Sri Lanka Institute of Information Technology

BSc Honors in Information Technology

Specializing in Cyber Security

IE3022- Applied Information Assurance

Penetration Testing Report

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Introduction

The more companies rely on technology to operate, the more they put themselves at the mercy of various cybersecurity threats. Cybercriminals continually work out how they can perfect a particular method of attack to exploit any weakness in systems and networks. In this regard, organizations such as Mayo Industries should be proactive regarding cybersecurity through measures that identify security gaps and nip them in the bud before they are utilized. This is where the importance of penetration testing comes into play.

Penetration testing also known as ethical hacking, is a methodical process of replicating attacks on an organization's network, applications and systems. The objective here is to identify weaknesses that could be exploited by real world adversaries. It helps firms to understand their vulnerabilities better measure the strength of their existing security controls, and enhance their general defensive capabilities by simulating these attacks. Unlike vulnerability scans penetration testing consists of a combination of both automated tools and manual techniques carried out by well seasoned security professionals. This way ensures deep analysis is achieved on some of the potential attack vectors uncovering complex vulnerabilities that would have otherwise been overlooked.

This penetration test was sought by Mayo Industries to strengthen its cybersecurity posture reduce the risk of data breaches and ultimately consolidate compliance with industry standards. The recommendations provided herein will help the organization build a more resilient security framework that can withstand current and emerging threats. Fundamentally this exercise is part and parcel of a broader strategy to ensure the reputation, continuity of operations, and customer confidence of Mayo Industries with digital assets protection against cyber threats.

Assumption

For the purpose of this penetration test, I assume that Mayo Industries is represented by a simulated environment based on the Metasploit 2 vulnerable framework.

Team roles and responsibilities

For the effective performance of the Pen test, Rus Group was organized into three teams Red Team, Blue Team and Purple Team each with sharply defined roles and responsibilities.

Red Team: The red team was responsible for conducting the offensive security operations. This team simulated both internal and external attacks against the systems of Mayo Industries to expose weaknesses in them. This can include reconnaissance, vulnerability scanning and exploitation attempts. The Red Team had to test the defenses of Mayo Industries with real tactics techniques and procedures used by adversaries in the wild.

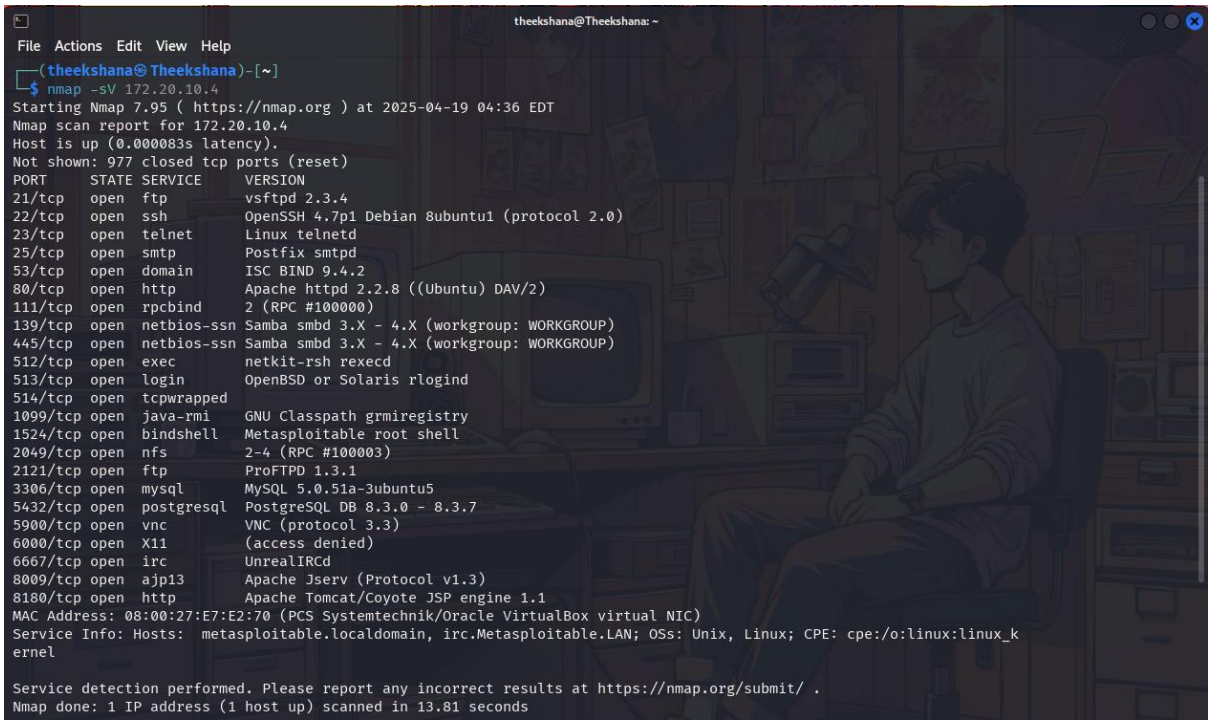
Blue Team: This team was the defender. Their task was to perform analysis on the Red Team's attack activity and determine how well Mayo Industries could respond to the threats posed by the attacks. The Blue Team took part in log analysis system alert monitoring network traffic analysis activities to detect and then respond against the intrusions. They would do this so as to find detection gaps and give recommendations for improvement of the organization's defensive posture.

