

The Perils of Excess: A Tale of Unbridled Access and Forgotten Accounts in SCCM

Overprivileged Network Access Accounts

1. Local admin (LA) on every client found in PXE media on SharePoint
2. Configured with client push installation account (LA everywhere)
3. Configured with DA account
4. LA on every SCCM site server
5. Previous (legacy) NAAs recovered from CIM Repository
6. AdminTo ADFS servers - @EricaZelic
7. Two DA accounts (disparate domains) configured - @rustla



g0xd @godacity_ · Sep 4, 2022

Fun new attack path I learned which netted me DA:
1. Compromised a client's SCCM server via print nightmare using @cube0x0 exploit.
2. Deobduscated **network access account** creds using SharpSCCM.
3. Pivoted to primary SCCM bcuz the NA account was local admin on all SCCMs.

typedef struct _IAMERICA{ @EricaZelic · Feb 20

I pulled the NAA account password with SharpDPAPI. It was AdminTo the ADFS farms. Then became the ADFS service account as interactive login.

Russ @rustla · Feb 20

Dump SCCM NAA creds on an endpoint, the creds were listed twice which was odd.

Looking more closely the domain prefix was different.

DA creds on 2 different domains with a single attack.

X-Technobro @vendetce · Feb 21

Classic , NAA is the same as push, same as SCCM admin and is a member of DA.

Trigatz @trigatz · Feb 20

Had an AD account that allowed me to join a Latte Panda to the domain. I ran gpupdate to install the SCCM stuff that was set to to be pulled from Group Policy. Removed the Panda from the network and later dumped NAA creds that gave me admin on all workstations.

potatoherder @hackingforbeer · Feb 21

Elevated locally on initial endpoint through KrbRelay then dumped NAA, account was in DA

Ryan Ephgrave @EphingPosh · Feb 7, 2021

Replying to @EphingPosh and @SwiftOnSecurity

Ive seen the domain administrator account be used as the **network access account** in SCCM because they didn't know the correct permissions, and it's just on the server.

The NAA account has it's password synced to all clients.

Booting Up to Boss Level: A Domain Controller's Unexpected Journey

When domain join accounts own the domain

- SCCM domain-join accounts (DJA) are used to join new computers to the domain after PXE booting
- Pushed out via task sequence policy
- The account used to join a computer has ownership rights on the computer
- This account joined servers to the domain which were later promoted DCs
- DJA (present on all clients) had ownership rights over DCs

THEY SAID I COULD BE ANYTHING I WANTED
SO I BECAME A DOMAIN CONTROLLER

Why not both?

~~Domain Controllers~~ SCCM Clients

- Sites can be configured to enroll domain controllers as clients
- If we can takeover the site, we can compromise the domain controller through remote execution
- SCCM execution methods:
  - Application deployment
  - Script deployment
  - Package deployment

Crawling Through the Darkness

From Random Connection String to SCCM Admin

1. Connection string found in script on network share
2. Authenticate to the MSSQL DB
3. Crawl three SQL links, ending at the SCCM site DB
4. Dump/Crack DBA credentials
5. Connect to SCCM site DB
6. Grant Full Admin
7. Host C2 payload on public file share
8. Execute beacons on client domain controllers as SYSTEM

NTLM's Wild Ride: From Internal Blocks to External Box

What network restrictions?

1. WebClient installed on SCCM site server
2. VPN config prevented internal NTLM relay
3. Unprivileged -> ADIDNS record for internet box
4. Coerce auth from site server (HTTP)
5. Route to box on internet
6. Relay to LDAP -> Kerberos Resource-based Constrained Delegation

Credit: @filip_dragovic

Love at First Site: The Unyielding Pursuit of a Laptop Long Gone

Client Push Installation to Non-existent Machines

1. Client push installation attempted to authenticate to computers that no longer existed
2. Site server attempted to authenticate to the CISO's old laptop.. Every hour… for two years…
3. Create an ADIDNS record for the old computer name, point it at our machine, capture/relay the authentication

