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Trinity Saint David

An Assignment
on

Ethical Hacking
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1. Introduction:

At a time when cyber threats are growing more sophisticated, conventional security is not enough to protect enterprises. To beat attackers at their own game, offensive security has become imperative a strategy that moves beyond defense to actively mimic real cyber-attacks [4]. This is no ordinary white-hat activity, and it's going well beyond typical penetration testing with its simulations of Advanced Persistent Threats (APTs) that try to recreate the tactics, techniques and procedures (TTPs) of authentic bad actors. In this way, offensive security enables organizations to find holes in their protection and test how well existing defenses are working including detection, prevention, and response.

Red Teaming is a specialized activity that mimics the profile, tactics and procedures of real-world adversaries to test an organization's security infrastructure. Instead of just looking for vulnerabilities, Red Team operations simulate the actions a full-scale hostile attack, in order to enable organizations to gauge how their defenses would hold up under an aggressive and persistent adversary [4]. These tests allow enterprises to evaluate how ready they are on discovering breaches, reacting when they identify the possibility of a breach and protecting key assets from potential attackers.

The goal for this assignment is to familiarize yourself with offensive security and threat emulations by completing two projects. The first Challenge will ask you to analyze a real-world cyberattack, match it with the MITRE ATT&CK framework and detail strategic recommendations around how to defend against it. This exercise has tested your understanding of how attackers work and the various ways organizations can be better prepared to defend themselves. Task two: Red Teaming the hybrid box infrastructure Again we're working towards taking on a hybrid infrastructure in a controlled environment for simulated engagements. You will pretend to be an APT and evaluate how organizations' security stacks up against hacking threats.

This consists of two main parts:

Strategic Threat Analysis: A deep dive into a complex attack, MSP from MITRE ATT&CK and recommendations for mitigation.

Red Team Engagement: A simulated targeted attack in which you will use expert tools and practice your response in a hybrid environment, allowing for critical insights into where vulnerabilities lie.

By performing such exercises, this homework assignment will hone your skills at looking from the "opposite perspective" and measure an organization's security posture as it appears to attackers - thus making you a valuable asset when building more robust defense mechanisms.

2. Strategic Threat Analysis

2.1 Cyber Attack: What Happened Overview

Description of the Attack:

In this post, we look at a ransomware attack against a healthcare entity (a hospital system) in 2023 [2]. It was the work of a brutally sophisticated strain of digital criminals likely using ransomware that turned the hospital's computer data into indecipherable gibberish and demanded significant payment for a key to retrieve it. At the same time, the intruders also stole important patient information such as personal health info (PHI), medical histories, and bills.

Attackers used a multi-stage approach to compromise the hospital's network [2]. The initial compromise was achieved via spear-phishing emails with the attachment inserting or link delivering ransomware to their network and staff when opened. The malware spread rapidly throughout the network, encrypting files and rendering several essential systems (like patient management and medical records databases) useless.

The ransomware also carried a second payload—data theft. As the hospital's own systems were being locked up, copies of sensitive patient information would have been copied and uploaded to servers that the attackers controlled. And much of the data was encrypted, too, so even if the hospital paid up, the stolen data would still be under lock and key somewhere else on the internet.

Key Details of the Attack:

Attack Date: 2023

Target: Healthcare organization (hospital system)

Method of Attack: Ransomware encrypts and exfiltrates files

Impact of the Attack: The aftermath of the bombing was both dire and complex.

Financial Damage:

The hospital has to pay a large ransom in order to gain access to its encrypted data — that not only consisted of operational systems but also vital patient records. The payment and response costs resulted in a huge financial loss.

More-over, the hospital's downtime caused major disruption for patients, allowing for postponement on surgeries, mismanagement of critical medical information and limited access to emergency services.

Reputation Loss:

Due to data breach, the hospital's name and reputation were badly hit. It caused patients to lose confidence that the hospital could protect their sensitive medical information, discouraging potential admissions. And the breach brought significant media attention to vulnerabilities in healthcare, adding to concerns about safety of medical data.

The breach also had a negative impact on the hospital's relationships with insurers, research partners and other healthcare providers after they began to wonder just how serious the institution was about protecting data.

Legal and Regulatory Implications:

Healthcare institutions are governed by strict regulatory environments (e.g., the Health Insurance Portability and Accountability Act in the U.S.). This attack brought about a patient data breach and saw the hospital being levied with considerable fines as well as legal penalties for its inability to safeguard sensitive information.

Further, the patient data leaked outside initiated inquiries by regulatory authorities which are likely result in long term observation and more damage to reputation.

2.2 Adversary campaign mapping to MITRE ATT&CK

MITRE ATT&CK Framework Overview:

The MITRE ATT&CK® concept is a living documentation of how adversaries operate, which tactic they use to perform particular activities and it helps defining techniques helping them with the execution [3]. It is commonly used to map cyber attacks and for threat emulation in Red Team exercises. This methodology allows for the detection of attack patterns in varied stages such as entry, execution, persistence and exfiltration. In this part of the blog, we will map attackers ransomware actions to MITRE ATT&CK framework.

TTPs Secrets Revealed During the Attack:

Initial Access – Spear-phishing Attachment (T1566. 001):

The attackers delivered spear-phishing emails containing weaponized attachments or links. When a member of staff clicked on the attachment, it triggered the ransomware. Spear-phishing attacks are a primary method of entry for threat actors since these campaigns are aimed at certain people within a company.

Execution – PowerShell (T1059. 001):

After the ransomware load was delivered, they ran malicious PowerShell scripts to sideload the ransomware. The encryption and installation of other malware on the compromised machines was performed via PowerShell.

Persistence – Scheduled Task (T1053. 005):

For persistence, these attacks installed scheduled tasks on the compromised machines to keep ransomware running post-reboot. This is a technique employed by adversaries to stay resident over long periods of time.

Privilege Escalation – Bypass User Account Control (T1068):

They used existing vulnerabilities in the hospital's old software to increase privileges and obtain administrative access to key systems. This enabled them to circumvent base-level security checks and have access throughout the network.

Defense Evasion – Obfuscated Files or Information (T1027):

The ransomware was evasive, so endpoint detection solutions would find it more difficult to make a positive identification. By using fileless ransomware, the attackers did not generate standard file-based signature to detect the malware.

Credential Dumping – LSASS Memory (T1003. 001):

Once the attackers escalated their privileges, they leveraged credential dumping to obtain usernames and passwords from process memory in the LSASS (Local Security Authority Subsystem Service). This enabled them to go sideways in the network.

Lateral Movement – SMB/Windows Admin Shares (T1075):

The hackers were able to have lateral movement in the hospital's network by using SMB (Server Message Block). This allowed them to further distribute the ransomware across additional devices, particularly onto internal medical and patient management-related systems.

Exfiltration – Exfiltration Over C2 Channel (T1041):

The malicious actors extracted the sensitive data through a maliciously established communication channel with concealment of existence developed in-the-wild during the targeted attack. They exfiltrated encrypted patient data to outside servers so that even if ransomware was defeated, the hackers would still have patient information.

Impact — Data Encrypted for Impact (T1486):

The hospital had its files encrypted by the attackers, making them unrecoverable without the decryption key. This is designed to cripple an organization and force it to pay the ransom.

Impact – Data Destruction (T1485):

Beyond encrypting the data, attackers could have used data destruction methods to ensure that even if ransoms were paid, victims would never be able to reach their critical information.

TTP Mapping Diagram:

To represent the TTP mapping, a visualization could be generated to visually map these stages into the MITRE ATT&CK matrix and illustrate how the attacker evolved from initial access until exfiltration of data and damage.

2.3 Generate Root Cause Analysis

Investigating the Causes of the Breach:

A number of vulnerabilities in the hospital's cyber defenses helped enable the attack [6].

Security Controls:

Missing Multi-Factor Authentication (MFA): Not having MFA on infrastructure such as email and administrative access provided a clear path for using stolen credentials to compromise sensitive resources [4].

Obsolete Software and Unpatched Vulnerabilities – The hospital's outdated software and unpatched systems were very easy vectors for the threat actors to both exploit vulnerabilities and elevate privileges. Calculated patching was not negligent enough.

Poor Endpoint Protection: The hospital did not have adequate endpoint detection and response (EDR) measures in place to find suspicious activity such as the running of PowerShell scripts and lateral movement.

Architectural Flaws:

Trait: Lack of network segmentation The hospital did not have a sufficient amount network separation and the attackers could transfer from one victim to another with ease. Life-saving systems including patient records and lab equipment had not been separated from the rest of the network, allowing the ransomware to spread.

Insufficient Segregation of Vital Systems: Segregation between the hospital's internal systems and public facing interfaces (such as Workstations, Email system) was not appropriate enough to prevent exposure from external attack.

Human Errors:

Employee Negligence: It shows that the training of users didn't work as these were spear-phishing emails. Workers would frequently click on attachments or URLs that were malicious without checking them out.

Poor Password Hygiene Systems that still had default or weak passwords made it easier for attackers to crack and gain unauthorized access.

Key Factors Facilitating the Attack:

Failure to Keep a Close Watch for Any Signs of Trouble:

The hospital's lack of implementing SIEM solutions, no network traffic monitoring in place exposed the security underbelly and let the attack go free. Because it lacked the ability to detect threats in real time, it did not even know that an attack was taking place.

Insufficient Incident Response Planning:

The incident response plan for the hospital was not sufficiently comprehensive and this delayed response to the attack. Due to lack of a formal response plan, the organization spent significant time figuring out the reach of the breach and responding in kind.

2.4 Recommendations for prevention and detection

Preventive Recommendations:

Implement Multi-Factor Authentication (MFA):

MFA should be enabled on all important accounts to drastically minimise chances of unauthorised entry. This will add another necessary layer of security to make it difficult for attackers to gain control over sensitive systems [5].