Purple Team: This team acted as a connection or bridge between the Red and the Blue Teams. They were to analyze the efficiency of the whole penetration testing process. This included assessing the Blue Team's defense strategies the attack techniques by the Red Team and ensuring that the two teams shared their insights. The recommendations provided by the Purple Team assisted in improving the effectiveness of the defensive measures put in place and also improved communication between the attack and the defense teams.

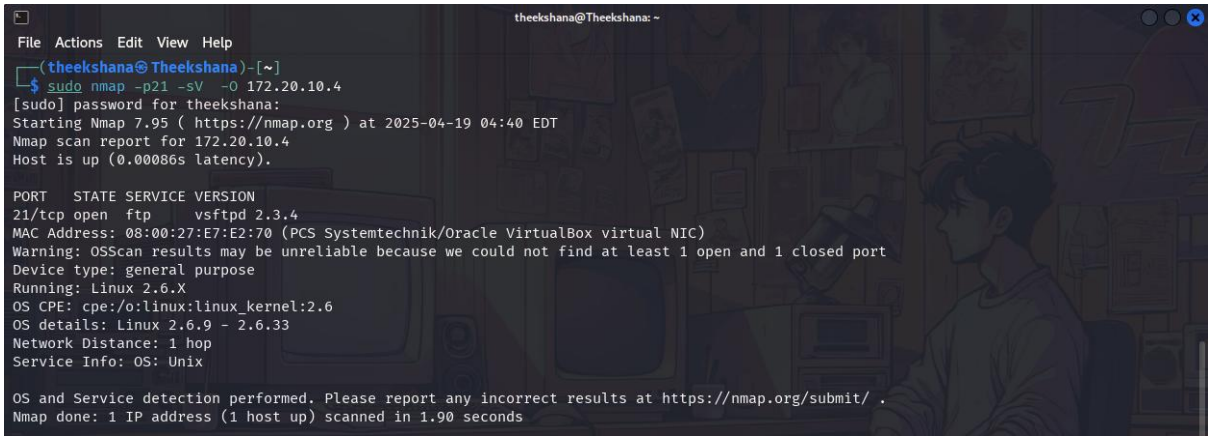
Red Team's Vulnerability Assessment

Scan the identify if a host is online

Use the -sV command option detects the version of the service running all on open ports in system.

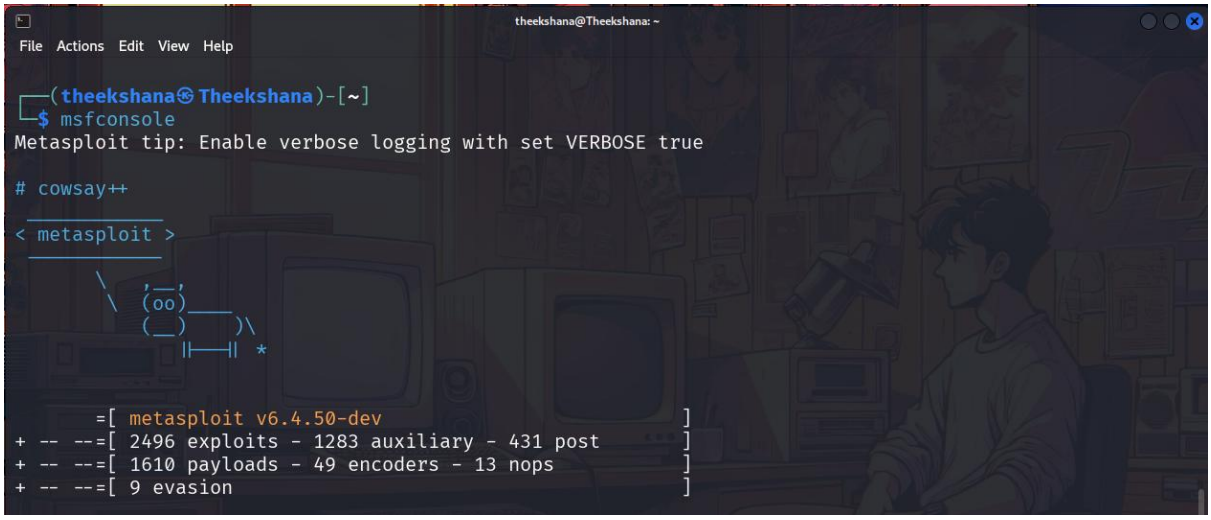


Next we use Nmap -sV to get target service version of open port 21/tcp.

