Brute-Force Attack Incident Response:

A Playbook, Investigation, Report and Guide

Prepared for: SOC Analysts, Managers and Recruiters

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1.0. Executive Summary:

This document provides a detailed technical analysis of a simulated brute-force attack conducted on an SSH service as part of a penetration testing exercise. The goal of this project was to evaluate system resilience, identify security vulnerabilities, and develop robust mitigation strategies to fortify defenses against real-world cyber threats.

This report follows the NIST Cybersecurity Framework, detailing each phase of incident response: ***Identification, Protection, Detection, Response,*** and ***Recovery***. The insights gained from this simulation serve not only to improve the security posture of the tested system but also to act as a playbook for security professionals responding to brute-force attacks in real-world environments. The report offers practical defensive strategies, logging enhancements, and response techniques that can be adapted across various IT infrastructures.

By simulating an attack, security weaknesses were identified in authentication mechanisms, logging policies, and access control configurations. The countermeasures outlined here emphasise proactive security measures, real-time detection strategies, and best practices for threat mitigation.

Tools & Technologies Used:

- **Kali Linux 2024.4** – Attacker Environment
- **Hydra** – Brute-force attack tool
- **Nmap** – Network scanning tool
- **Splunk** – Security Information and Event Management (SIEM) platform
- **Linux SSH Service** – Targeted system component

2.0. The Attack:

2.1. Simulating a Brute-Force Attack using Hydra:

1. Identifying the Target

- local IP address of the host as 127.0.0.1
- SSH Service: Initially disabled; manually enabled for controlled testing.

```
┌──(kali㉿kali)-[~]
└─$ ifconfig
eth0: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500
        ether 00:0c:29:36:38:36  txqueuelen 1000  (Ethernet)
        RX packets 589  bytes 37648 (36.7 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 82810  bytes 92514693 (88.2 MiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 82810  bytes 92514693 (88.2 MiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0


┌──(kali㉿kali)-[~]
└─$
```

Check if SSH is running (it was disabled) and starting it:

```
┌──(kali㉿kali)-[~]
└─$ sudo systemctl status ssh
○ ssh.service - OpenBSD Secure Shell server
     Loaded: loaded (/usr/lib/systemd/system/ssh.service; disabled; preset: disabled)
     Active: inactive (dead)
       Docs: man:sshd(8)
             man:sshd_config(5)

┌──(kali㉿kali)-[~]
└─$ sudo systemctl start ssh

┌──(kali㉿kali)-[~]
└─$
```

Executing the Attack:

```
┌──(kali㉿kali)-[~]
└─$ hydra -t 1 -W 5 -l kali -P /tmp/rockyou_limited.txt ssh://127.0.0.1 -V > hydra_attack.log
```

Monitoring the attack using *tail -f hydra_attack.log*:

```
┌──(kali㉿kali)-[~]
└─$ tail -f hydra_attack.log
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "123456789" - 3 of 500 [child 2] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "password" - 4 of 500 [child 3] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "iloveyou" - 5 of 500 [child 2] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "princess" - 6 of 500 [child 0] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "1234567" - 7 of 500 [child 1] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "rockyou" - 8 of 500 [child 3] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "12345678" - 9 of 500 [child 2] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "abc123" - 10 of 500 [child 0] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "nicole" - 11 of 500 [child 1] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "daniel" - 12 of 500 [child 3] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "babygirl" - 13 of 500 [child 2] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "monkey" - 14 of 500 [child 0] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "lovely" - 15 of 500 [child 1] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "jessica" - 16 of 500 [child 3] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "654321" - 17 of 500 [child 2] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "michael" - 18 of 500 [child 0] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "ashley" - 19 of 500 [child 1] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "qwerty" - 20 of 500 [child 3] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "111111" - 21 of 500 [child 2] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "iloveu" - 22 of 500 [child 1] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "000000" - 23 of 500 [child 0] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "michelle" - 24 of 500 [child 3] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "tigger" - 25 of 500 [child 2] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "sunshine" - 26 of 500 [child 1] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "chocolate" - 27 of 500 [child 0] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "password1" - 28 of 500 [child 3] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "soccer" - 29 of 500 [child 2] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "anthony" - 30 of 500 [child 1] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "friends" - 31 of 500 [child 0] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "butterfly" - 32 of 500 [child 3] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "purple" - 33 of 500 [child 2] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "angel" - 34 of 500 [child 1] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "jordan" - 35 of 500 [child 0] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "liverpool" - 36 of 500 [child 3] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "justin" - 37 of 500 [child 2] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "loveme" - 38 of 500 [child 1] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "fuckyou" - 39 of 500 [child 0] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "123123" - 40 of 500 [child 3] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "football" - 41 of 500 [child 2] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "secret" - 42 of 500 [child 1] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "andrea" - 43 of 500 [child 0] (0/0)
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "carlos" - 44 of 500 [child 3] (0/0)
```

- Password successfully cracked on 500th attempt:

```
[ATTEMPT] target 127.0.0.1 - login "kali" - pass "kali" - 500 of 500 [child 0] (0/0)
```

2.2. Identifying the Security Breach:

- System logs recorded multiple failed authentication attempts, indicating brute-force activity.
- Hydra's output log confirmed a successful password compromise:

```
[22][ssh] host: 127.0.0.1   login: kali   password: kali
1 of 1 target successfully completed, 1 valid password found
Hydra (https://github.com/vanhauser-thc/thc-hydra) finished at 2025-03-07 08:29:30
```

2.3. Immediate Protection Measures:

Locked the compromised user account ‘kali’, to prevent further unauthorised access:

```
┌──(kali㉿kali)-[~]
└─$ sudo passwd -l kali
[sudo] password for kali:
passwd: password changed.
```

- Restarted **SSH service** to terminate all active sessions:

```
┌──(kali㉿kali)-[~]
└─$ sudo systemctl restart ssh
```

2.4. Detecting the Successful Password Crack:

In order to begin the detection phase, the log from the brute-force attack was saved to *hydra_attack.log*. For official documentation, output was saved to Documents for further use:

```
┌──(kali㉿kali)-[~]
└─$ cp hydra_attack.log ~/Documents/hydra_attack_report.txt
```

- Running the scan to find open ports (after the attack has been launched):

```
┌──(kali㉿kali)-[~]
└─$ nmap -sV 127.0.0.1
Starting Nmap 7.94SVN ( https://nmap.org ) at 2025-03-07 08:51 EST
Nmap scan report for localhost (127.0.0.1)
Host is up (0.0000030s latency).
Not shown: 999 closed tcp ports (reset)
PORT   STATE SERVICE VERSION
22/tcp open  ssh     OpenSSH 9.9p1 Debian 3 (protocol 2.0)
Service Info: OS: Linux; CPE: cpe:/o:linux:linux_kernel

Service detection performed. Please report any incorrect results at https://nmap.org/submit/ .
Nmap done: 1 IP address (1 host up) scanned in 0.38 seconds
```