Regular Patching and Vulnerability Management:

The hospital needs to establish a patch management process/regimen for all systems, including medical equipment, and upgrade regularly. Patch automation software might also be used to reduce the time needed to mitigate known vulnerabilities [5].

Network Segmentation:

The hospital could use network segmenting to separate core systems (patient data, medical devices) from regular office networks. This would help to contain lateral movement and make it more challenging for attackers spreading ransomware throughout an entire network.

Detection Recommendations:

Enhance SIEM Capabilities:

The hospital organization should be implementing or bolstering its Security Information and Event Management (SIEM) system to give the security staff real-time visibility into the network. This could provide faster detection on adversarial activities, whether that be unusual PowerShell scripts or fictitious access attempts.

Tune EDR Solutions:

The hospital must configure their EDR solutions to more effectively catch fileless malware and PowerShell based attacks, that are commonly employed in advanced ransomware campaigns." It would have also considered anomalous behavior that could indicate lateral movement or privilege escalation.

User Awareness Training:

The hospital needs to continuously provide user training regarding phishing attacks, suspicious emails and Internet browsing. Regular simulated phishing campaigns to assess and shore up employee awareness can play a role here.

By shutting these preventative and detection holes the hospital can harden itself against future ransomware and other related attacks.

Red Team Engagement: Operation IP Shield

3.1 Campaign Design

Rules of Engagement (RoE):

The Rules of Engagement (RoE) are important from a perspective to outline what is and what is not allowed, the limits that need to be adhered to, engagement procedures for Red Team [8]. This project is a simulated APT actor to challenge hybrid defenses of on prem, AWS and CI/CD. Following are the salient features of RoE:

In-Scope:

Research Data Exfiltration: Stealing is the main target, to conduct an unauthorized penetration into the organization's R&D systems, access sensitive data and exfiltrate it undetected [7].

Simulate APT techniques The relationship will assess the company's ability to identify and stop tactics like spear phishing, lateral movement and data exfiltration [3].

Through the Wall: Beating AWS VPC and CI/CD Pipelines The encroachment into the AWS-instanced clinical data portal and CI/CD pipeline systems will demonstrate an attacker's navigation through the health system in a move that makes us proud of being hood hackers.

Out-of-Scope:

Physical Infrastructure: The Red Team will refrain from damaging any physical systems or equipment. The emphasis is purely on simulating the attacks to test security defenses.

Operational Disruption: The task of annexation should not interfere with the business as usual operations of critical business processes, specifically in areas such as medicine and research where availability is key.

Communication Protocols:

Successful Exploit Reporting: The Red Team should have to alert of any successful exploitation that results in lateral movement across the network. Communication will occur in a safe way using some pre-specified channels to avoid being detected.

Escalation Protocols: If the fight results in collateral damage, the Red Team will immediately contact and work to contain collateral impact with affected teams. The Blue Team will only be taught “#” of epic exploitation after the game over otherwise, we are simply losing focus from its internal assessment.

Threat Emulation Plan:**Tactics & Objectives:**

The Red Team engagement will be traced to the MITRE ATT&CK® framework so that every stage in the operation translates to established APT group tactics and techniques. The goal is to mimic an actual adversary via a mix of social engineering, network exploitation and data exfiltration. The engagement will be guided by:

Initial Access (Spear-phishing - T1566. 001):

The operation will start with the attackers sending spear-phishing emails to chosen employees of the company. These emails will have nefarious attachments or links, that when clicked on, download and execute the ransomware – then creating access to the internal network by the attackers.

The mails will be personalised convincingly, based on data altered from publicly available sources to further increase the likelihood of success.

Execution (PowerShell - T1059. 001):

After the payload is delivered via spear-phishing, malicious scripts will be ran using PowerShell. The attackers would use the living-off-the-land (LOLBin) tactics to avoid potential detection and continue to spread the backdoor across the victim’s network.

Persistence (Scheduled Tasks - T1053. 005):

In order to persist, the Red Team will implant scheduled tasks so that the malware runs every time computers are turned on. This enables to renew the access if interrupted in initial assessment.

Privilege Escalation (Elevation of Privilege) - Exploitation for Free T1068:

The attackers will be looking for unpatched vulnerabilities in the organization's systems that could give them high-level access. For instance, one might exploit a known vulnerability in Windows Server or some other software to acquire administrative rights.

Lateral Movement (SMB/Windows Admin Shares - T1075):

The Red Team will laterally traverse the internal network of the organization, using SMB (Server Message Block) and Remote Desktop Protocol (RDP). The attackers would then try to move laterally within clinical data portal's major systems and CI/CD pipeline in an attempt to carry out other attack actions and exfiltrate research valuable data.

Exfiltration (Exfiltration Over C2 Channel - T1041)

After the attackers have found the data they seek, exfiltration follows. by means of some secret communication channel and eventually via FTP or HTTPS the encrypted results will be uploaded by the attackers to an external server that they control.

Data Encrypted for Impact - T1486:

In the third cycle, final phase, the Red Team will encrypt sensitive data (e.g., clinical trial-data) as a representation of what happens in a ransomware situation, rendering it impossible for the organization to access and forcing them to pay.

Red Team Objectives to MITRE ATT&CK Mapping:

The goals of the Red Team will be aligned to the following TTPs from MITRE ATT&CK:

Initial Access (Spear-phishing - T1566. 001)

Execution (PowerShell - T1059. 001)

Persistence (Scheduled Tasks - T1053. 005)

Command-Line Interface can be Easily Defeated / Bypassed (D6TB001)

Lateral Movement (SMB - T1075)

Exfiltration (T1041 - Exfiltration Over C2 Channel)

Impact (Data Encrypted for Impact - T1486)

3.2 Environment & Execution

Designing the Virtualized Lab Environment: In order to emulate this hybrid infrastructure accordingly, the Red Team will create a virtualized lab environment which consists of both on-premises infrastructure and cloud-based resources. The parts to be included are:

R&D Systems: On Prem Active Directory Network

The organizations internal network will be simulated using Active Directory administration which is a part of Windows Server. This will turn your internal users and computers into one, centralized authentication system. The Red Team, on their part, will attack machines within this network and elevate privileges and perform lateral movement to achieve access the most critical R&D systems.