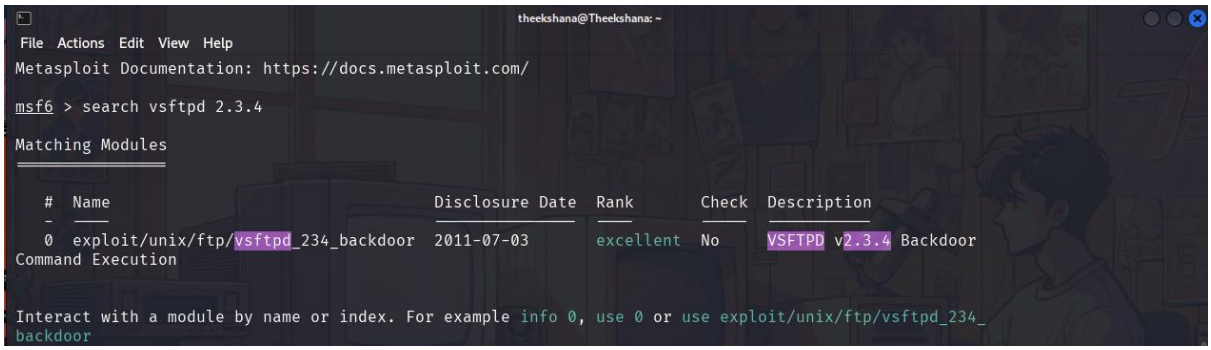


1. Backdoor Exploit in vsftpd 2.3.4 (FTP Service)

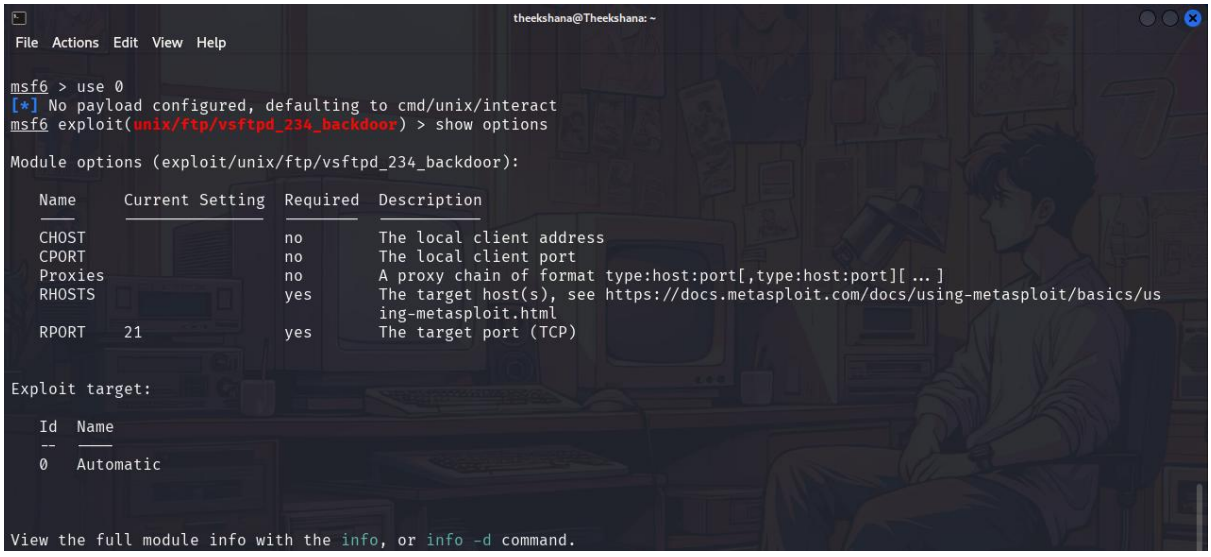
Nmap scanning Identify vsftpd 2.3.4 open port 21/tcp , vsftpd 2.3.4 version have backdoor vulnerabilities. Use to Metasploit to exploit backdoor vulnerability



Search vsftpd 2.3.4 in Metasploit



Used (exploit/unix/ftp/vsftpd_234_backdoor) to exploit



Set to target IP Address .

Exploit the vsftpd backdoor vulnerabilities. We used command "uname" to confirm if we had been successful in accessing the target system.

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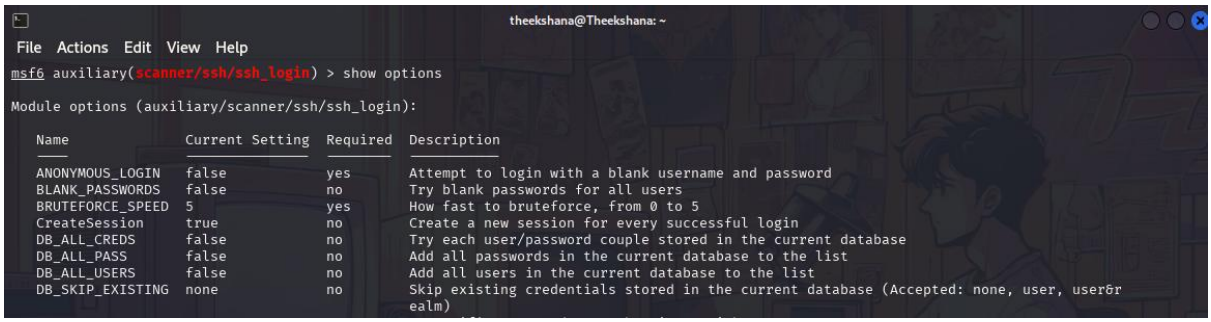
2. Brute Forcing in OpenSSH open Port 22/tcp