Now that you see what's possible…

Misconfiguration Manager

Helping you manage SCCM attack paths

- Living knowledge-base that aims to ease SCCM attack path management
- Contains foundational, offensive, and defensive write-ups for most known techniques
- Introduces a taxonomy to simplify and demystify concepts (à la Certified Pre-Owned)
- Based on MITRE ATT&CK and inspired by the SaaS Attacks Matrix

https://github.com/pushsecurity/saas-attacks
https://attack.mitre.org/

Misconfiguration Manager

Initial Access	Execution	Persistence	Privilege Escalation	Defense Evasion	Credential Access	Discovery	Lateral Movement	Collection	Command and Control	Exfiltration
PXE Credentials	App Deployment	App Deployment	Relay to Site Server SMB	App Deployment	PXE Credentials	LDAP Enumeration	App Deployment	CMPivot		CMPivot
	Script Deployment	Script Deployment	Relay Client Push Installation	Script Deployment	Policy Request Credentials	SMB Enumeration	Script Deployment			
		ADCS Relay	Relay to DB MSSQL		DPAPI Credentials	HTTP Enumeration	Relay to Site Server SMB			
		LDAP Relay	Relay to DB SMB		Legacy Credentials	CMPivot	Relay Client Push Installation			
			Relay to ADCS				Relay to DB MSSQL			
			Relay to AdminService		Site Database Credentials		Relay to DB SMB			
			Relay CAS to Child				Relay CAS to Child			
			Relay to SMS Provider SMB				Relay to AdminService			
			Relay between HA				Relay to SMS Provider SMB			

https://misconfigurationmanager.com

Misconfiguration Manager Taxonomy

Because "Hierarchy takeover via NTLM coercion and relay to MSSQL on remote site database" does not roll off the tongue…

CRED

1. Retrieve credentials from PXE boot media
2. Deobfuscate computer policy
3. Decrypt via DPAPI
4. Legacy credentials (DPAPI)
5. SC_UserAccount on Site DB

ELEVATE

1. SMB relay on site server
2. Automatic client push NTLM relay

EXEC

1. Application deployment
2. Script deployment

RECON

1. LDAP Enumeration
2. SMB Enumeration
3. HTTP(S) Enumeration
4. CMPivot

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SCCM Hierarchy Takeover Attack Paths

Because "Hierarchy takeover via NTLM coercion and relay to MSSQL on remote site database" does not roll off the tongue…

TAKEOVER-1

NTLM coercion and relay to MSSQL on remote site database

TAKEOVER-2

NTLM coercion and relay to SMB on remote site database

TAKEOVER-3

NTLM coercion and relay to HTTP on ADCS

TAKEOVER-4

NTLM coercion and relay from CAS to origin primary site server

TAKEOVER-5

NTLM coercion and relay to AdminService on remote SMS Provider

TAKEOVER-6

NTLM coercion and relay to SMB on remote SMS Provider

TAKEOVER-7

NTLM coercion and relay to SMB between primary and passive site servers

TAKEOVER-8

NTLM coercion and relay HTTP to LDAP on domain controller

SCCM Mitigation and Detection Guidance

You didn't think we'd leave you hanging, did you?

PREVENT

Currently 23 SCCM and AD configuration changes to mitigate the attack techniques covered

DETECT

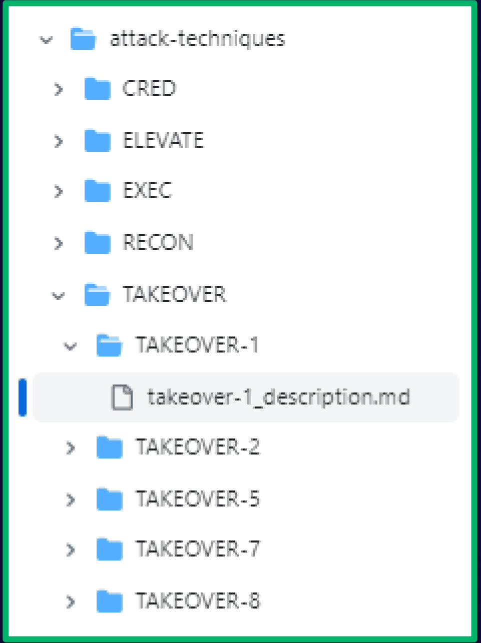
Strategies to detect SCCM attack techniques and attack paths