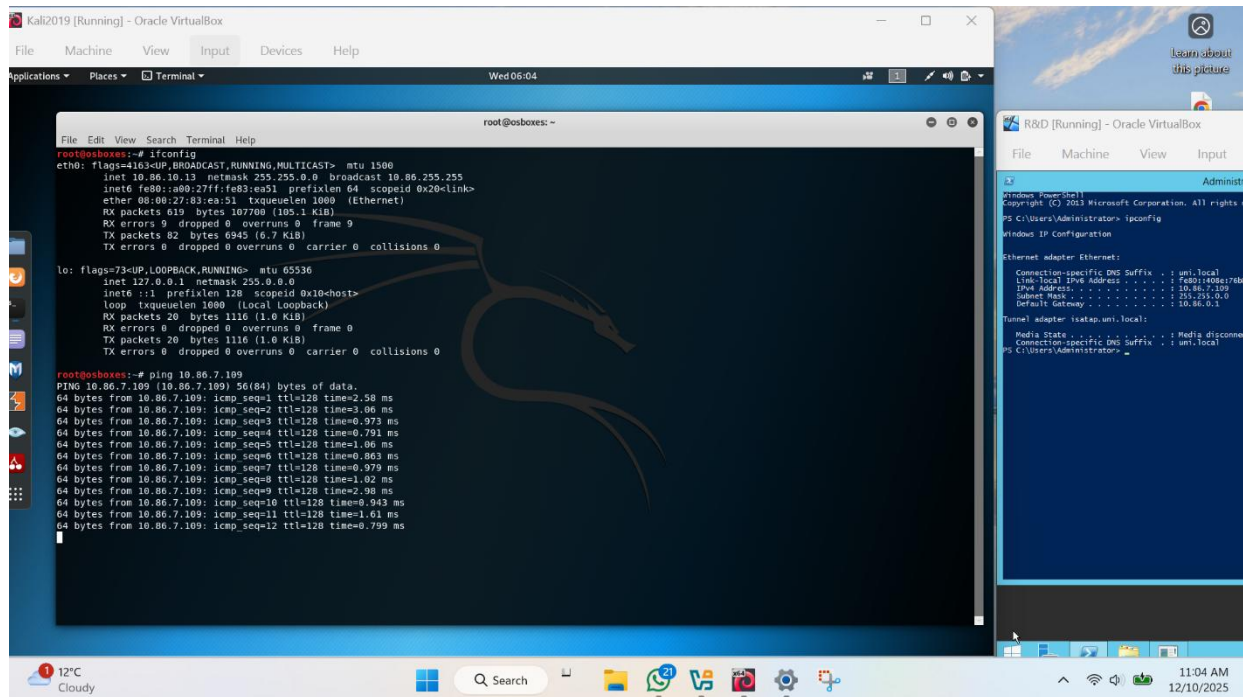


Fig: Ping Kali to R&D

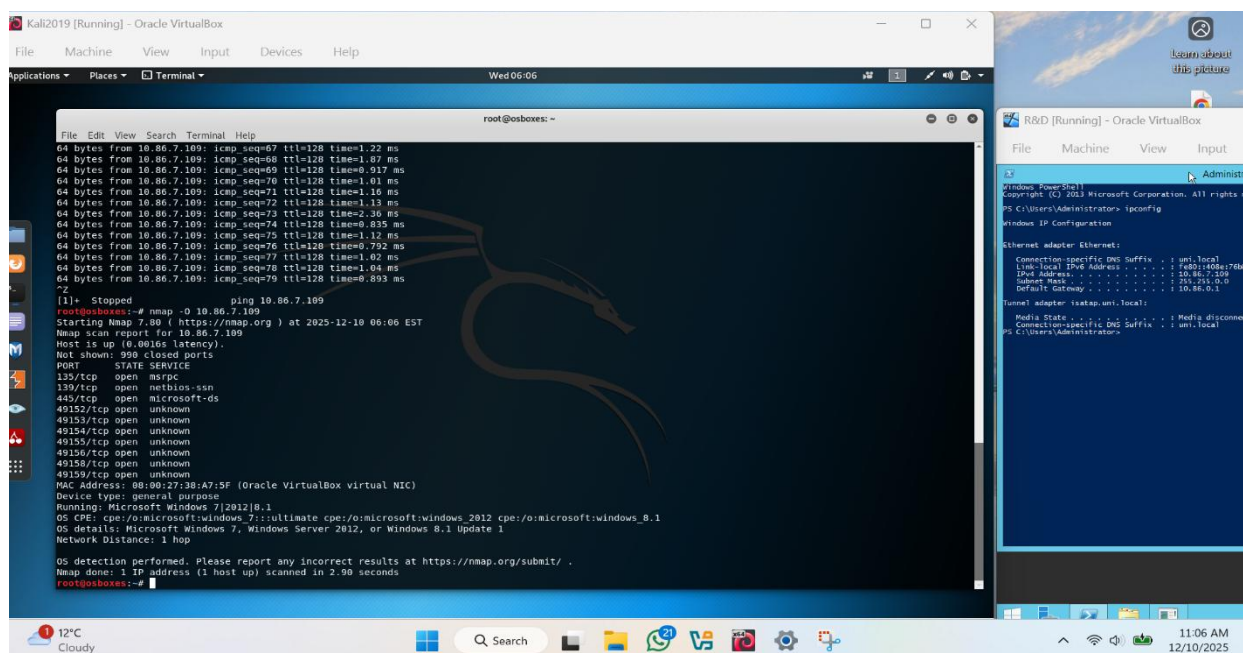


Fig: Host up Kali to R&D

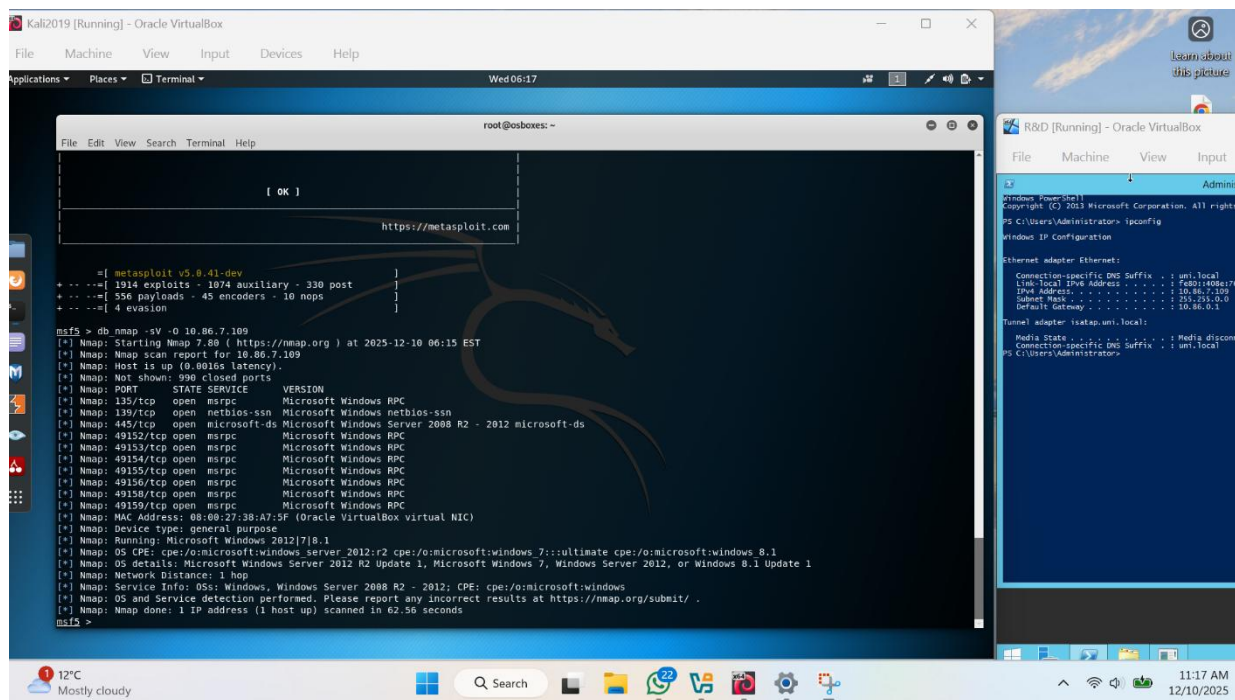


Fig: Scan Kali to R&D

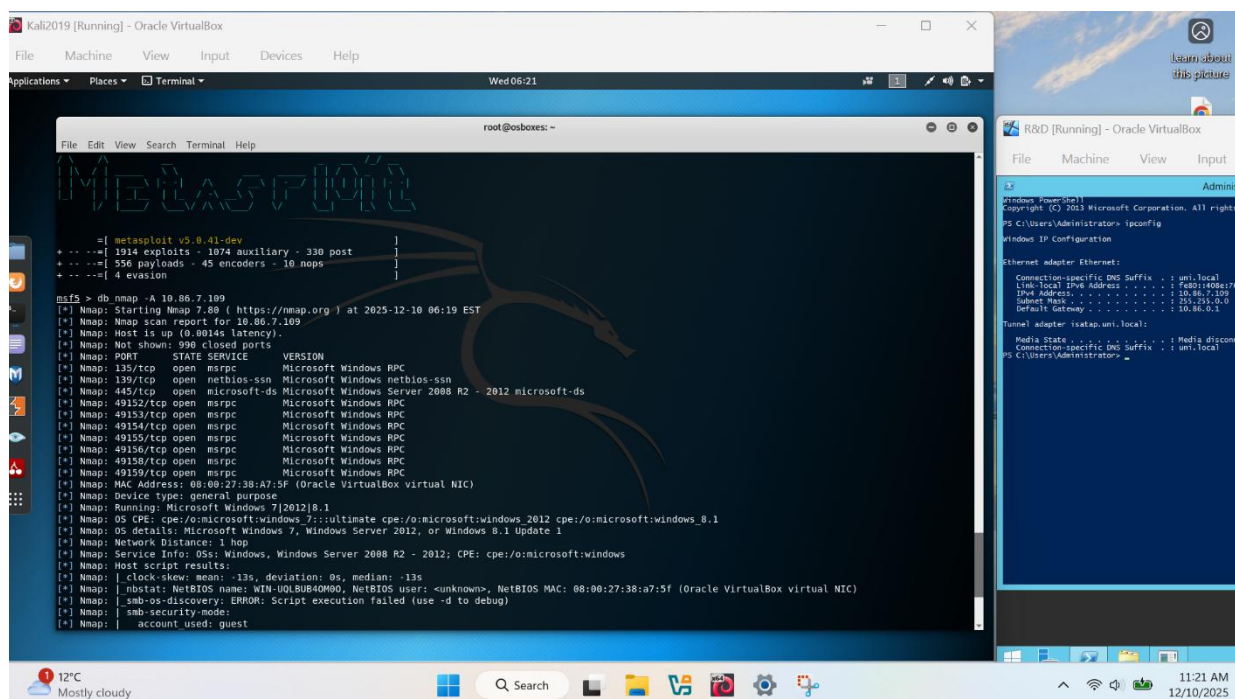


Fig: Aggressive scan Kali to R&D

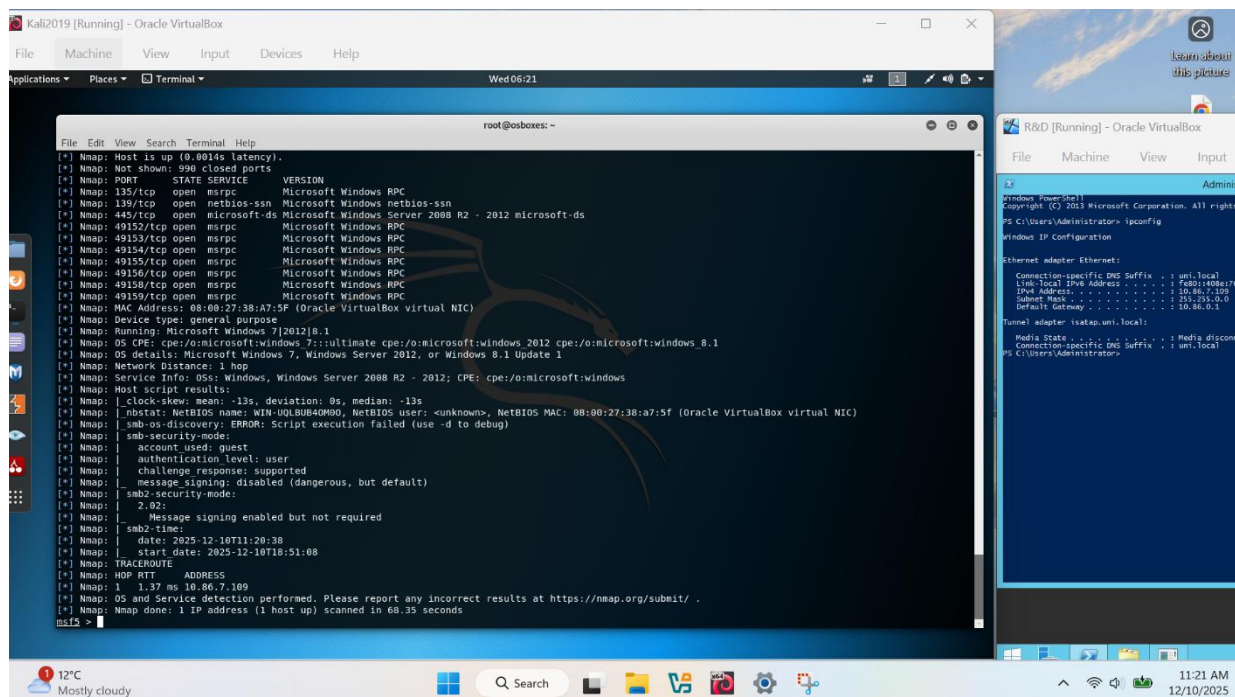


Fig: DNS scan Kali to R&D

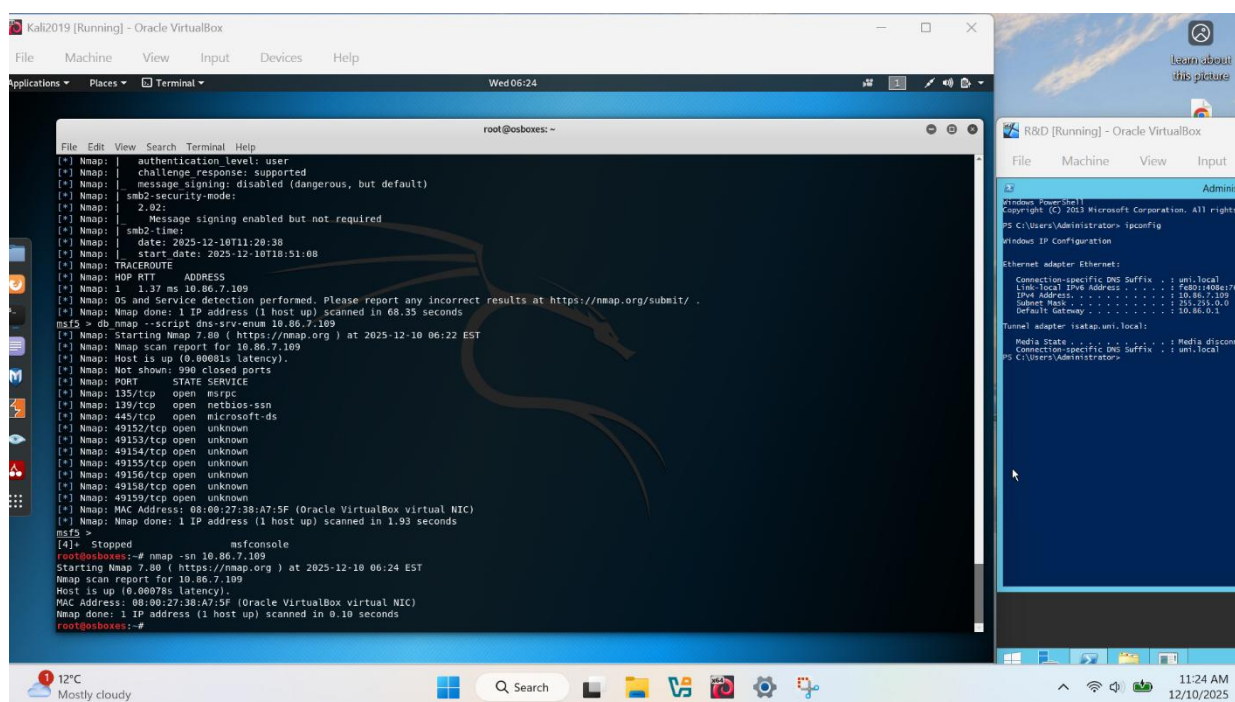


Fig: Host up Kali to R&D

The AWS VPC will represent the cloud environment of the organization where the clinical research data portal is deployed. Sensitive patient information and research findings are kept in the portal. The Red Team will challenge its security posture through exploiting gaps in the VPC's security groups, traversing access controls and lateral movement from the on-premises network.