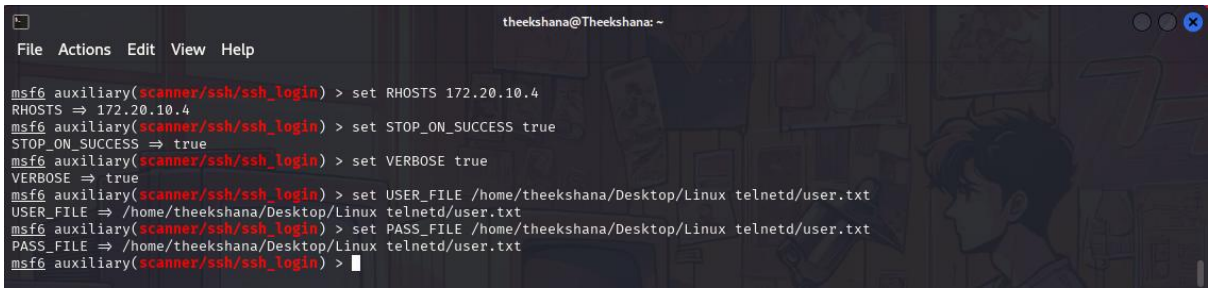
Nmap scanning Identify OpenSSH open port 22/tcp , OpenSSH 4.7p1 Debian 8ubuntu1 (protocol 2.0) version .Use to Metasploit to Brute Forcing

Search SSH_login in Metasploit

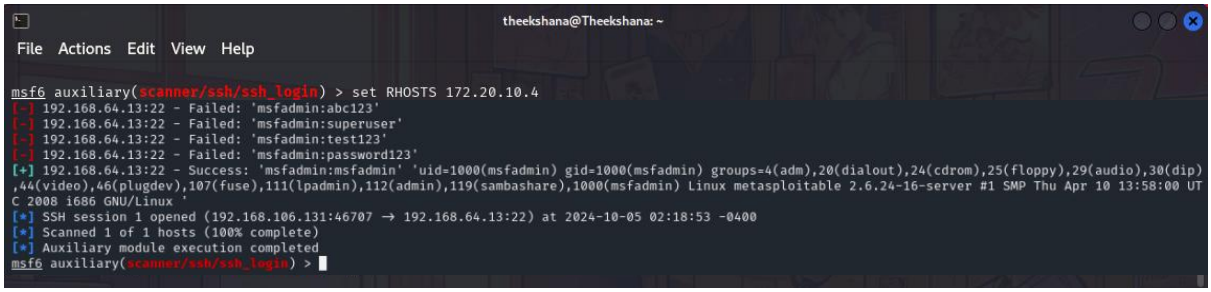
Used (auxiliary/scanner/ssh/ssh_login) to exploit



Set to target IP Address , User name and Password list file for Brute Forcing.



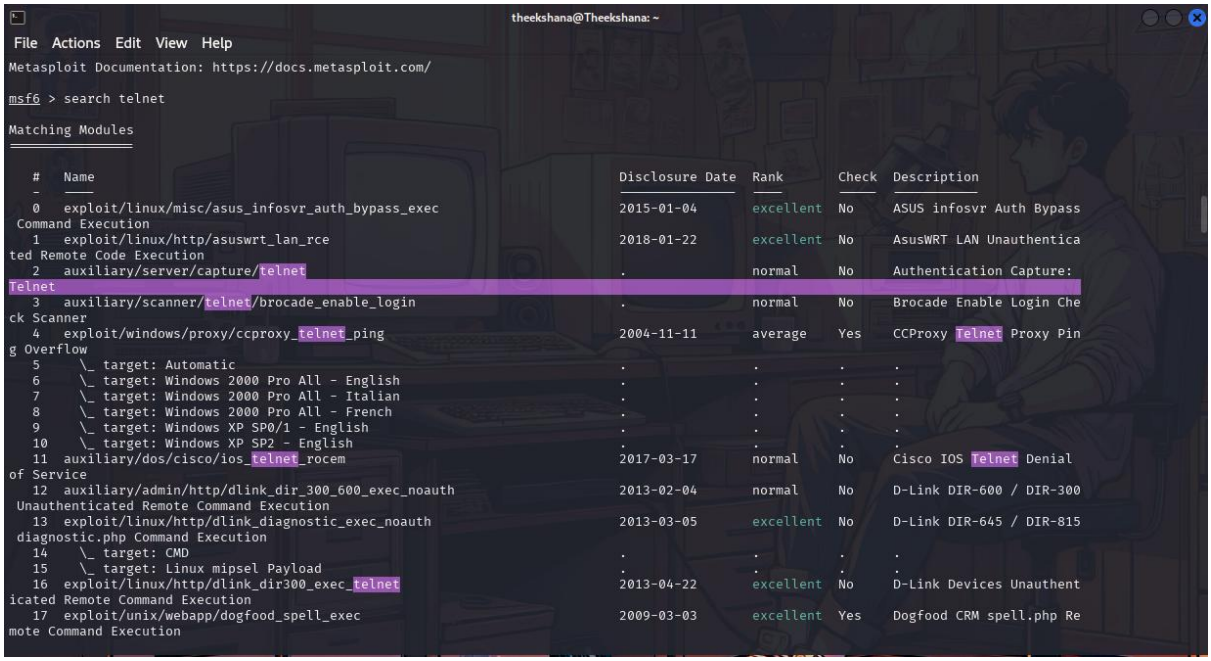
All set , after starting Brute Forcing.