- Running (a more detailed scan):

```
┌──(kali㉿kali)-[~]
└─$ nmap -A -T4 127.0.0.1
Starting Nmap 7.94SVN ( https://nmap.org ) at 2025-03-07 08:52 EST
Nmap scan report for localhost (127.0.0.1)
Host is up (0.000064s latency).
Not shown: 999 closed tcp ports (reset)
PORT   STATE SERVICE VERSION
22/tcp open  ssh     OpenSSH 9.9p1 Debian 3 (protocol 2.0)
| ssh-hostkey:
|   256 93:a6:6d:63:27:70:94:04:c5:f5:da:60:2c:5e:a5:e8 (ECDSA)
|_  256 90:3e:d5:e4:64:58:fe:f0:64:f7:42:22:45:f8:38:e7 (ED25519)
Device type: general purpose
Running: Linux 2.6.X
OS CPE: cpe:/o:linux:linux_kernel:2.6.32
OS details: Linux 2.6.32
Network Distance: 0 hops
Service Info: OS: Linux; CPE: cpe:/o:linux:linux_kernel

OS and Service detection performed. Please report any incorrect results at https://nmap.org/submit/ .
Nmap done: 1 IP address (1 host up) scanned in 6.63 seconds
```

- Saving scan results to a file for further analysis:

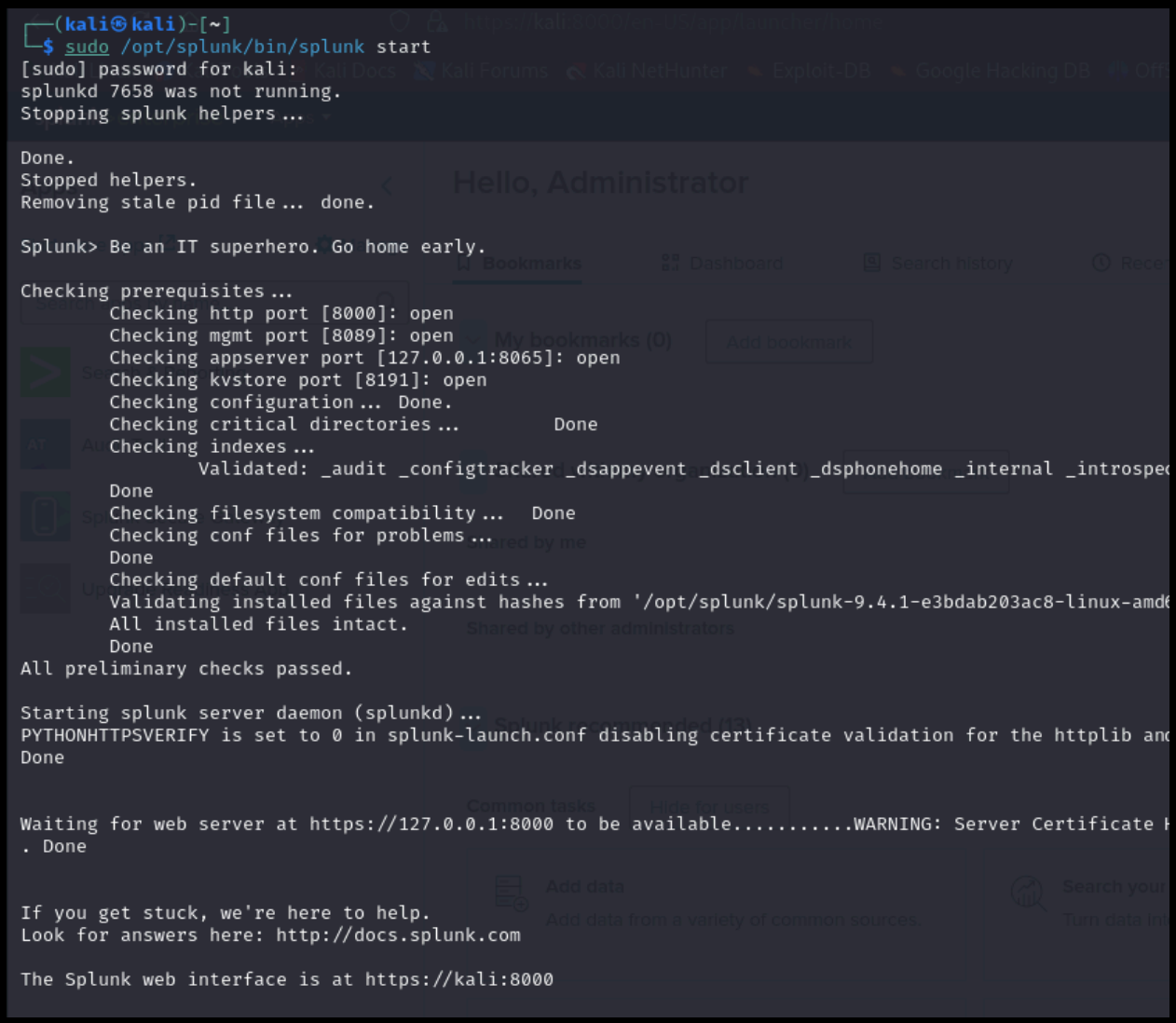
```
┌──(kali㉿kali)-[~]
└─$ nmap -A -T4 127.0.0.1 -oN ~/Documents/nmap_scan_results.txt
Starting Nmap 7.94SVN ( https://nmap.org ) at 2025-03-07 08:54 EST
Nmap scan report for localhost (127.0.0.1)
Host is up (0.000078s latency).
Not shown: 999 closed tcp ports (reset)
PORT   STATE SERVICE VERSION
22/tcp open  ssh     OpenSSH 9.9p1 Debian 3 (protocol 2.0)
| ssh-hostkey:
|   256 93:a6:6d:63:27:70:94:04:c5:f5:da:60:2c:5e:a5:e8 (ECDSA)
|_  256 90:3e:d5:e4:64:58:fe:f0:64:f7:42:22:45:f8:38:e7 (ED25519)
Device type: general purpose
Running: Linux 2.6.X
OS CPE: cpe:/o:linux:linux_kernel:2.6.32
OS details: Linux 2.6.32
Network Distance: 0 hops
Service Info: OS: Linux; CPE: cpe:/o:linux:linux_kernel

OS and Service detection performed. Please report any incorrect results at https://nmap.org/submit/ .
Nmap done: 1 IP address (1 host up) scanned in 2.10 seconds
```