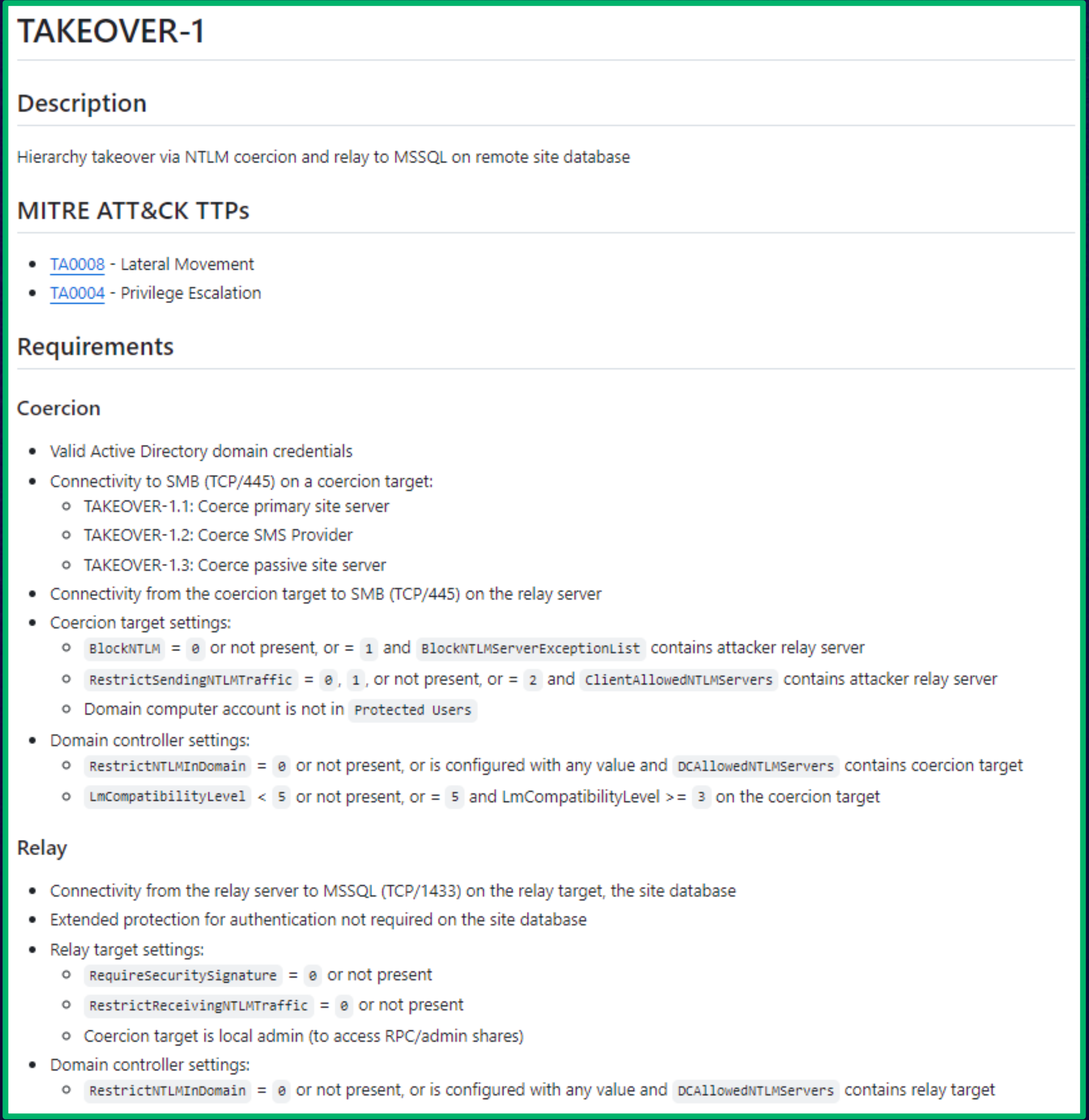
CANARY

Deception techniques that take advantage of SCCM misconfigurations

https://misconfigurationmanager.com

Misconfiguration Manager: A Glimpse





TAKEOVER-1

Description

Hierarchy takeover via NTLM coercion and relay to MSSQL on remote site database

MITRE ATT&CK TTPs

- TA0008 - Lateral Movement
- TA0004 - Privilege Escalation

Requirements

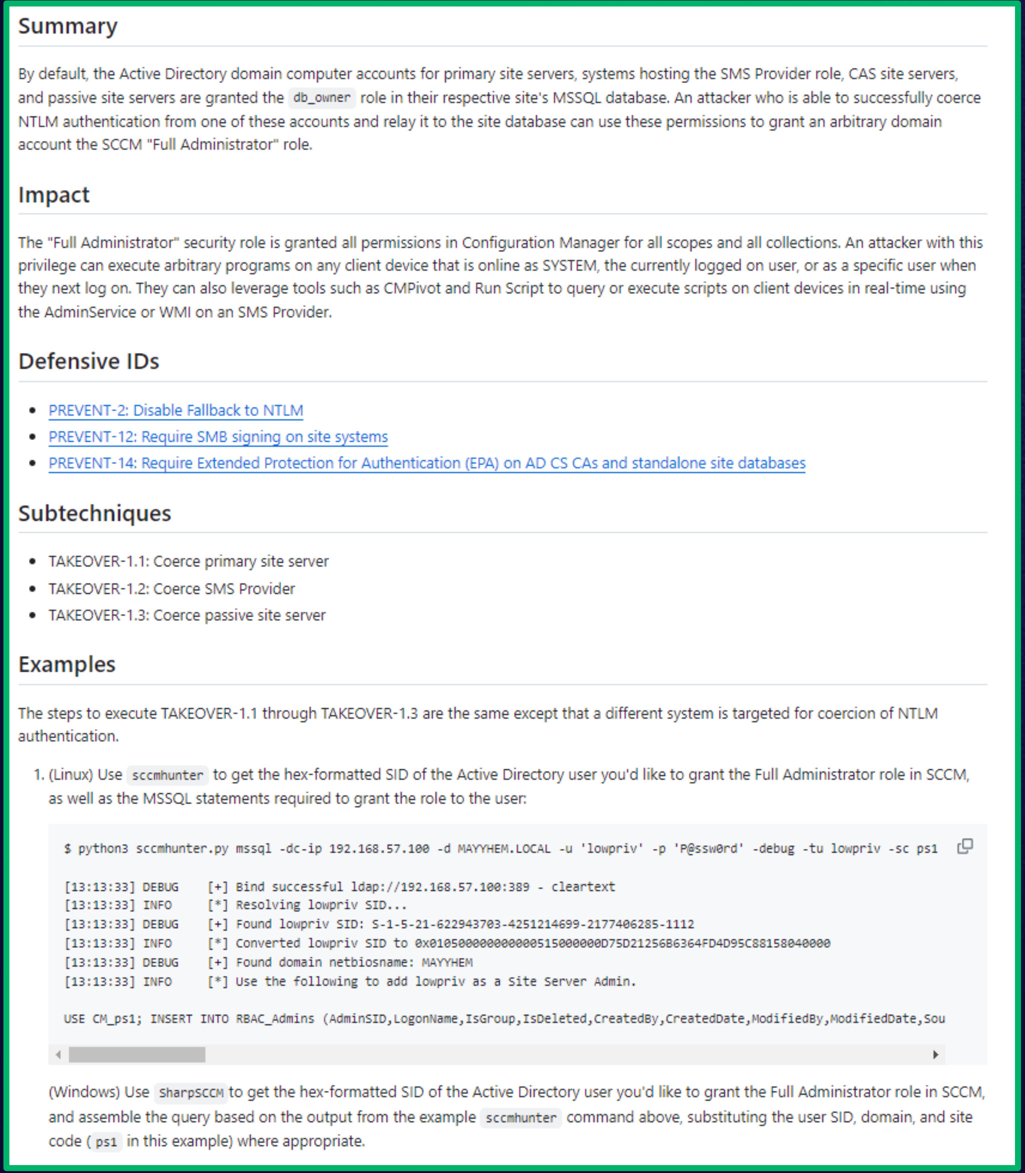
Coercion

- Valid Active Directory domain credentials
- Connectivity to SMB (TCP/445) on a coercion target:
  - TAKEOVER-1.1: Coerce primary site server
  - TAKEOVER-1.2: Coerce SMS Provider
  - TAKEOVER-1.3: Coerce passive site server
- Connectivity from the coercion target to SMB (TCP/445) on the relay server
- Coercion target settings:
  - `BlockNTLM` = `0` or not present, or = `1` and `BlockNTLMServerExceptionList` contains attacker relay server
  - `RestrictSendingNTLMTraffic` = `0`, `1`, or not present, or = `2` and `ClientAllowedNTLMServers` contains attacker relay server
  - Domain computer account is not in `Protected Users`
- Domain controller settings:
  - `RestrictNTLMInDomain` = `0` or not present, or is configured with any value and `DCAllowedNTLMServers` contains coercion target
  - `LmCompatibilityLevel` < `5` or not present, or = `5` and LmCompatibilityLevel >= `3` on the coercion target