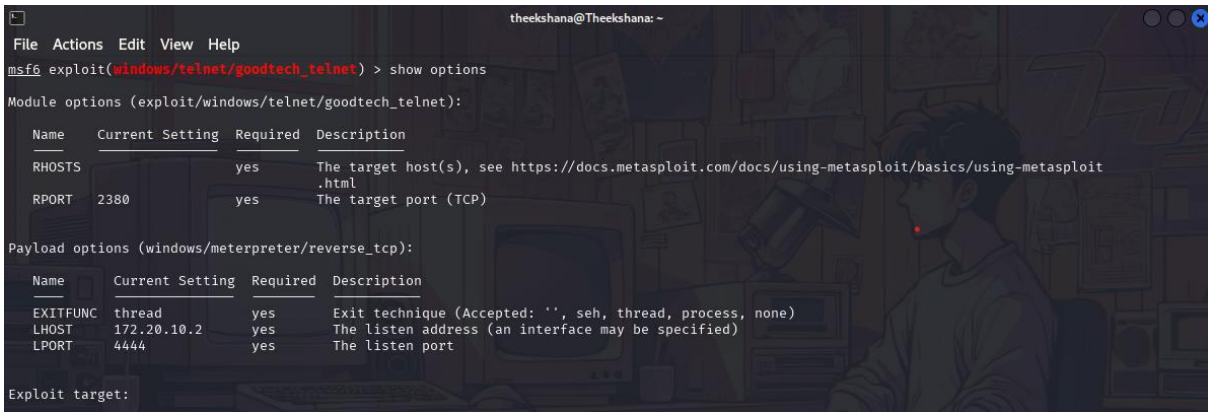
3. Exploit Telnet Services port 23/tcp

Nmap scanning Identify Telnet open port 23/tcp , Brute Forcing and get user login and Password Use to Metasploit to Brute Forcing