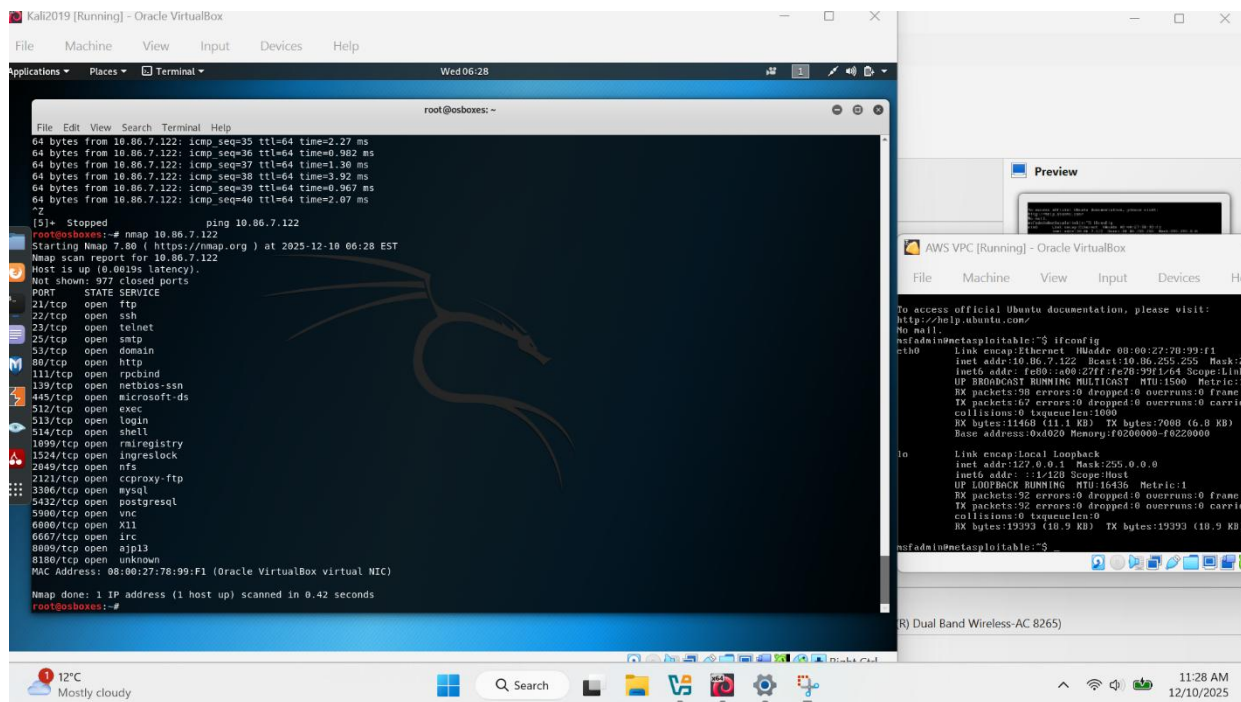


Fig: nmap Kali to AWS

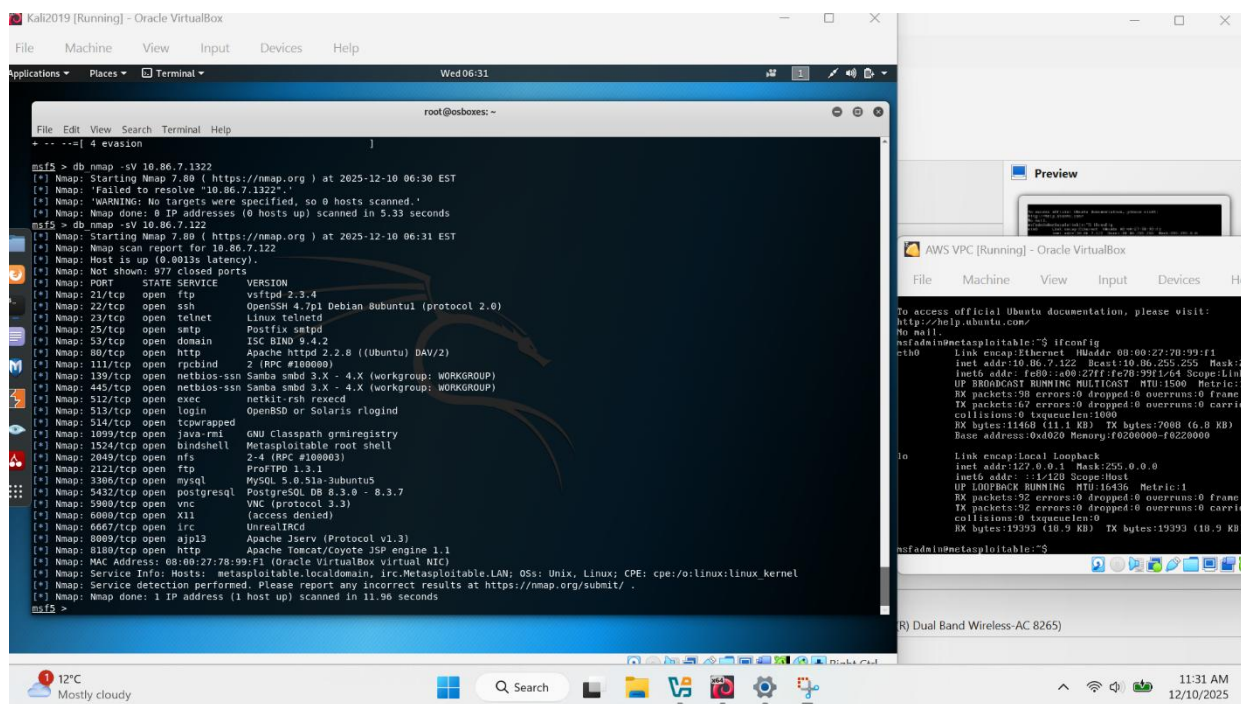


Fig: dbnmap sv Kali to AWS

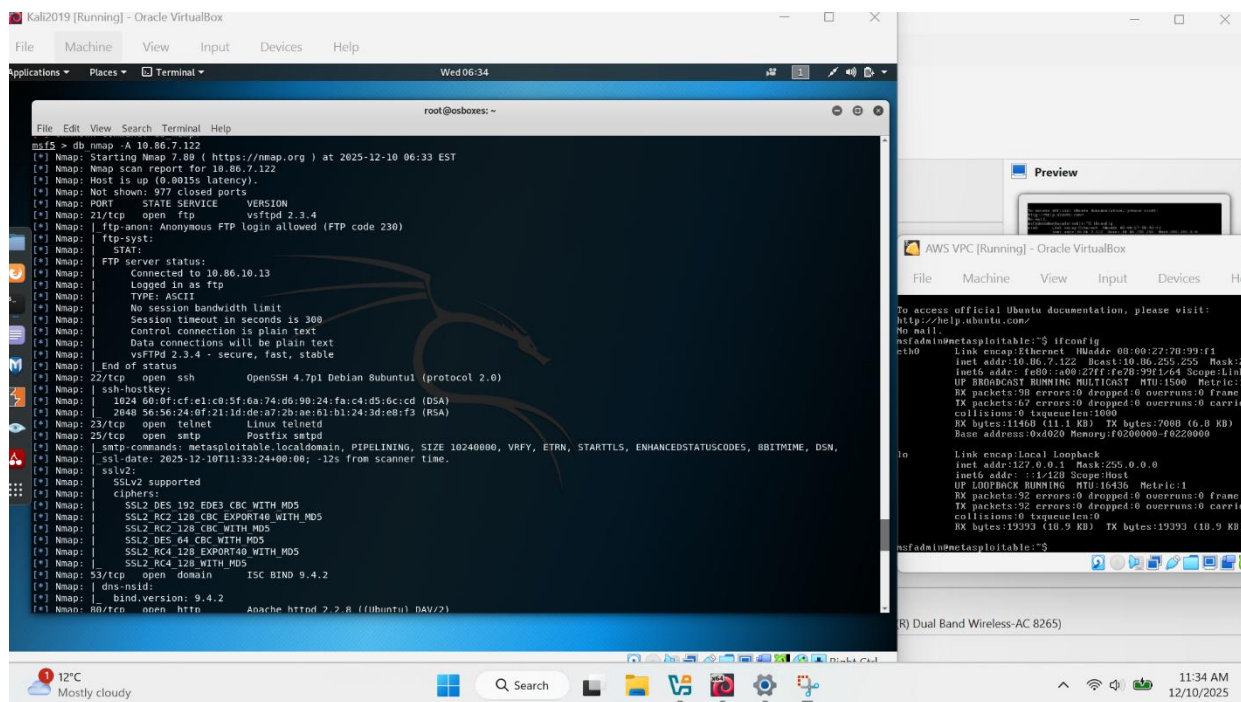