Relay

- Connectivity from the relay server to MSSQL (TCP/1433) on the relay target, the site database
- Extended protection for authentication not required on the site database
- Relay target settings:
  - `RequireSecuritySignature` = `0` or not present
  - `RestrictReceivingNTLMTraffic` = `0` or not present
  - Coercion target is local admin (to access RPC/admin shares)
- Domain controller settings:
  - `RestrictNTLMInDomain` = `0` or not present, or is configured with any value and `DCAllowedNTLMServers` contains relay target

Misconfiguration Manager: A Glimpse



Summary

By default, the Active Directory domain computer accounts for primary site servers, systems hosting the SMS Provider role, CAS site servers, and passive site servers are granted the `db_owner` role in their respective site's MSSQL database. An attacker who is able to successfully coerce NTLM authentication from one of these accounts and relay it to the site database can use these permissions to grant an arbitrary domain account the SCCM "Full Administrator" role.

Impact

The "Full Administrator" security role is granted all permissions in Configuration Manager for all scopes and all collections. An attacker with this privilege can execute arbitrary programs on any client device that is online as SYSTEM, the currently logged on user, or as a specific user when they next log on. They can also leverage tools such as CMPivot and Run Script to query or execute scripts on client devices in real-time using the AdminService or WMI on an SMS Provider.

Defensive IDs

- PREVENT-2: Disable Fallback to NTLM
- PREVENT-12: Require SMB signing on site systems
- PREVENT-14: Require Extended Protection for Authentication (EPA) on AD CS CAs and standalone site databases

Subtechniques

- TAKEOVER-1.1: Coerce primary site server
- TAKEOVER-1.2: Coerce SMS Provider
- TAKEOVER-1.3: Coerce passive site server

Examples

The steps to execute TAKEOVER-1.1 through TAKEOVER-1.3 are the same except that a different system is targeted for coercion of NTLM authentication.