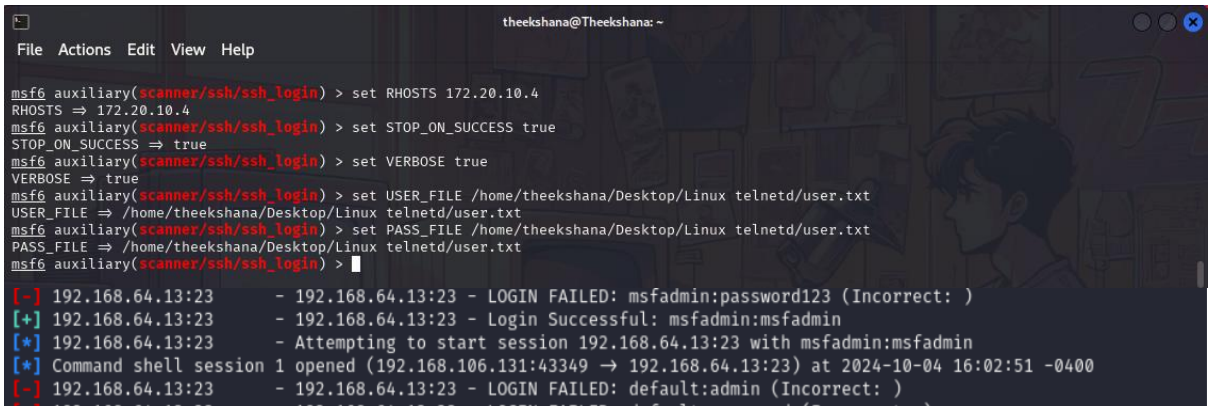
Search telnet in Metasploit



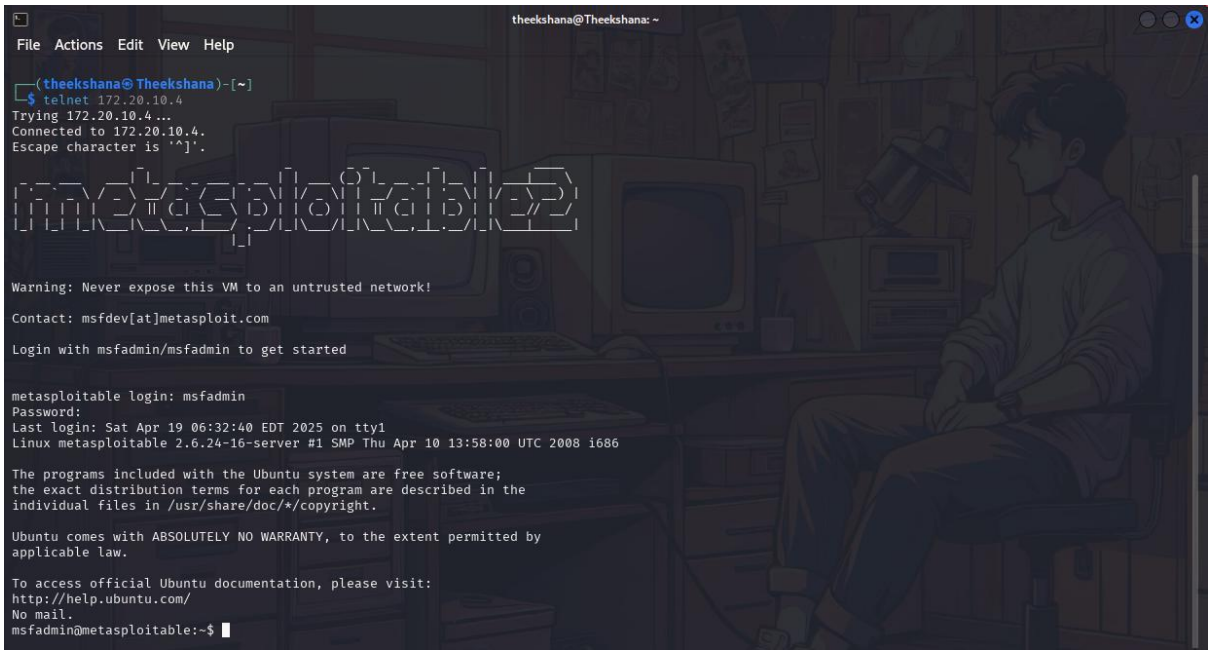
Used (auxiliary/scanner/telnet/telnet_login) to exploit.



Set to target IP Address , User name and Password list file for Brute Forcing. All set , after starting Brute Forcing and Find the correct user name and password , start the session and login the Metasploitable 2 system



Finaly login the system using telnet service Used to login “telnet [ip address][port]” and used to find user name and password to login Metasploitable 2 system.



Blue Team Analysis

1. Backdoor Exploit (FTP Service)

Vsftpd 2.3.4 backdoor exploitation would not have been possible had the Blue Team implemented mechanisms of real-time monitoring, logging, and alerting about the FTP service, a highly critical detection gap. The attacks were not visible because there was no insight into what happened on port 21, where the Red Team had exploited a known vulnerability that allowed for remote code execution when connecting to the server with a crafted username and password. Because of this, no monitoring was configured to monitor for suspicious login activity or the creation of a command shell on port 21.

Additionally, no alerting had been set up for anomalous logins via FTP. Because of this, the attacker had acquired remote access undetected, underscoring a limitation in visibility by the Blue Team and an inability to track suspicious FTP activity.

- Immediate Action: Disable the Vulnerable FTP Service Disable vsftpd 2.3.4 Immediately stop the running FTP service on the server to prevent any further exploitation.

- Upgrade the FTP Service :Upgrading vsftpd to the latest available version is the best long-term mitigation.

- Apply Strong Authentication Mechanisms: Implement strong user authentication mechanisms for the FTP accounts and set password complexity rules, like the minimum length of the password, usage of special characters.

- Firewall Controls :Apply the firewall rules to block access to the FTP port 21 /tcp. This way, it allows only trusted IP addresses or subnets that need the services of FTP.

- Encryption for FTP Traffic :If FTP is still needed, upgrade to FTPS to ensure all communications are encrypted with SSL/TLS.

- Regularly Monitor Logs and Alerts: Ensure that the FTP service is configured to log all user activities. This can help identify suspicious login attempts or unusual activity in vsftpd.

2. Brute Force Attack on OpenSSH (Port 22)

Log analysis by the Blue Team highlighted a high volume of failed login attempts after the brute force attack occurred, but the detection was reactive rather than proactive. Without real time alerts set to notify the team during the course of the attack, the delay in action allowed the Red Team to further the brute-force attempts until valid credentials were found thus compromising the SSH service.

This points out the huge detection gap since the Blue Team had not set any threshold or automatic triggers for alerts. For example alerts could be set up to occur after so many failed login attempts coming from the same IP address in a specified time period. Without that automation even though the logs were indeed available the attack was only identified well after the system had already been compromised.

- Upgrade OpenSSH to the Latest Version: Upgrade OpenSSH to the latest stable version. This will ensure that you are running a secure version complete with the latest protections.