Fig: dbnamp -a Kali to AWS

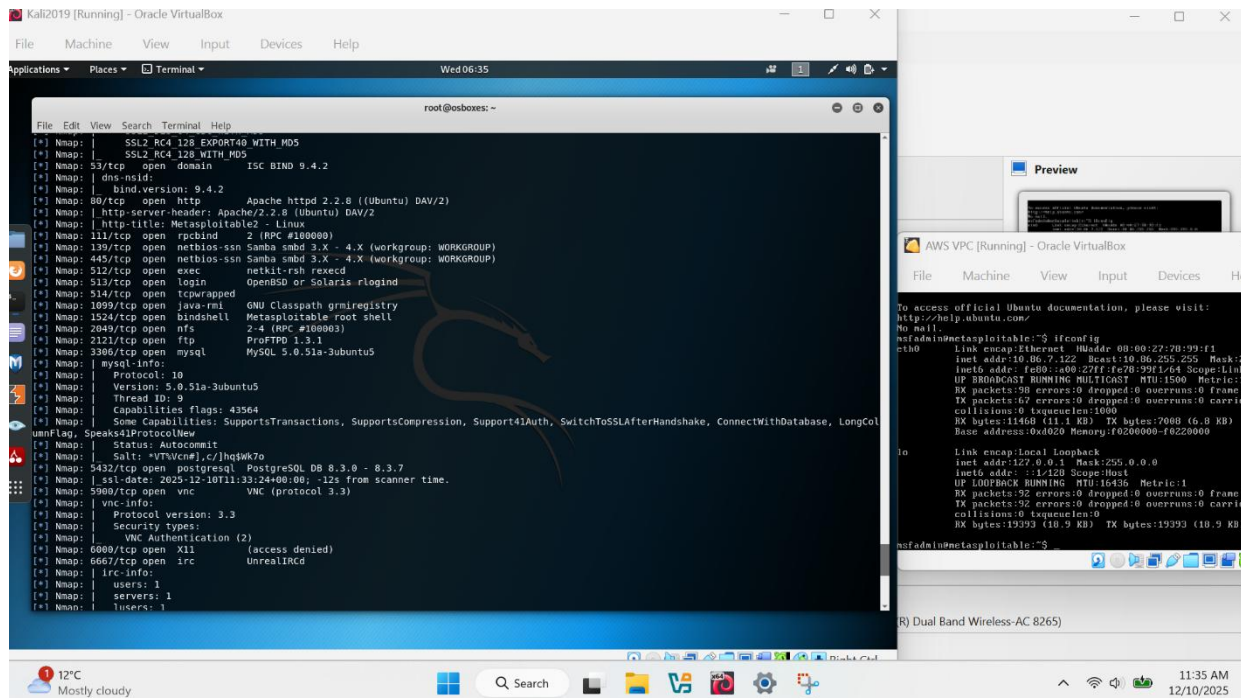


Fig: Ping Kali to AWS

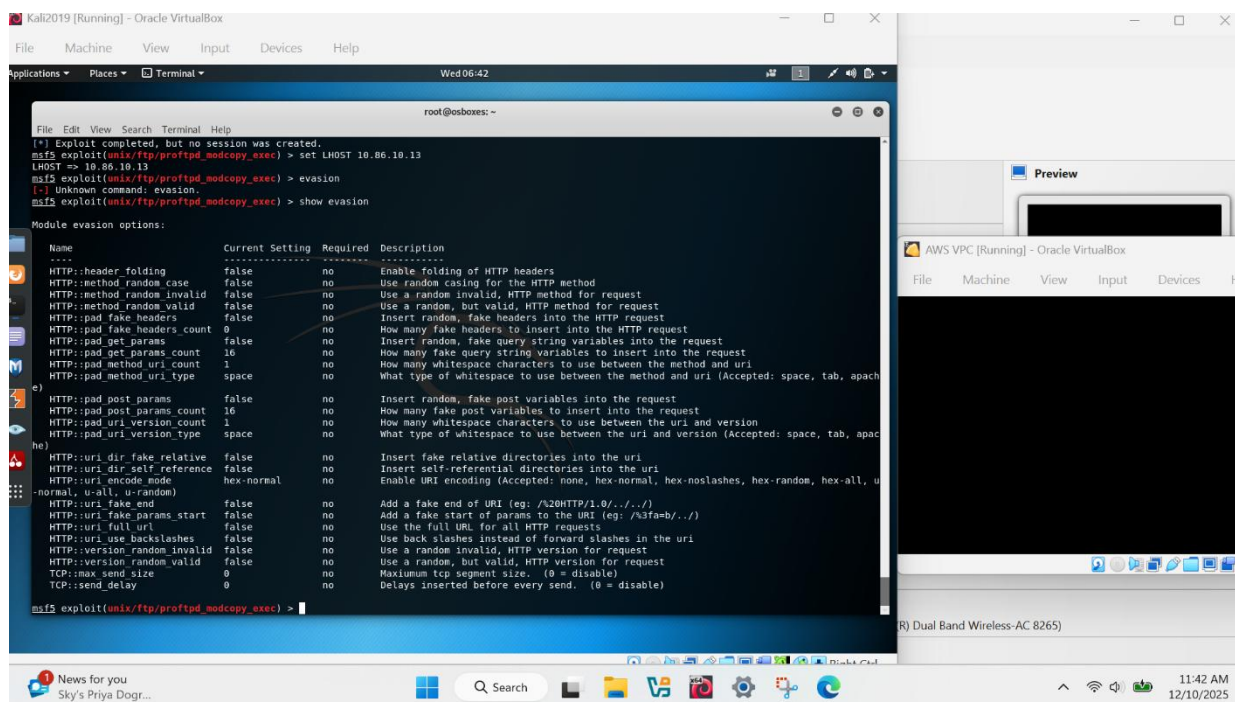
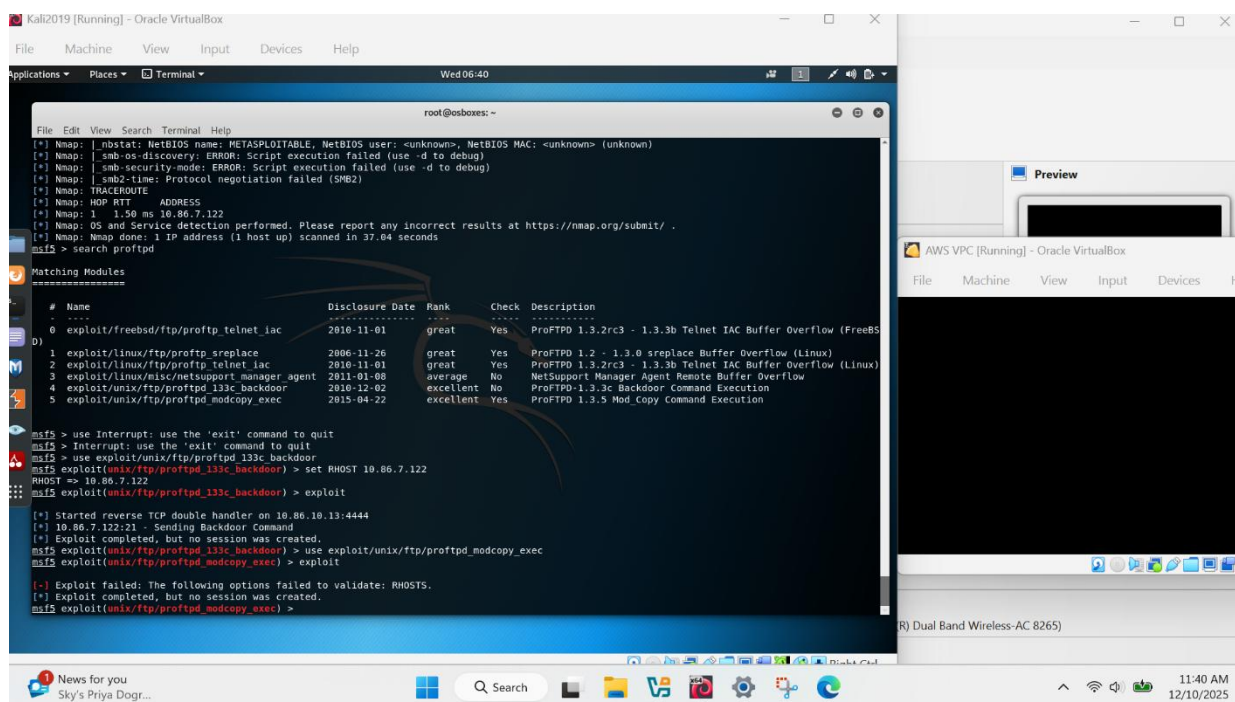