3.0. The Response:

3.1. Investigating the Attack with Splunk:

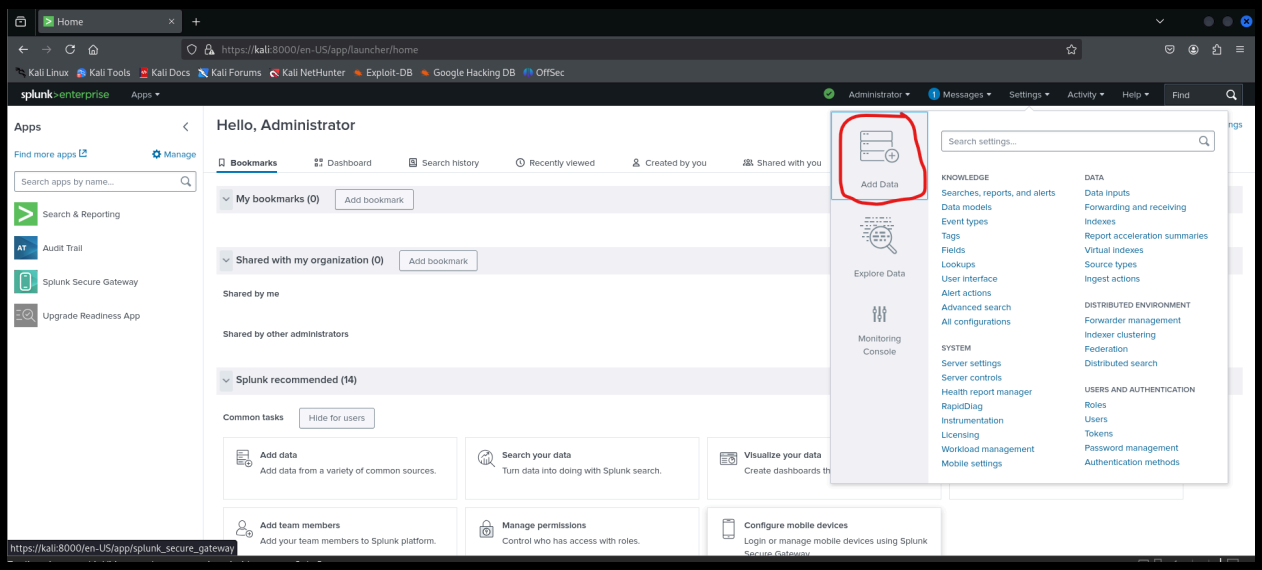
3.1.1 Open Splunk:

Begin responding to this cybersecurity risk, by opening [Splunk], a Security Information and Event Management (SIEM) solution:



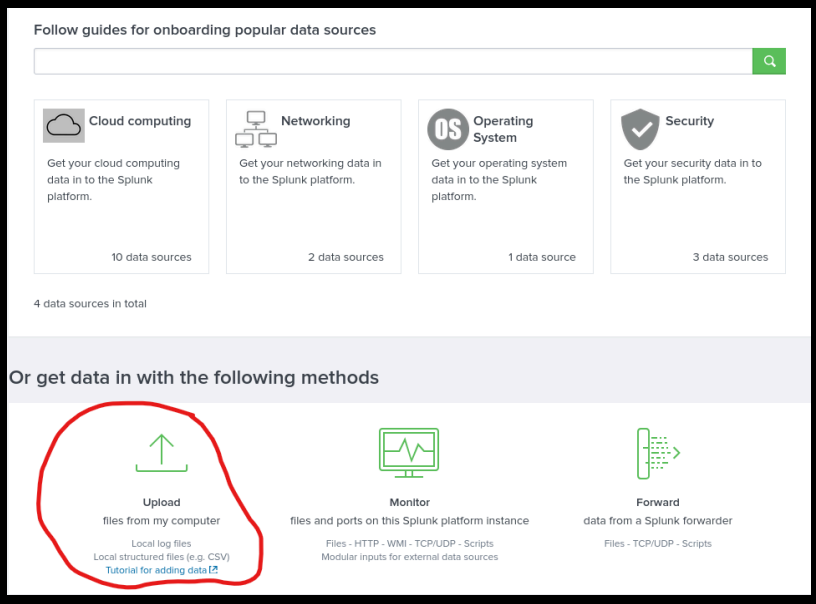
3.1.2 Upload Scan Results onto Splunk:

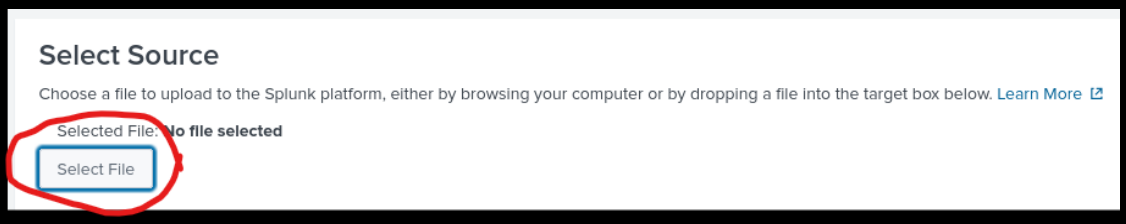
3.1.2.1 Add Data under Settings:



3.1.2.2 Upload from Local Files:

Both scan results and the Hydra attack log was saved under */home/kali/Documents*