- Enforce Strong Password Policies: Implement a strong password policy forcing the user to create a password containing a mix of uppercase, lowercase, numbers and special characters. This will make it difficult for brute force tools to guess the passwords effectively.

- . Disable Root Login via SSH :The enabling of root login can be very risky since root has full privileges. Disabling root login reduces the attack surface to a great extent.

- Two-Factor Authentication (2FA): Implement two-factor authentication (2FA) for SSH. Even if an attacker successfully guesses the username and password they will be blocked by an additional verification step.
- Rate Limiting on SSH Logins :Prevent brute force attempts coming from the same IP by limiting the number of login attempts within a certain time to a maximum number.

- SSH Connection Timeouts :Establish Timeouts for Connections By setting timeouts for SSH sessions, can minimize the chances that abandoned or unattended sessions are exploited.

3. Telnet Brute Force Attack (Port 23)

The direct root cause here was a visibility gap with complete lack of monitoring of this Telnet activity and an outdated protocol that allowed this brute force attack to go unnoticed. That means mechanisms for detection or flags were not available for suspicious Telnet login attempts and no alerts were triggered at the time this attack occurred. Since there was no logging or real time monitoring the Blue Team had no idea about any failed login attempts, successful logins or any other suspicious activity over port 23. They brute forced the credentials and then accessed Telnet undetected.

The incident serves to provide critical risks in that such unmonitored legacy services usually give an attacker an easy entry point. In the post-attack analysis it was found that Telnet was used as the attack vector thus the protocol was disabled immediately on all systems to prevent further exploitation. They further conducted an in-depth infrastructure assessment to ensure no other uses of Telnet were operational, and they completely removed the service from critical infrastructure reconfiguring any legacy systems to make use of more secure alternatives.

- Immediate Mitigation: Disable Telnet The easiest countermeasure to prevent brute force attacks is by turning off the Telnet service and replacing it with other secure services such as SSH .

- Replace Telnet with SSH: SSH introduces encryption to the data being transmitted, including authentication credentials against eavesdropping and man-in-the-middle attacks. This is a secure alternative to Telnet.

- Implement Strong Authentication: Require complex passwords for Telnet users with a minimum length and the inclusion of numbers, uppercase, lowercase and special characters. This reduces the likelihood of successful brute force attacks. Implement account lockout policies that automatically lock an account after a certain number of failed login attempts as a prevention against brute force attacks.

- IP Address Whitelisting and Access Control :Use firewall rules to limit Telnet access to trusted IP addresses only. IP tables or any other firewall program that blocks all Telnet traffic aside from known networks might be used for this.

- Rate Limiting on Telnet Logins :When restricting how many times a user can log in from the same IP address, you can stop bruteforce attacks.

Purple Team Analysis

1. Backdoor Exploit (FTP Service)

Red Team Findings : The Red Team was able to successfully exploit a known backdoor vulnerability with vsftpd 2.3.4 service and gain unauthorized access to the system port 21. This occurred undetected due to the lack of monitoring and alerting in real time.

Blue Team Response : The Blues had no visibility into the activity of the FTP service. No alerts were configured to monitor malicious login attempts or activity associated with port 6200 for the creation of a command shell. They mitigated the issue by disabling vsftpd and upgrading to a secure version.

Purple Team Recommendations :

Real-Time Monitoring: Enable continuous monitoring and alerting for FTP services, including the capability to log suspicious login attempts and detect command shell activity on non-standard ports.

Improved Authentication :Improve FTP security by setting password policies, enabling the encryption of FTP FTPS and setting firewall controls to make sure FTP access is only granted on trusted IP addresses.

2. Brute Force Attack on OpenSSH (Port 22)

Red Team Findings : The attack against SSH was conducted through a brute force method where poor credentials allowed unauthorized access to the applications.

Blue Team Response :The attack had been detected by the Blue Team only after reviewing the logs while the real time action did not happen. As a response it involved resetting passwords and enforcing SSH key based authentication. o

Purple Team Recommendations : Automated Response Employ automated defense tools such as Fail2Ban to block the IP address after a certain number of login attempts. Real time alerting using SIEM for failed login events.

Rate Limiting and Account Lockout :Apply rate limits to SSH login attempts introduce account lockout policies which will impede brute force attacks.

3. Telnet Brute Force Attack (Port 23)

• **Red Team Findings :**The Red Team leveraged the presence of the outdated Telnet service to gain access to the system through a brute force attack.

• **Blue Team Response:** There was no monitoring for Telnet so this attack surface was quite latent. The Blue Team disabled Telnet and replaced it with SSH.

Purple Team Recommendations:

Legacy Service Monitoring: Legacy services if needed include monitoring of Telnet. Segment them in the network and limit access to trusted IP addresses only in case they cannot be replaced.

Replace Legacy Protocols: Replace insecure services like Telnet with secure services like SSH and regularly review all the legacy services.

Response Effectiveness

Red Team Strengths

- Used real-world attack methods (Metasploit modules, brute-force, reverse shell).
- Covered multiple attack vectors: network, service-level, and web app.
- Demonstrated proper exploitation of known CVEs.