Fig: Exploit

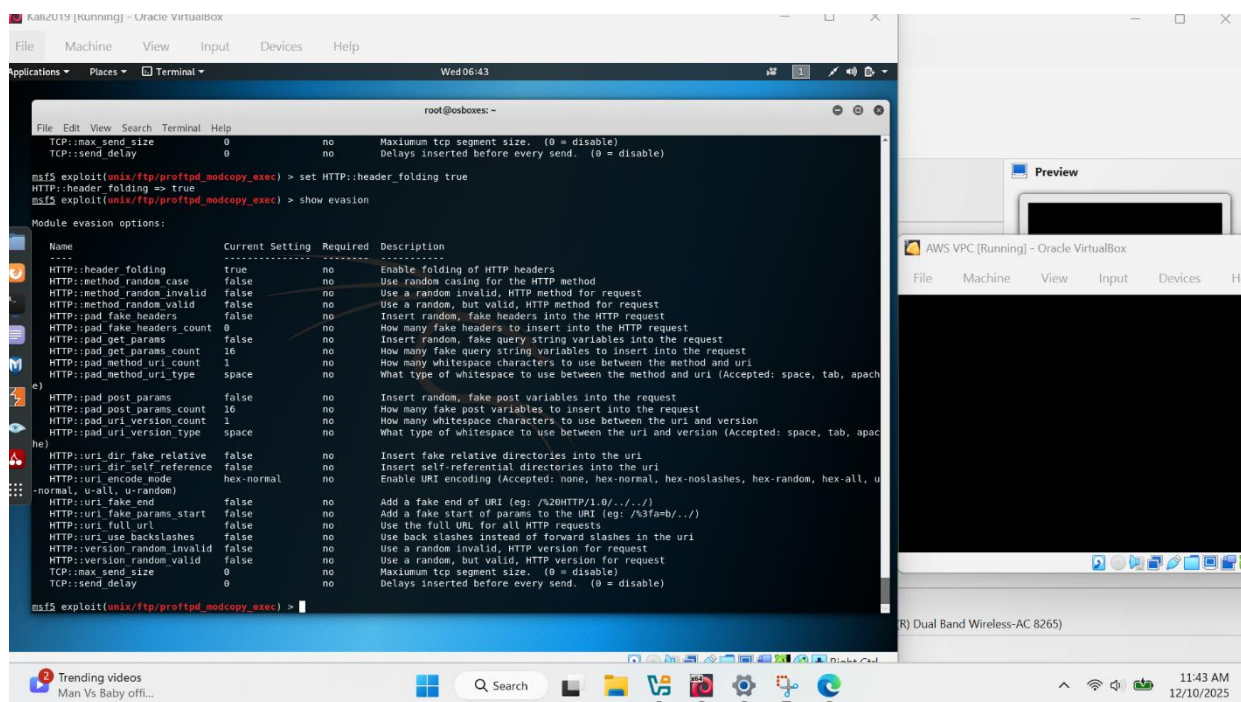


Fig: Exploit

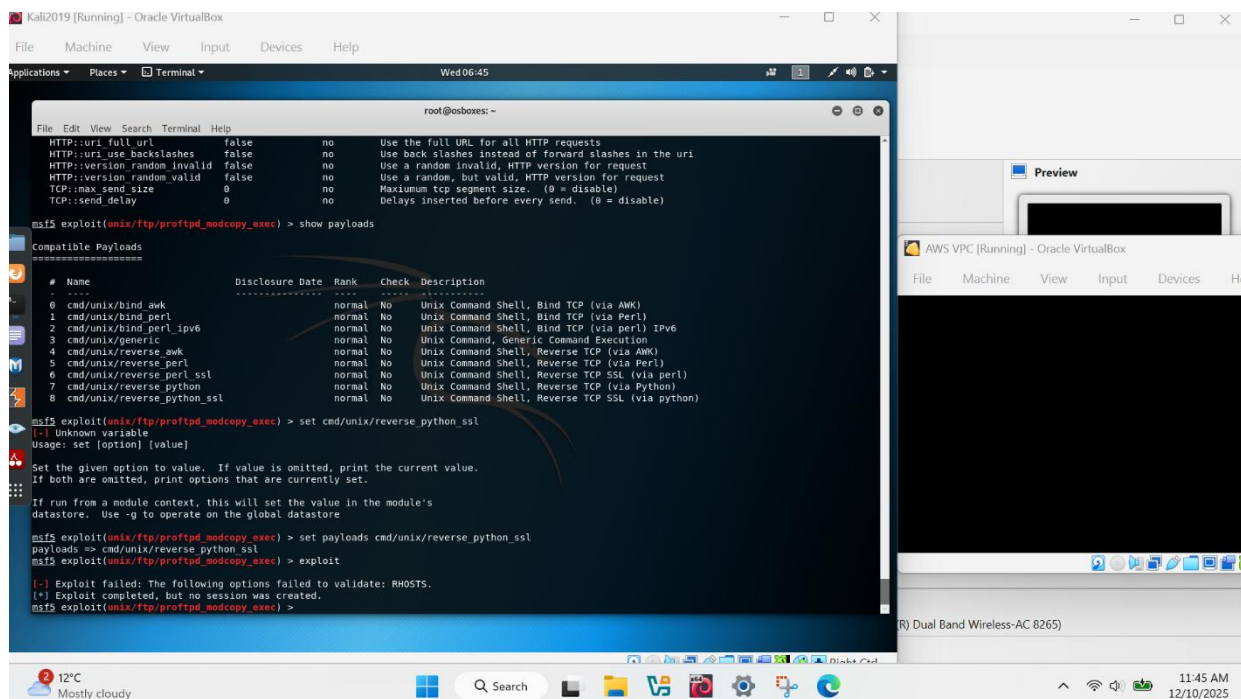


Fig: Payloads

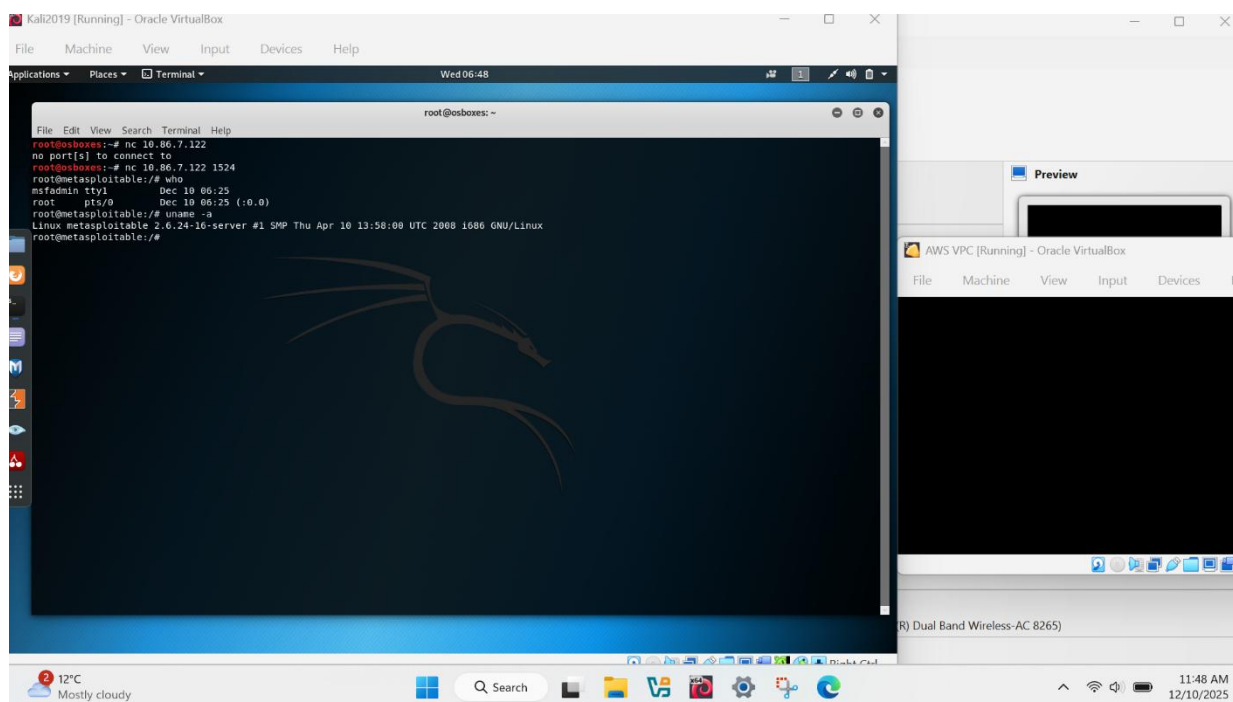


Fig: Success

CI/CD Pipelines for Application Development:

The Red Team will focus on the Continuous Integration / Continuous Deployment (CI/CD) pipeline – a critical asset for application development and software deployment. If the treatment is capable of breaking into the pipeline, this would enable Red Team to inject malicious code in production systems, hijack software builds, and perform a mass breach on an organization's software supply chain.