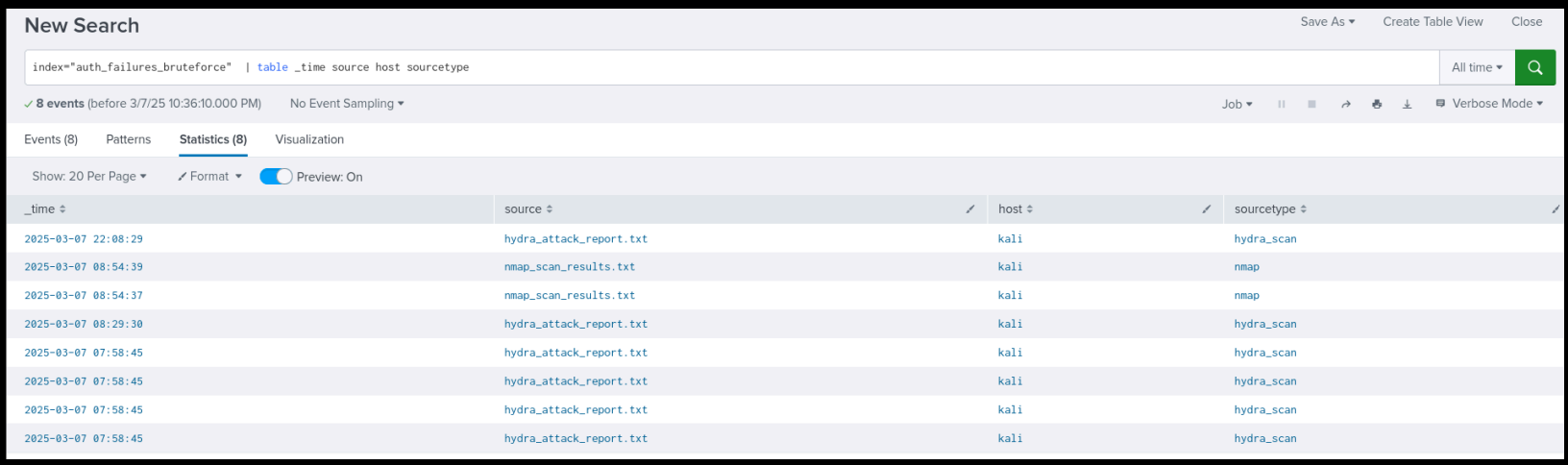


For the purpose of the investigation, the source type of the file *nmap_scan_results.txt* was set to *nmap*, and the source type of the file *hydra_attack_report.txt* was set to *hydra_scan*.

The index for both files is *auth_failures_bruteforce.*

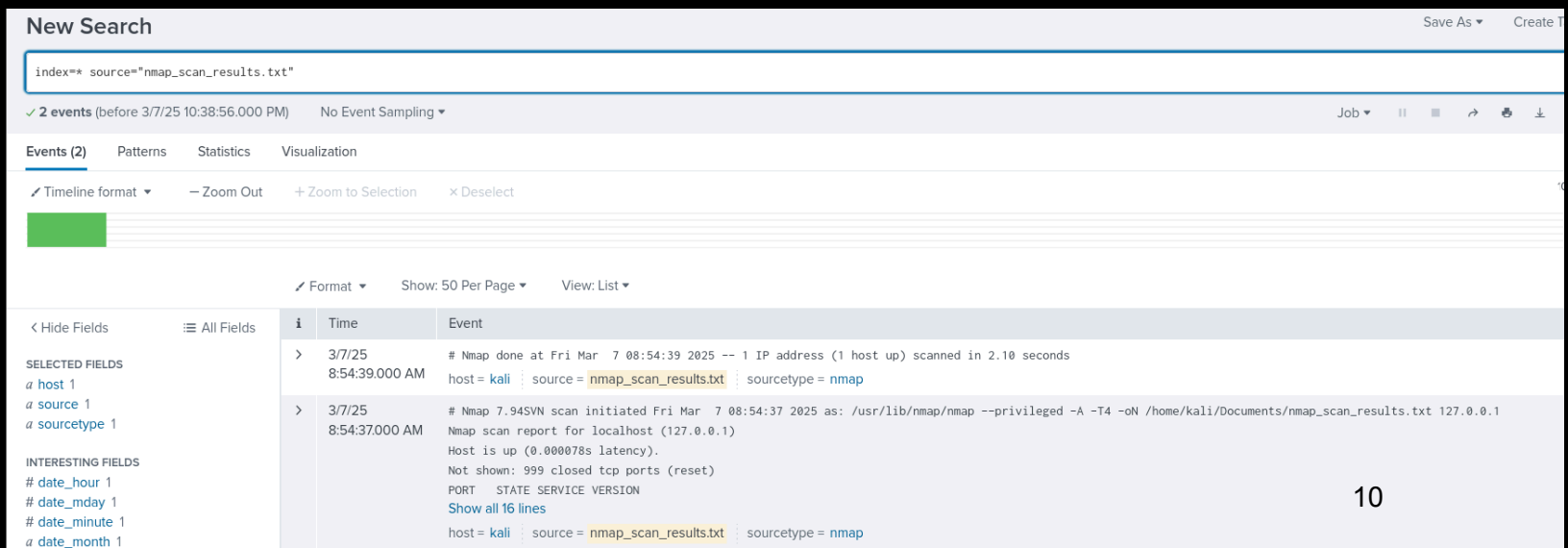
3.2 Use Splunk's Filtered Log Searches:

Query used to extract key logs: *index=* | table _time source host sourcetype*



3.2.1 Searching for Nmap Scan Results:

Next, the results from the nmap scan run after the brute-force attack were filtered using *index=* source="nmap_scan_results.txt"*



3.3 Analysis Results:

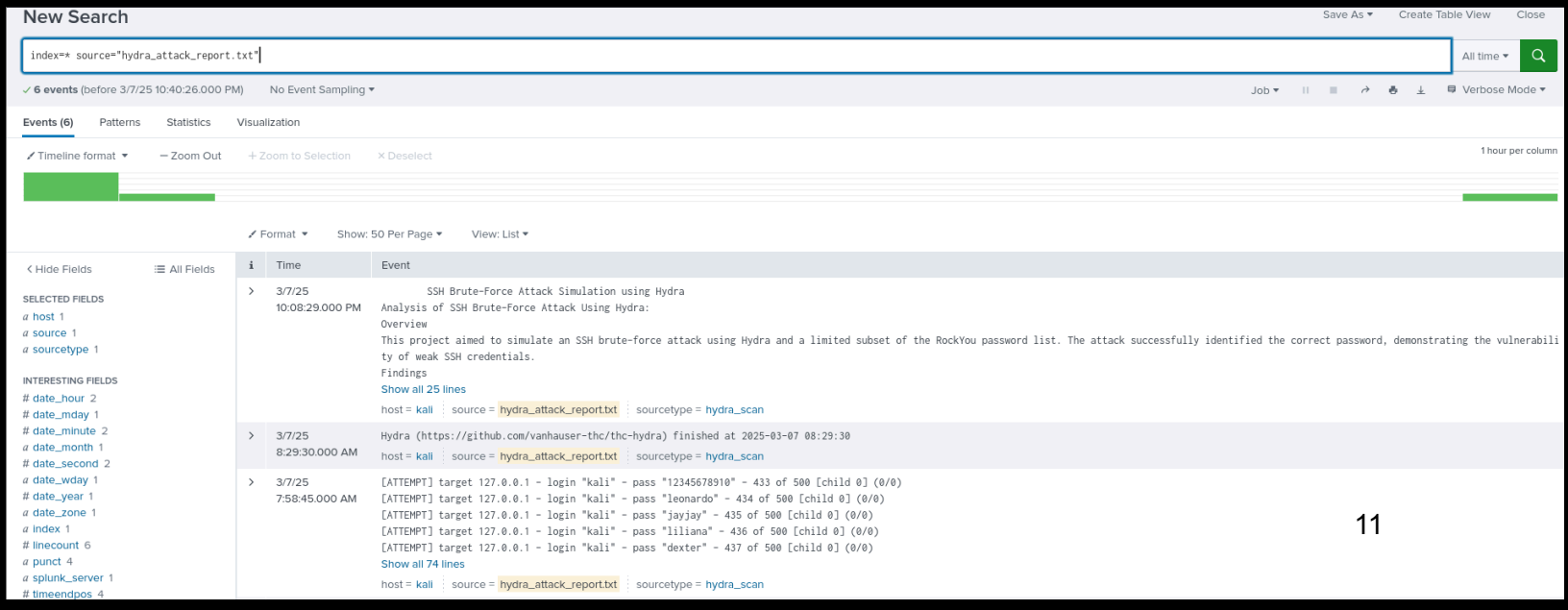
- port (22) was open at the time of attack
- Hydra successfully brute-forced the password at 7:58:45 AM on March 7, 2025.
- Real-time alerts were absent, exposing a logging and alerting deficiency.

```
Nmap scan report for localhost (127.0.0.1)
Host is up (0.000078s latency).
Not shown: 999 closed tcp ports (reset)
PORT   STATE SERVICE VERSION
22/tcp open  ssh     OpenSSH 9.9p1 Debian 3 (protocol 2.0)
| ssh-hostkey:
|   256 93:a6:6d:63:27:70:94:04:c5:f5:da:60:2c:5e:a5:e8 (ECDSA)
|_  256 90:3e:d5:e4:64:58:fe:f0:64:f7:42:22:45:f8:38:e7 (ED25519)
```