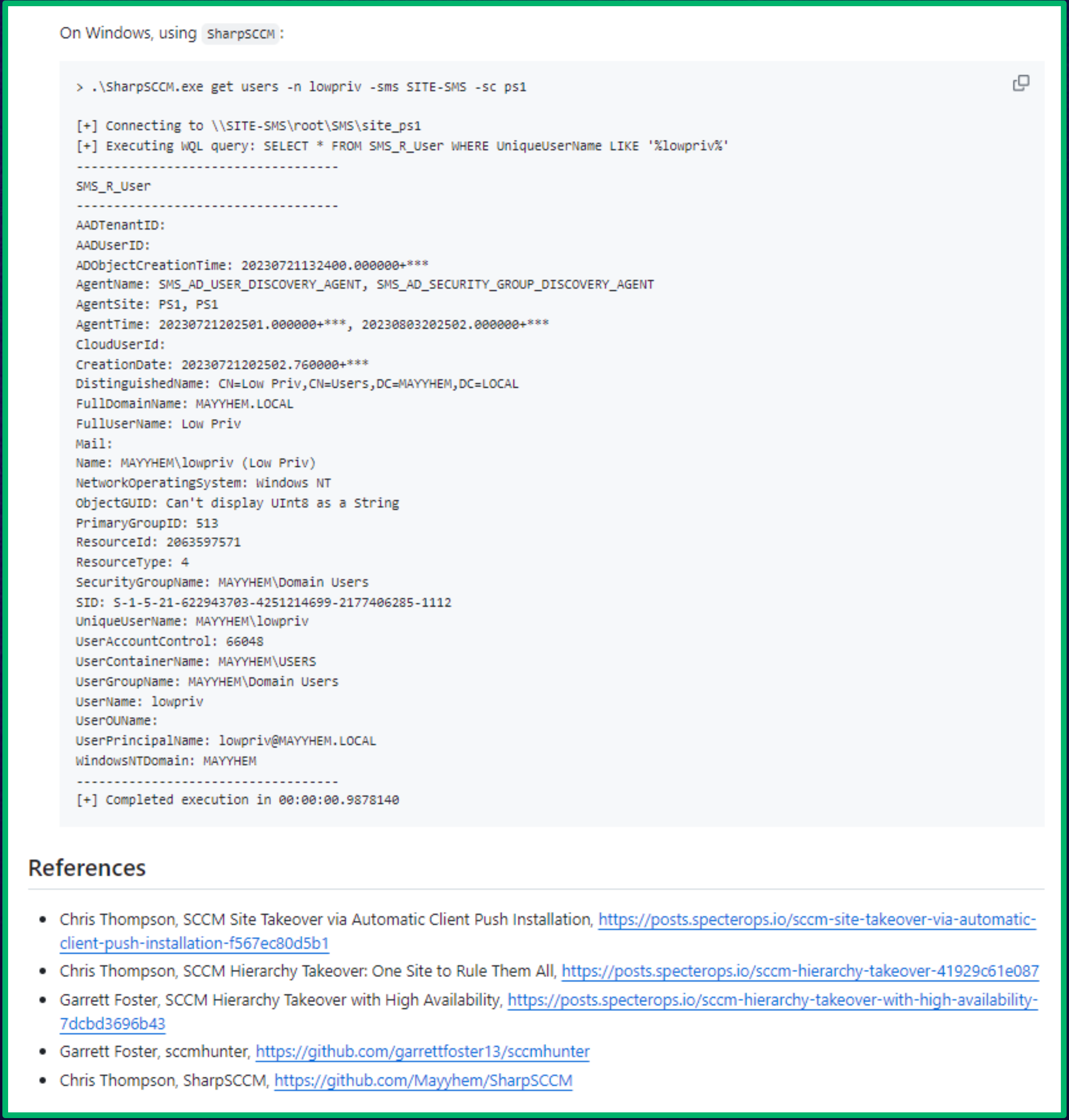
1. (Linux) Use `sccmhunter` to get the hex-formatted SID of the Active Directory user you'd like to grant the Full Administrator role in SCCM, as well as the MSSQL statements required to grant the role to the user:

```
$ python3 sccmhunter.py mssql -dc-ip 192.168.57.100 -d MAYYHEM.LOCAL -u 'lowpriv' -p 'P@ssw0rd' -debug -tu lowpriv -sc ps1

[13:13:33] DEBUG    [+] Bind successful ldap://192.168.57.100:389 - cleartext
[13:13:33] INFO     [*] Resolving lowpriv SID...
[13:13:33] DEBUG    [+] Found lowpriv SID: S-1-5-21-622943703-4251214699-2177406285-1112
[13:13:33] INFO     [*] Converted lowpriv SID to 0x010500000000000515000000D75D21256B6364FD4D95C88158040000
[13:13:33] DEBUG    [+] Found domain netbiosname: MAYYHEM
[13:13:33] INFO     [*] Use the following to add lowpriv as a Site Server Admin.

USE CM_ps1; INSERT INTO RBAC_Admins (AdminSID,LogonName,IsGroup,IsDeleted,CreatedBy,CreatedDate,ModifiedBy,ModifiedDate,Sou
```

(Windows) Use `SharpSCCM` to get the hex-formatted SID of the Active Directory user you'd like to grant the Full Administrator role in SCCM, and assemble the query based on the output from the example `sccmhunter` command above, substituting the user SID, domain, and site code (`ps1` in this example) where appropriate.



On Windows, using `SharpSCCM` :