Areas to Improve :

- Red Team could diversify payloads or introduce evasion techniques.
- Post-exploitation activities were not deeply explored.

Blue Team Strengths

- Logs were properly configured and retained.
- Detection of brute-force attacks and scanner behavior was thorough.
- Correlation between multiple log sources (auth.log, error.log, access.log) was achieved.

Areas for Improvement:

- No indicators of alerting or real-time monitoring, manual analysis was required.
- No evidence of any blocking or mitigation (firewall, fail2ban).
- File upload was not prevented or flagged by WAF or AV; the reverse shell was missed.

Purple Team Recommendations

1. Enhance Blue Team's Post-Exploitation Visibility
   - Enable full session logging (e.g., TTY, bash history) for shell access.
   - Use EDR tools to monitor suspicious processes and file activity.

2. Improve Real-Time Monitoring
   - Set up SIEM to ingest logs and raise alerts for brute force, scanning, and unusual behavior. 3. Red Team Expansion
   - Include lateral movement, privilege escalation, or data exfiltration in future attack simulations.

Business Impact Assessment

1. Backdoor Exploit (FTP Service) Impact Analysis

Financial Impact

Revenue Loss : Downtime of FTP services due to an attack could lead to disruption in the transferring of data leading to delays in business operations and possible loss of revenue.

Fines and Penalties : If sensitive data related to customers or business operations is compromised, penalties under relevant regulations, such as non compliance with GDPR laws for protection of information will most likely be imposed on the organization.

Recovery Costs : Incident response patching, and recovery costs may include legal fees and compensation to customers affected.

Operational Impact

Data Breach : Business critical data loss or compromise due to unauthorized sensitive file access via FTP.

Service Disruption: Compromise or Unavailability of FTP Service FTP service compromise unusable with resultant delays in key business processes related to customer file transfers or internal sharing of data.

IT Resource Strain : Extra work for the IT staff who have to restore the services investigate the breach and secure the systems.

2. Brute Force Attack on OpenSSH (Port 22) Impact Analysis

Financial Impact

Direct Costs : Extra costs due to the unavailability of the system, re deployment of resources and deployment of response measures in case of unauthorized access.

Indirect Costs : Possible fines for breach of compliance in case sensitive data is compromised due to unauthorized access. Additional costs associated with implementing security measures on an emergency basis and the recovery of systems.

Loss of Revenue : This disruption to key IT services could impact the continuity of business and this in turn could lead to delays in project delivery and revenue loss

.**Operational Impact**

Service Disruption : That is if successful a brute force access might indeed compromise control of servers leading to either a shutdown or disruption of critical business services.

Data Breach : OpenSSH Compromise This will lead to the attackers being able to access and manipulate sensitive information or even critical infrastructure.

Strain on IT Resources : Additional workload for IT personnel in responding investigating and securing compromised systems.

Reputational Impact

Loss of Trust : A vulnerability in the systems because of OpenSSH will result in losing the confidence of clients partners and stakeholders.

Public Relations Damage : Publicly disclosed security breaches also tend to attract adverse media attention that can harm an organization's reputation and affect its customer relationships.

3. Telnet Brute Force Attack (Port 23) Impact Analysis

Financial Impact

Recovery Costs : Costs to investigate the attack secure compromised systems and migrate to more secure protocols.

Revenue Loss : Disruption to remote management capabilities delays vital operations therefore impacting productivity and revenue generation.

Penalties : If sensitive information becomes exposed because of unauthorized access then regulatory fines and penalties can be levied based on non-compliance.

Operational Impact

Service Disruption : This unauthorized access could mean attackers manipulate or disable systems leading to serious downtime and service interruptions.

Data Compromise : The attack will therefore have unauthorized access to sensitive system configurations and data hence compromise protected critical business information.

IT Resource Strain : Increase the IT team's workload in terms of responding and securing the violated systems affecting other key IT services.

Reputational Impact

Loss of Client Trust : A system compromise via Telnet will lead to loss of trust from clients stakeholders and business partners.

Loss of Client Trust : This will make an organization develop bad publicity through a Telnet breach which hurts its image and credibility.

CONCLUSION

It showed a number of key vulnerabilities in the network and applications that would indicate clearly where Mayo Industries needed to make improvements for the organization's cybersecurity posture to be enhanced. These when exploited could lead to unauthorized access data breaches and lots of operational disruption. This included poor authentication mechanisms aging software versions and a lack of monitoring and alerting.

Risk associated with it can be reduced by following a few steps and actions mentioned below:

- Patch all known vulnerabilities of network services and applications.
- Strengthening mechanisms of authentication, including enforcement of password policy and multi-factor authentication.
- This includes putting in place an extensive monitoring and alert system to monitor for suspect activities in real-time.
- Perform periodic vulnerability testing and penetration testing to keep up with newly emerging threats.

The report results clearly indicate that though the company has implemented a reasonable baseline of security controls improvement of its defense strategies proactively is called for to protect against threats that are becoming increasingly sophisticated