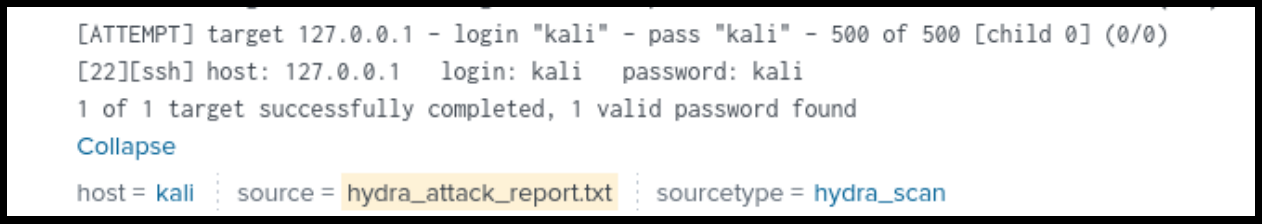
3.4 Attack Pattern Analysis:

- **Attack Rate**: 16.23 attempts per minute
- **Insufficient Logging**: System did not log permission-denied messages, reducing visibility of brute-force attempts.
- **Detection Gap**: No automatic SIEM alerting was in place to flag the attack

Logs generated from the hydra brute-force attack:

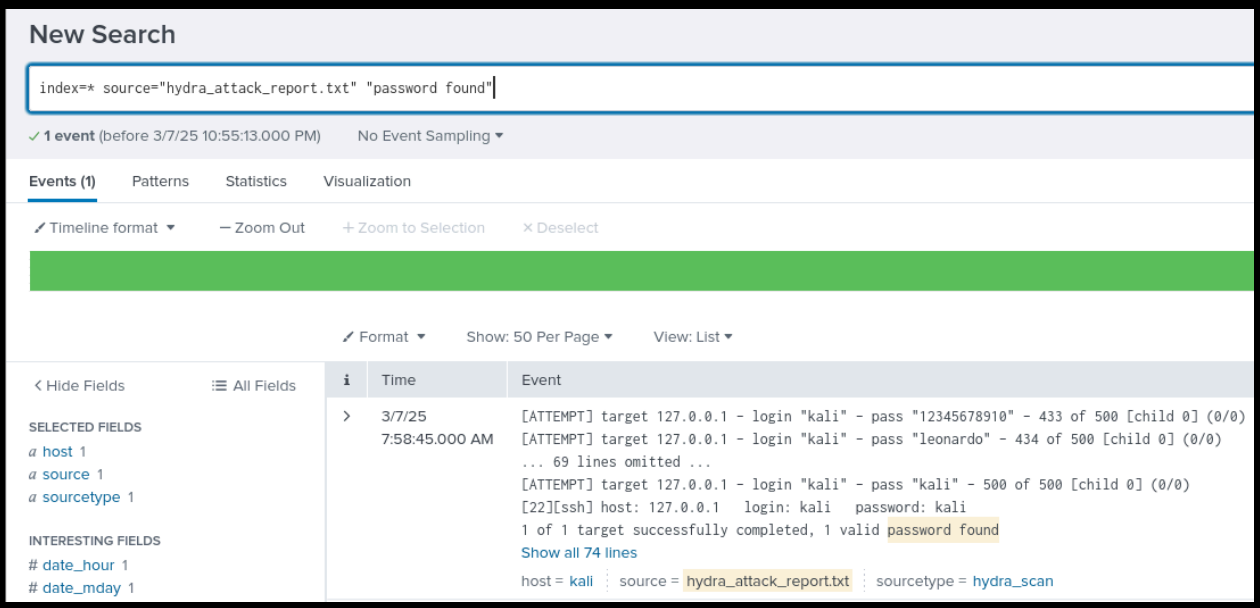


Row 3 provided context regarding the successful password-crack. On the 7th of March 2025, at 7:58:45 AM, the machine's brute-force attack was successful. Upon detailed inspection, the correct password "kali" was guessed, on the 500th attempt. The status message a few lines above suggested the machine was attempting passwords at a rate of 16.23 tries per minute.



Unsuccessful login attempts did not provide any "permission denied" or "unsuccessful" message. Although the system printed a message confirming the successful guess of the password "kali", once the attempt was made.