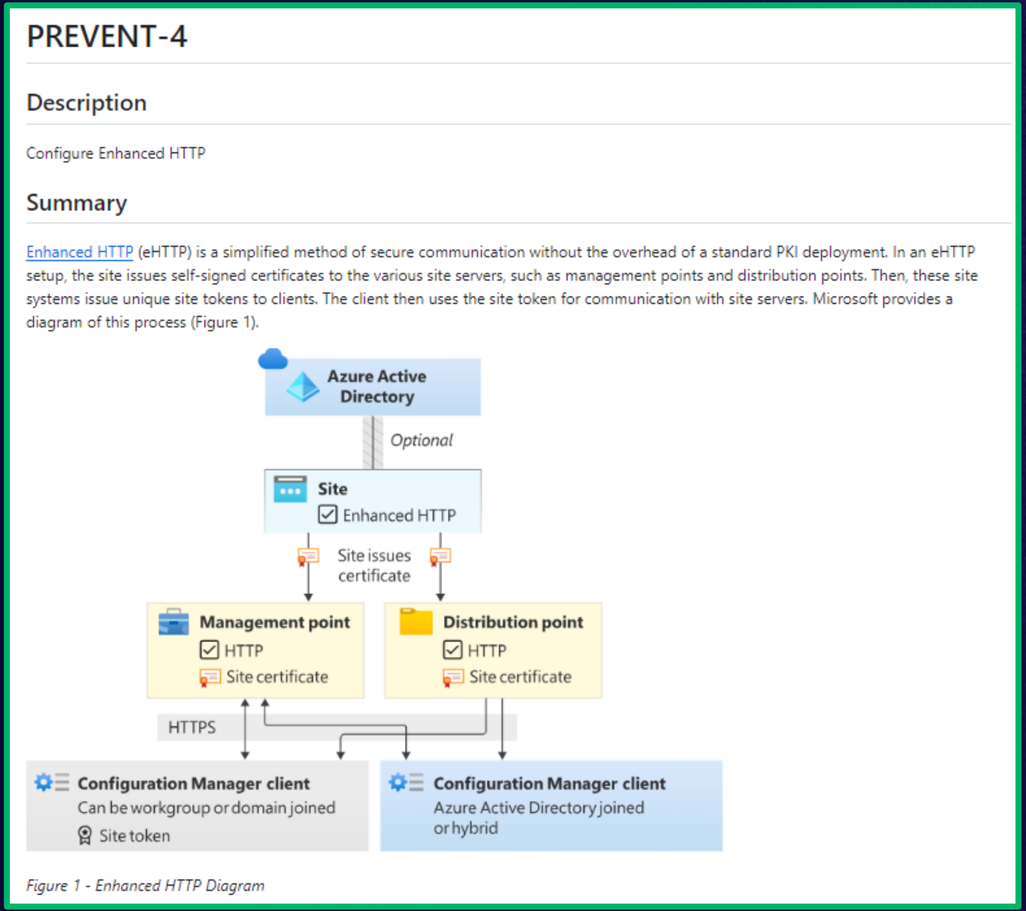
```
> .\SharpSCCM.exe get users -n lowpriv -sms SITE-SMS -sc ps1

[+] Connecting to \\SITE-SMS\root\SMS\site_ps1
[+] Executing WQL query: SELECT * FROM SMS_R_User WHERE UniqueUserName LIKE '%lowpriv%'
-----------------------------------
SMS_R_User
-----------------------------------
AADTenantID:
AADUserID:
ADObjectCreationTime: 20230721132400.000000+***
AgentName: SMS_AD_USER_DISCOVERY_AGENT, SMS_AD_SECURITY_GROUP_DISCOVERY_AGENT
AgentSite: PS1, PS1
AgentTime: 20230721202501.000000+***, 20230803202502.000000+***
CloudUserId:
CreationDate: 20230721202502.760000+***
DistinguishedName: CN=Low Priv,CN=Users,DC=MAYYHEM,DC=LOCAL
FullDomainName: MAYYHEM.LOCAL
FullUserName: Low Priv
Mail:
Name: MAYYHEM\lowpriv (Low Priv)
NetworkOperatingSystem: Windows NT
ObjectGUID: Can't display UInt8 as a String
PrimaryGroupID: 513
ResourceId: 2063597571
ResourceType: 4
SecurityGroupName: MAYYHEM\Domain Users
SID: S-1-5-21-622943703-4251214699-2177406285-1112
UniqueUserName: MAYYHEM\lowpriv
UserAccountControl: 66048
UserContainerName: MAYYHEM\USERS
UserGroupName: MAYYHEM\Domain Users
UserName: lowpriv
UserOUName:
UserPrincipalName: lowpriv@MAYYHEM.LOCAL
WindowsNTDomain: MAYYHEM
-----------------------------------
[+] Completed execution in 00:00:00.9878140
```

References

- Chris Thompson, SCCM Site Takeover via Automatic Client Push Installation, https://posts.specterops.io/sccm-site-takeover-via-automatic-client-push-installation-f567ec80d5b1
- Chris Thompson, SCCM Hierarchy Takeover: One Site to Rule Them All, https://posts.specterops.io/sccm-hierarchy-takeover-41929c61e087
- Garrett Foster, SCCM Hierarchy Takeover with High Availability, https://posts.specterops.io/sccm-hierarchy-takeover-with-high-availability-7dcbd3696b43
- Garrett Foster, sccmhunter, https://github.com/garrettfoster13/sccmhunter
- Chris Thompson, SharpSCCM, https://github.com/Mayyhem/SharpSCCM