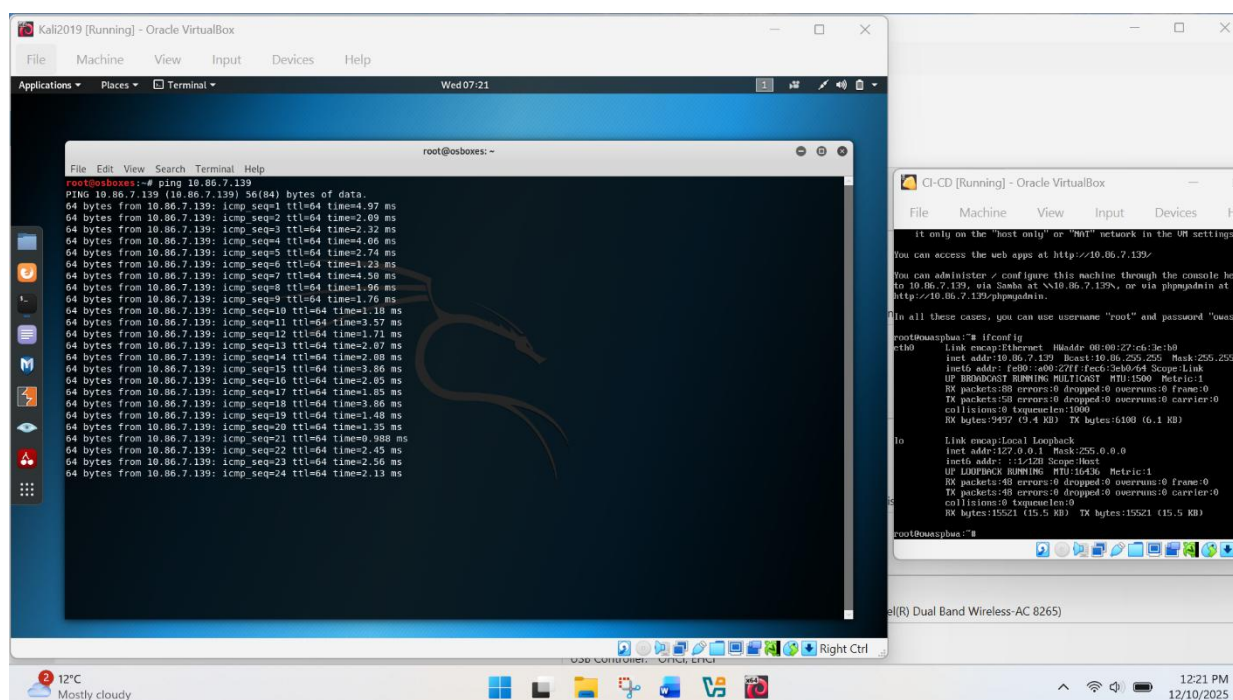


Fig: Kali to CI/CD

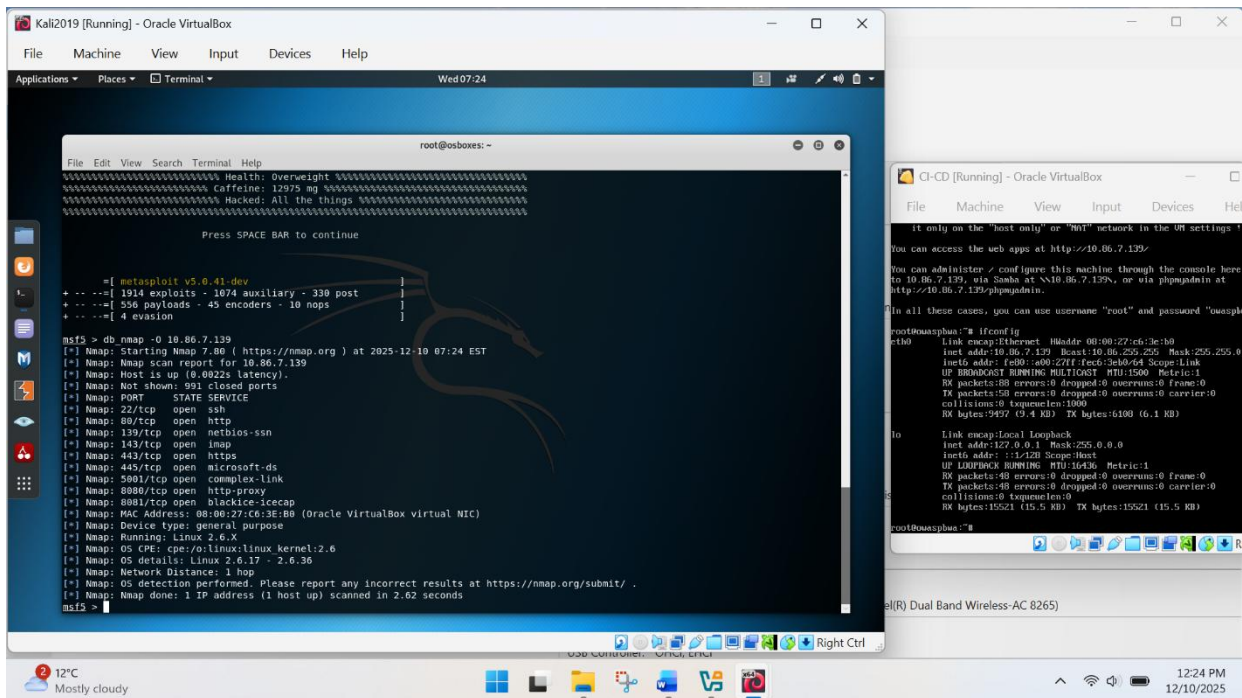
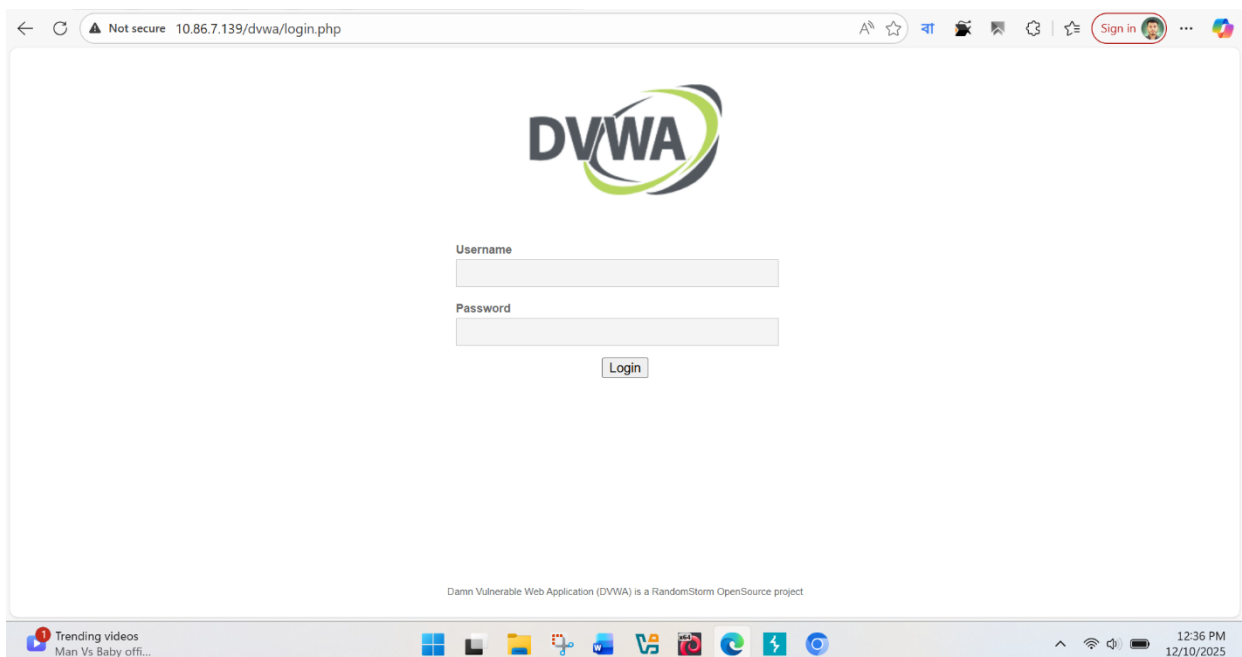