This can be noted when filtering for *index=* source="hydra_attack_report.txt" "password found"*

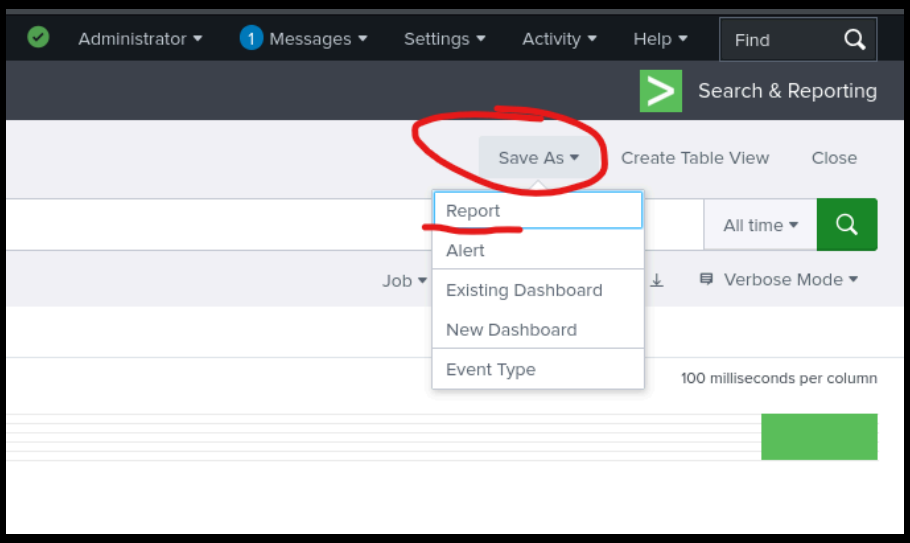


4.0. The Recovery:

4.1 Constructing Reports:

For cybersecurity, it is best practice to save all Splunk query results as reports for later use. Because cyber threats continue to grow in sophistication and effectiveness, cyber incident reporting is not only important but also necessary for other organizations to learn from and prevent making the same mistakes *(Upguard, 2025)*. Splunk has a feature to generate reports for each search.

4.1.1 Export Each Search Result by Clicking "Save As → Report":

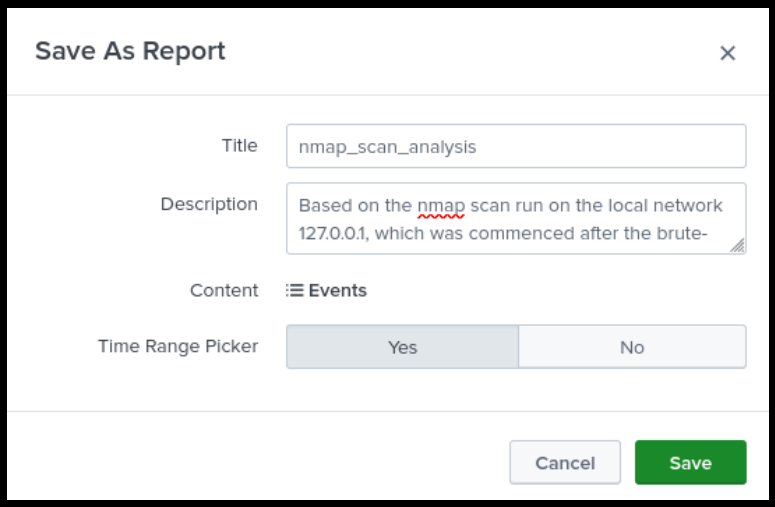


4.1.2 Exporting Nmap Scan Log:

To stay organised, it is essential that reports are named relevant to the incident, so they can be accessed quickly. In order to maintain confidentiality, reports should be stored in locations where only privileged users have access. Good practice would be to include an administrative password before accessing reports. To maintain integrity, reports should only be made once the user can confirm Splunk has correctly parsed all log info, with correct file names and times.1 Backups of all reports should also be made, to maintain availability of the information in case of a system malfunction or data theft, which would result in file loss.

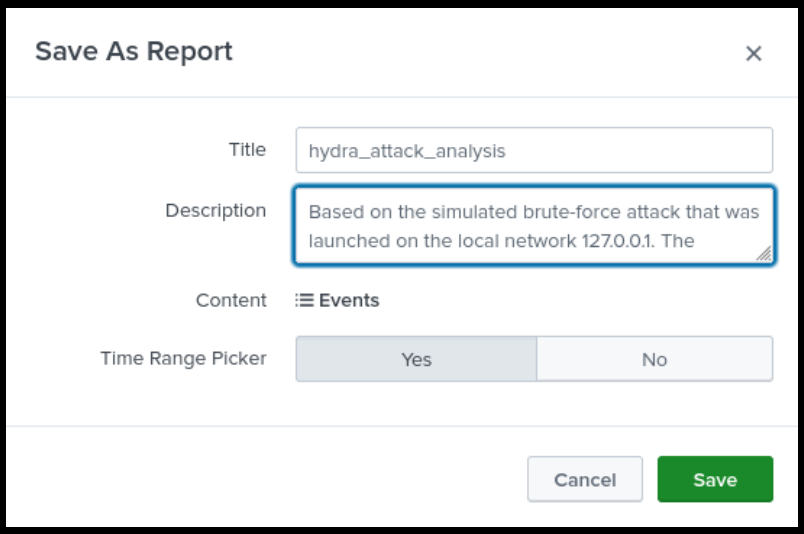
4.1.2 Exporting Nmap Scan Log:

The report for the *nmap_scan_results.txt* has been named *nmap_scan_analysis*.

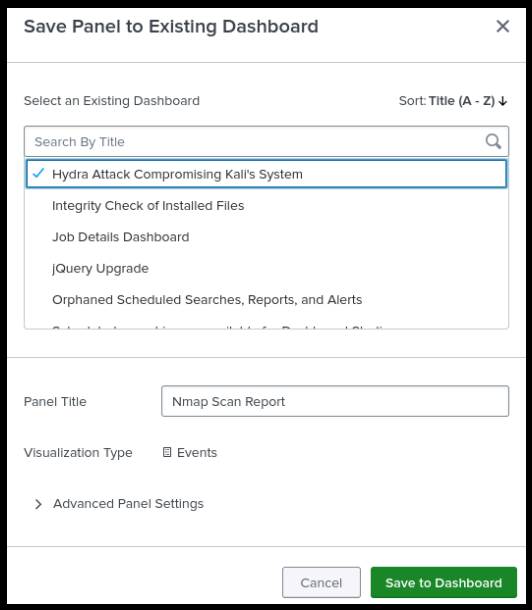


4.1.2 Exporting Hydra Attack Log:

The report for the *hydra_attack_report.txt* has been named *hydra_attack_analysis.*