Misconfiguration Manager: A Glimpse



PREVENT-4

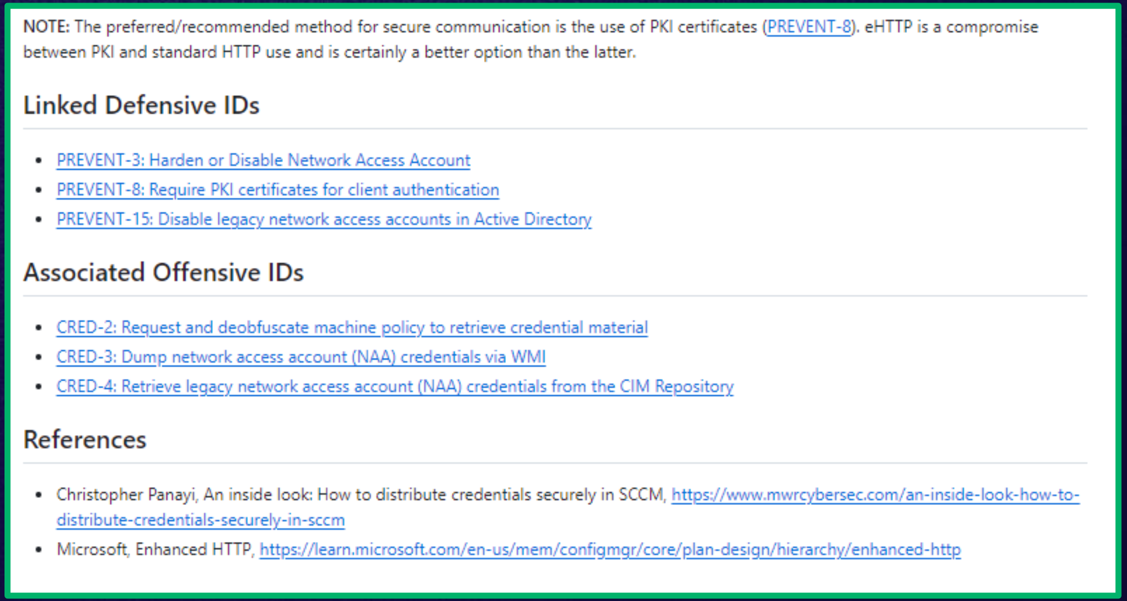
Description

Configure Enhanced HTTP

Summary

Enhanced HTTP (eHTTP) is a simplified method of secure communication without the overhead of a standard PKI deployment. In an eHTTP setup, the site issues self-signed certificates to the various site servers, such as management points and distribution points. Then, these site systems issue unique site tokens to clients. The client then uses the site token for communication with site servers. Microsoft provides a diagram of this process (Figure 1).

Figure 1 - Enhanced HTTP Diagram



NOTE: The preferred/recommended method for secure communication is the use of PKI certificates (PREVENT-8). eHTTP is a compromise between PKI and standard HTTP use and is certainly a better option than the latter.

Linked Defensive IDs

- PREVENT-3: Harden or Disable Network Access Account
- PREVENT-8: Require PKI certificates for client authentication
- PREVENT-15: Disable legacy network access accounts in Active Directory

Associated Offensive IDs

- CRED-2: Request and deobfuscate machine policy to retrieve credential material
- CRED-3: Dump network access account (NAA) credentials via WMI
- CRED-4: Retrieve legacy network access account (NAA) credentials from the CIM Repository

References

- Christopher Panayi, An inside look: How to distribute credentials securely in SCCM, https://www.mwrcybersec.com/an-inside-look-how-to-distribute-credentials-securely-in-sccm
- Microsoft, Enhanced HTTP, https://learn.microsoft.com/en-us/mem/configmgr/core/plan-design/hierarchy/enhanced-http

Misconfiguration Manager

Helping you manage SCCM attack paths

- There is SO much more work to be done:
  - Offensive research
  - Detection strategies
  - Configuration guidance
- We want to hear your stories and ideas!
- Pull requests welcome and encouraged
- Collaborate with us in #sccm on BloodHound Slack
  - Invite link: https://ghst.ly/BHSlack

https://misconfigurationmanager.com

SCCM's flaws exposed,

Missteps in the code's weave shown,

Security frays.

Chris Thompson | @_Mayyhem

Duane Michael | @subat0mik

Garrett Foster | @garrfoster