Fig: nmap Kali to CI/CD



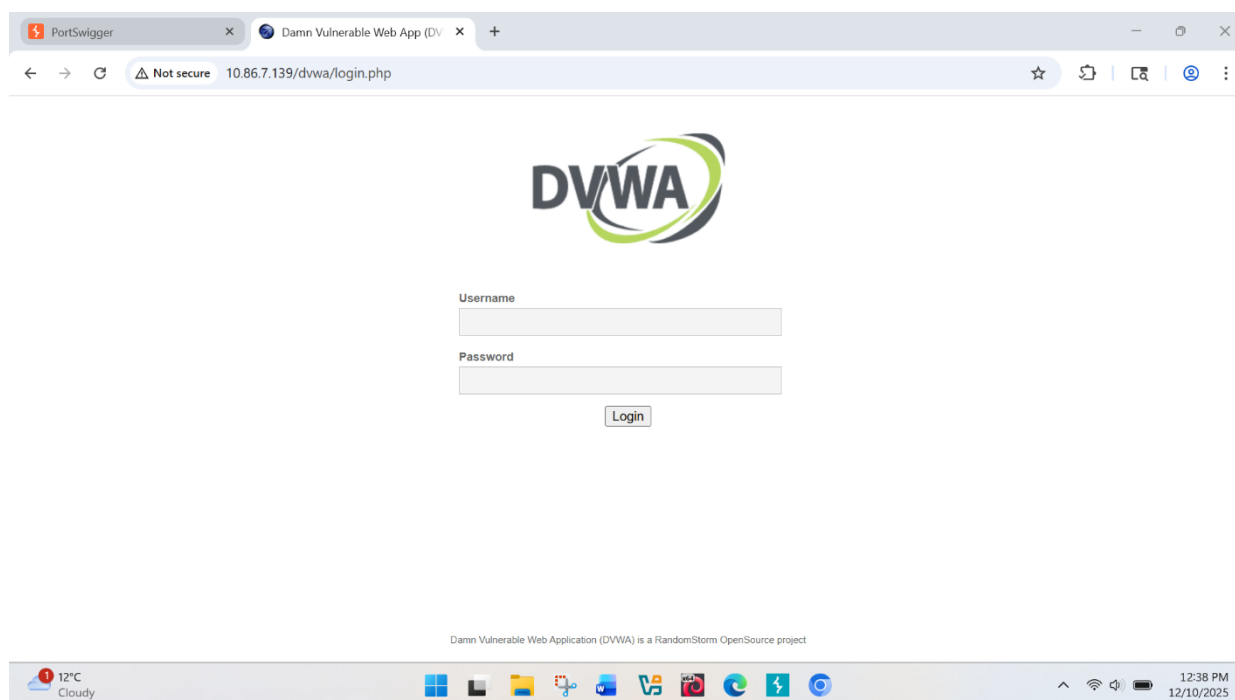


Fig: Burp Suite

Attack Execution Strategy:

To perform the attack, The Red Team will leverage various tools and techniques that imitate the tactics of a real world APT actor - focusing on true stealth and evasion:

Cobalt Strike:

Cobalt Strike will be leveraged to simulate advanced threat actors by setting up a command and control (C2) pipe for the Red Team. This will aid in beaconing, post-exploitation activities, lateral movement. The crew will use privilege escalation and data extraction first grade, with the goal to stay hidden in security wings.

Sliver Framework:

Sliver will serve as an alternative C2 framework for remote access and exploitation. Its versatility also in the establishment of steganographic channels (HTTP or DNS channel) will circumvent detection produced by network-based security systems such as IDS (Intrusion Detection System) and firewall.

Living-Off-the-Land (LOLBin) Techniques:

The Red Team will also use LOLBins to bypass endpoint protection solutions. Existing network tools like PowerShell, WMI and Command Prompt will be used for nefarious activities including lateral movement and credential dumping.

Credential Dumping and Lateral Movement:

The group will take advantage of poor password policies and credential-dumping tools in order to gain access to sensitive information. After exploitation, the team will traverse using SMB and RDP, ultimately looking for sensitive data within the AWS VPC as well as CI/CD pipeline.

Stealthy Data Exfiltration:

The Red Team will exfiltrate its collected information over encrypted channels to avoid network security tools detection. FTP over SSL or HTTPS to circumvent defences, and exfiltrate the stolen data to a remote destination managed by threat actors.

3.3 Reporting & Analysis

Technical Report for Blue Team:

The Technical Report will go into detail about the entire attack chain from initial access to data theft. This report is going to be organized in a play-by-play format covering the Red Teams actions and how they would have been overlaid to an actual adversary tactic. The main contents of the report will consist:

Initial Access:

The report will describe how the spear-phishing attack worked, including how the infiltrators used malware-laden attachments or links in emails to gain access to employees. It will detail how the spear-phishing emails were designed to appear genuine and how the malware was executed when victims clicked on the email.

The point of entry into the network will be explicitly described once they uncover it, so everyone understands how the adversaries were able to circumvent over initial lines of defense such as email filters and perimeter security.

Execution & Privilege Escalation:

This section will explore the actual methods, tools, and commands that the Red Team used to navigate to different areas of the network. It will detail how the attackers leveraged pre-existing weaknesses to escalate privileges and compromise sensitive systems.

The report will detail the actual time-line of the attack and how attackers used tools such as PowerShell to execute code for an exploit that was exploited against UAC (User Account Control) in order to elevate access to administrator level.

Persistence & Lateral Movement:

The report will describe how the Red Team maintained network access following initial access. This will involve looking at persistence mechanisms—how the attackers would create a scheduled task, or modify a registry key to retain access even after the box was rebooted.

The section would also feature the lateral movement techniques used and discuss SMB (Server Message Block) and RDP (Remote Desktop Protocol) as they are used to move across into the internal network. The report will explain how these techniques enabled the attackers to breach and exploit additional systems without detection from endpoint protection solutions.

Exfiltration & Impact:

This part of the report aims to describe how data was exfiltrated from the network, being described options for the Red Team to move sensitive information (e.g., patient's data or intellectual property) over secure protocols as FTPS or HTTPS.

The report will also investigate how effective the organization's detection systems are. Any gaps in detections – e.g it was unable to see fileless malware or lateral movement over RDP – are highlighted and how these gaps enabled the success of the attack. The implications of the attack for the security posture of organizations will be assessed, including a description of key assets at risk and the inability to identify important TTPs.

Detection Gaps:

The report won't just cover what the Red Team did, but also areas where the Blue Team's security controls fell short in detecting they were being attacked. This analysis will include:

Red Team Usage of Fileless Malware: The Red Team leveraged the use of fileless malware, for example, scripts that ran in memory (e.g., PowerShell or WMI), evading traditional antivirus and endpoint protection. The report also will detail how the Blue Team failed to identify these threats.

The use of RDP for lateral movement: The report will focus on how the Red Team shuttling itself around inside the network using RDP wasn't covered, and explain that's because they didn't have proper monitoring of it when remote administrators were traipsing about with – duck, duck, goose – privileged access.

The objective of this section is to demonstrate how the Blue Team would enhance their capabilities in detecting and defending against future attacks.

Executive Brief for the Board:

Executive Brief An executive summary of the attack's details, specifically for business users. The brief will address the financial and strategic consequences of the attack, offering suggestions for additional improvements in organizational security. Key points will include:

Financial Losses:

The brief will call attention to potential financial impact of the attack, such as ransom payments, operational downtime and brand reputation damage. That report will describe the many ways in which the attack impacted on the hospital's ability to serve patients, as well as financial implications for its operations over time.

It is also equipped with a cost estimate of regulatory penalties and legal fees as a result of the data breach theft of sensitive patient information.

Strategic Security Enhancements:

The report will recommend changes to strategic security based on the lessons learned from the attack. These will involve advice for increasing the effectiveness of incident detection and response mechanisms, enhancing data protection measures and perimeter defense via network segmenting and patch management.

The filing will stress the necessity of implementing more sophisticated threat sensing techniques, such as endpoint detection and response (EDR), Security Information and Event Management (SIEM), and intrusion prevention systems (IPS) to more quickly identify and respond to similar attacks in future.

Cost-Benefit Analysis:

The brief will also feature a cost benefit analysis to prove why more money is needed for cybersecurity. It will also help you measure potential security improvements (like enhancing security monitoring, or enabling multi-factor authentication) against the cost of a breach in the future. What the analysis would reveal is that prevention and increased security cost far less than financial, reputational and legal penalties of such follow-on attacks.

This section will make a strong argument for diverting resources to better security infrastructure and give credibility to cybersecurity as an important asset for the future of the company.

The Letter of Transmittal will be written in non-technical language, include plain- English summary information for the benefit of the board members and emphasize why it is critical to improve the organizations security posture to reduce future exposure risks and ensure business continuity.

Conclusion:

It also surfaced the cybersecurity shortcomings from the hospital — which included the absence of multi-factor authentication (MFA), a outdated software and deficiencies in network segmentation. Attackers were able to compromise via spear phishing, elevate privileges with unpatched vulns, and steal information over SMB and side-channel communications. This attack revealed some key shortfalls in the preventative and detective controls of the organization with considerable monetary, reputational, and regulatory implications.

During the Red Team engagement, the simulated attack was all about emulating and testing an organization's hybrid infrastructure (on-premises AD network and AWS VPC) combined with CI/CD pipelines. The attack proved an APTs ability to take advantage of vulnerabilities in such systems, emphasizing the need for networked-segmentation, incident response planning, and for being able to detect advanced malware. The incident was suspected to have been carried out via tooling such as Cobalt Strike, Sliver, and highlighted the importance of stealth and evasion in a real-world attack.

Offensive security, and especially Red Team exercises are essential to increasing a company's defensive preparedness [4]. Red Team exercises simulate real attacks, so that organizations can know how attackers are going to act or find weaknesses and test the defense it has in place. This proactive methodology allows teams to hone all of their incident detection, response programs and architectural systems without a real attack taking place. Given the threat landscape, where cyber threats are evolving and attackers are increasingly advanced, employing offensive security techniques like Red Teaming is critical for outpacing adversaries and maintaining business operations.

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