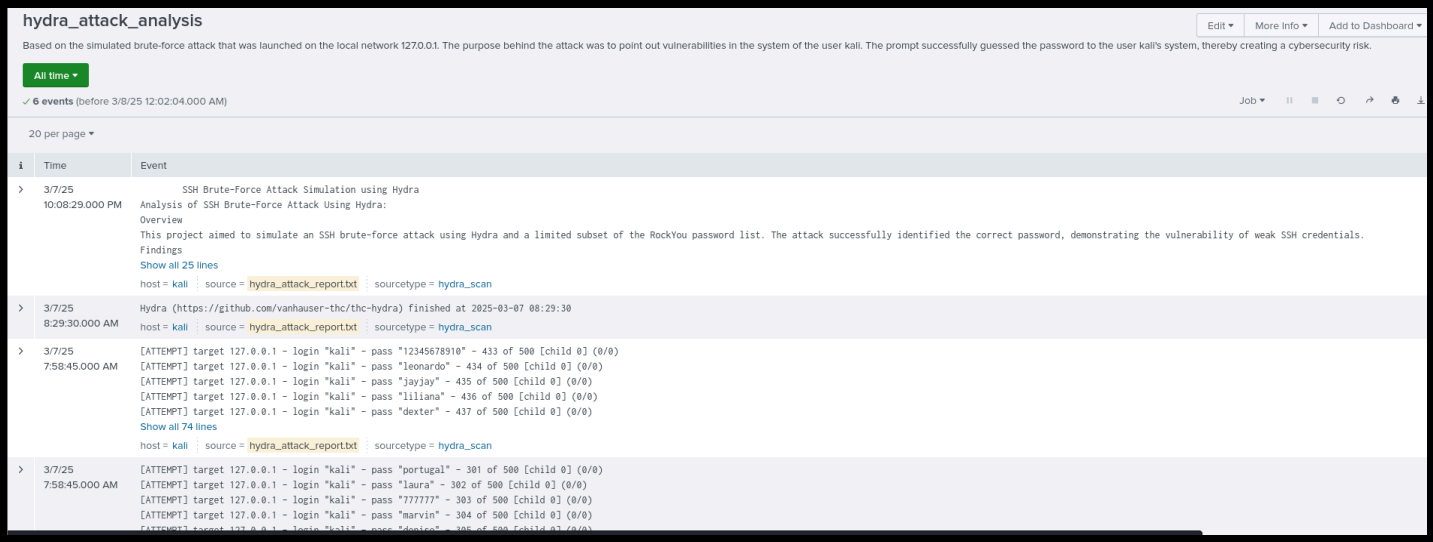
Another method to stay organised on various cybersecurity incidents, is by creating dashboards on Splunk. Dashboards offer an interactive, visual and easy-to-understand medium of presenting a cybersecurity incident.



4.2.0 Log Reports

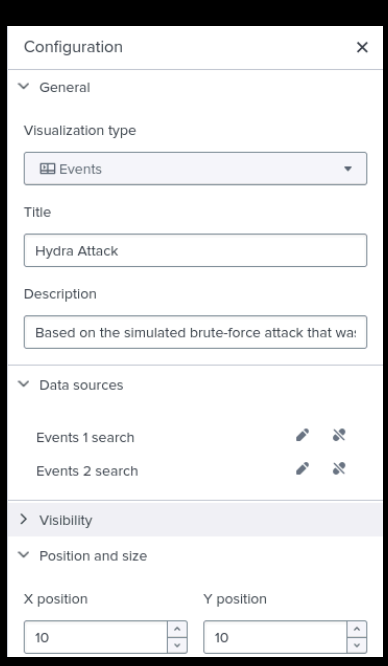
4.2.1 Nmap Scan Report:

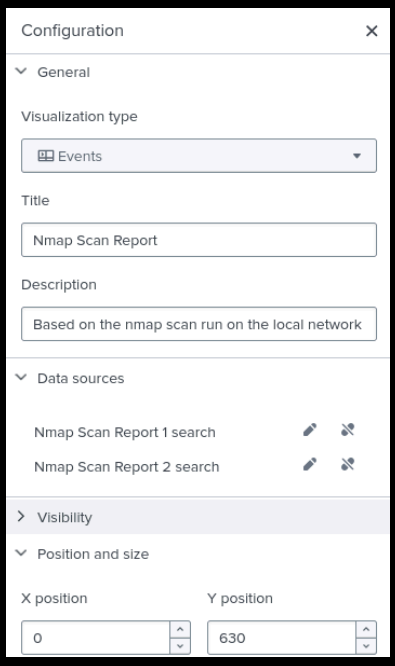
4.2.2 Hydra Scan Report:



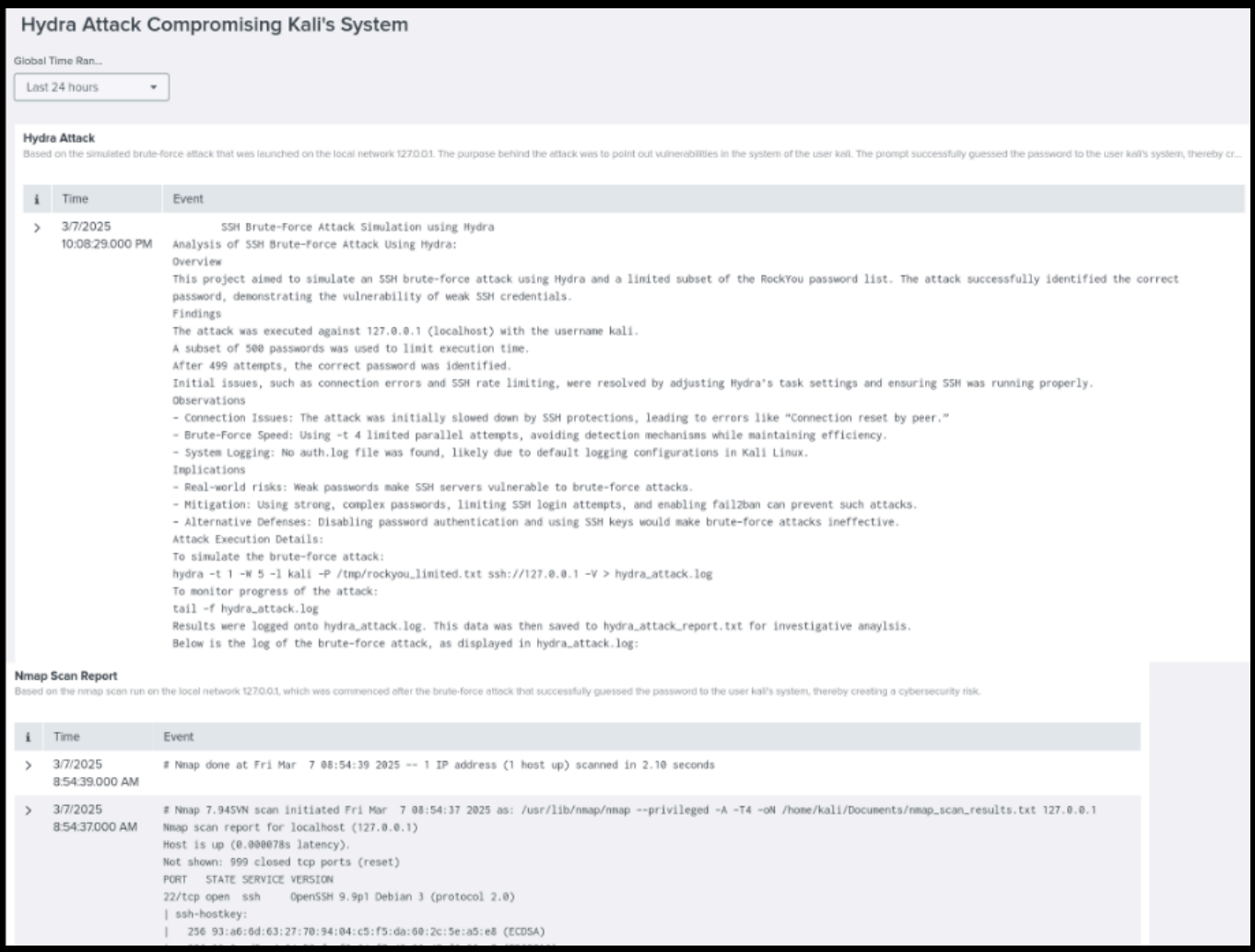
4.2.3 Editing Dashboards:

Edit each report added to the dashboard under Configuration, as each report requires:





4.2.4 Final Dashboard:



Link to [pdf](#)version of Dashboard

4.3 Security Enhancements and Remediation

An effective recovery process for this attack would involve a process that minimises attack vectors that the simulated brute-force attack pointed out. These include:

- Open ports allowing unauthorised access
- Weak passwords
- Lack of limits on login attempts

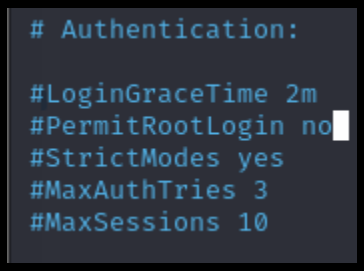
To address this, SSH was disabled for unnecessary users, and maximum authentication attempts was reduced to 3. Refer below for remediation steps:

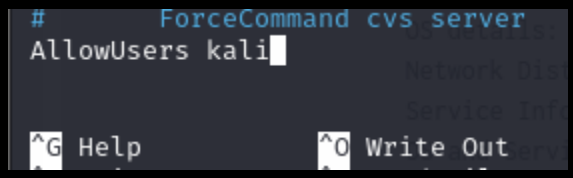
1. Hardening SSH Configuration:

- Modified SSH settings to enforce stricter authentication controls

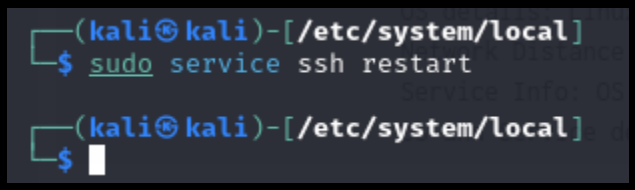
Using *sudo nano /etc/ssh/sshd_config*, the text file was edited as such:

#MaxAuthTries was set to 3 (Limit login attempts to 3)
#PermitRootLogin no (Disable root login)
AllowUsers kali (Restrict SSH access to other unauthorised users)





- Restart SSH service to apply changes:



Be sure to verify user access, by logging in with the user's credentials. This is to ensure access is allowed. Also attempt to log in with any other user account, in order to verify that SSH access is denied.

Further Recommendations:

4.3.1 Firewall Configuration (UFW & iptables):

Firewalls - It is worth considering configuring the system's firewall (e.g., ufw or iptables) to further restrict access.

sudo ufw allow from 192.168.1.100 to any port 22

sudo iptables -A INPUT -p tcp --dport 22 -m limit --limit 3/min -j ACCEPT

4.3.2 Monitoring and Logging Enhancements:

- Enabled real-time alerts for failed login attempts:

sudo journalctl -u ssh --since "1 hour ago"

- Configured Splunk to detect brute-force patterns and generate automated alerts.

4.3.3 Future Security Considerations:

- *Periodic penetration testing* to identify potential vulnerabilities.
- *Multi-Factor Authentication* (MFA) enforcement for SSH access.
- *Automated intrusion detection systems* (IDS) and *honeypots* for real-time attack mitigation.
  Public Key Authentication - For further security measures, consider using public key authentication and disabling password-based logins by setting *PasswordAuthentication no* in the *sshd_config file*.

4.4 Recovery Summary

The recovery process aims to revive the compromised system and affected files and people from a security breach/incident. By following the above process and recommendations, the system's security risk of unauthorised access, which can be exploited by an attacker using the guessed password, can be mitigated. It is essential for the system to uphold practices that support its security posture, in order to maintain standards that uphold the CIA triad.

5.0. Conclusion:

This in-depth analysis of a brute-force attack revealed significant security risks associated with exposed SSH services, weak authentication policies, and insufficient logging mechanisms. The countermeasures implemented focused on hardening access control, improving detection capabilities, and enforcing industry-standard security best practices.

Moving forward, proactive security monitoring, continuous threat modeling, and automated defense mechanisms will be key to mitigating brute-force and other authentication-based cyber threats. This report serves as a practical guide for cybersecurity teams in formulating structured incident response strategies.

6.0. References:

UpGuard. (n.d.). *Cyber incident reporting: Best practices for protecting your organization.* UpGuard. https://www.upguard.com/blog/cyber-incident-reporting

National Institute of Standards and Technology. (n.d.). *The Cybersecurity Framework*. U.S. Department of Commerce. https://www.nist.gov/cyberframework

7.0 Appendix:

7.1 Files

Splunk Dashboard:

Hydra Attack Compromising Kali's System_2025-03-07 at 11.52.52-0500_Splunk

Splunk Reports:

Hydra_attack_analysis-2025-03-08
nmap_scan_analysis-2025-03-08

Log Files:

Hydra_attack_report.txt
nmap_scan_results.txt

7.2 Further Notes:

There were issues with time parsing for the *hydra_attack_report.txt*. This would compromise the integrity of any analysis I would make using Splunk. To ensure Splunk correctly recognised the times from the logs, I was required to enter Linux's command line, and manually change the time format for this file through the *props.conf* file. This file, and its corresponding directory, were not available on my local Kali Linux virtual machine, meaning I had to create them under the correct parent directories. I also didn't initially have write permissions to files in these directories. I fixed this by giving myself write permissions, using *sudo chmod u+w $SPLUNK_HOME/etc/system/local/props.conf*

After editing the *props.conf* file using *sudo nano*

$SPLUNK_HOME/etc/system/local/props.conf, I restarted Splunk and confirmed that the times were correctly parsed on the relevant file.