

1 Threat Analysis

1.1 Authentication

According to the Annual Cyber Threat Report (ACTR) 2023-2024, the most frequently reported threat in Australia were Authentication attacks in the form of “compromised accounts or credentials”[1], accounting for nearly one-third of all cybercrime incidents nationwide. This prevalence underscores the critical importance of understanding and mitigating authentication-related threats in the current cybersecurity landscape.

Authentication breaches encompass a wide array of attack categories, each exploiting different weaknesses in user and system behavior. The most prominent include **phishing**, which leverages psychological manipulation to trick users into divulging credentials, and **brute force attacks**, where adversaries systematically guess passwords using automated tools. **Password spraying** represents a “low and slow” approach, targeting many accounts with common passwords to evade detection. **Credential stuffing** utilizes previously breached username-password pairs, often sourced from large-scale data leaks, to gain unauthorized access through automation. These categories highlight the multifaceted nature of authentication threats, demonstrating why password-based attacks remain a critical focus for security research and organizational defense.

1.2 Threats in the Authentication Landscape

1.2.1 Current Threat Landscape

Authentication threats represent a critical challenge in today’s cybersecurity landscape, both in Australia and globally. The Albanese Government’s commitment of \$15–\$20 billion through 2033–34 to strengthen cyber domain capabilities underscores the national urgency to address these issues[1]. In the 2023–24 financial year, the Australian Signals Directorate received over 36,700 calls to its Cyber Security Hotline 12% increase from the previous year, reflecting the growing prevalence of cyber incidents[1]. Notably, compromised accounts or credentials accounted for **32% of all cybercrime**, making it the leading contributor to reported incidents. On a global scale, Microsoft Entra data reveals that of more than **600 million identity attacks per day**, over **99% are password-based**[2]. These statistics highlight the widespread and persistent nature of authentication-related threats, demonstrating why robust authentication mechanisms are essential for organizational and national security.

1.2.2 Typical Adversary Types

Authentication attacks are executed through several distinct methods, each exploiting specific vulnerabilities in user behavior and system design.

- **Phishing** is a psychological manipulation technique where adversaries impersonate trusted entities, often via email or messaging platforms, to deceive users into revealing their credentials. This method remains highly effective due to its reliance on social engineering rather than technical flaws.
- **Brute force attacks** involve systematically generating and attempting password combinations until a valid login is achieved. Attackers leverage automated tools to accelerate this process, targeting accounts with weak or commonly used passwords.
- **Password spraying** refines brute force tactics by distributing login attempts across many accounts using a shortlist of popular passwords, thereby evading detection mechanisms that monitor for rapid, repeated failures. A notable example is the 2024 Midnight Blizzard incident, where attackers employed password spraying against Microsoft’s infrastructure, prompting significant defensive actions[3].
- **Credential stuffing** utilizes credentials harvested from previous data breaches, exploiting the widespread practice of password reuse across multiple services. The 2022 Optus breach illustrated the impact of this technique, as compromised credentials were repurposed to target other organizations[4]. These methods collectively demonstrate the evolving sophistication and persistence of authentication threats in the modern cyber landscape.

1.2.3 Impact

This section starts with how phishing and credential stuffing can be used as good starts

The organizational impact of authentication breaches is starkly illustrated by the 2022 Optus incident, which exposed sensitive data of nearly 10 million Australians and triggered widespread concerns over identity theft and fraud [4]. More recently, the Qantas breach in July 2025 affected 5.7 million customers, with varying degrees of personal information compromised [5]. Both cases highlight the persistent threat posed by credential stuffing, where attackers leverage previously leaked credentials to infiltrate systems at scale. The consequences include

substantial financial losses, operational disruption, and enduring reputational harm, emphasizing the critical need for organizations to strengthen authentication controls and proactively address credential-based threats.

1.3 Threat Choice Justification

The selection of authentication attacks as the focal threat for this analysis is driven by their overwhelming prevalence and critical impact on both Australian and global organizations. Recent reports indicate that compromised credentials account for nearly one-third of all cybercrime incidents in Australia, with high-profile breaches such as Optus and Qantas underscoring the real-world consequences of these attacks[1], [4], [5]. The universal reliance on password-based authentication across industries makes this threat highly relevant and widely applicable. From a technical perspective, authentication attacks such as brute force, password spraying, and credential stuffing offer a rich landscape for analysis, enabling clear success and failure metrics and supporting laboratory-based experimentation.

While phishing remains a significant aspect of authentication security due to its effectiveness and prevalence, it is not easily testable in a controlled lab environment and will not be the focus of practical testing in this assignment. Nevertheless, its role in the broader authentication threat landscape will be acknowledged. Furthermore, the threat aligns strongly with established frameworks like MITRE ATT&CK (T1110 family)[6], providing a robust foundation for evaluating defensive strategies and mapping adversary techniques.

This combination of prevalence, technical depth, and framework integration makes authentication attacks an ideal subject for comprehensive security analysis. It will also be interesting to see how easy it is to break into hypothetical systems and gain a practical understanding of how secure my own personal passwords really are.

2 Overview of Attacker Tools

This section examines four prominent authentication attack tools to understand their capabilities, limitations, and practical applications in cybersecurity research. The analysis evaluates both offline password recovery tools (Hashcat, John the Ripper) and online network-based attack tools (Hydra, NetExec), providing a comprehensive overview of the current authentication threat landscape. By comparing these tools across different attack methodologies—from hash cracking to live network authentication testing—this research establishes the foundation for selecting the most appropriate tool for subsequent defensive analysis and laboratoryd

2.1 Comparison Table

Tool	Attack Type	Primary Use Case	Key Strengths
Hashcat	Offline hash cracking	Password recovery from hashes/encrypted files	450+ algorithms, GPU acceleration, high performance
Hydra	Online network attacks	Live service authentication testing	50+ protocols, real-time feedback, flexible attack modes
John the Ripper	Offline hash cracking	Educational/legacy password auditing	Rule engine, single mode, broad compatibility
NetExec	Network reconnaissance	Enterprise Active Directory assessment	Multi-protocol, BloodHound integration, lateral movement

Table 1: Attack Tools Comparison

2.2 Hashcat

Hashcat is a specialized tool for password-based attacks, focusing on scenarios where the attacker has access to known hash or encrypted data and aims to recover the original password or passphrase. It employs brute force, dictionary, and hybrid attack methods to achieve this goal. Hashcat excels at cracking password hashes across more than 450 supported algorithms[7], recovering passwords for encrypted file formats, and deciphering offline authentication tokens.

Hashcat is limited to offline password recovery and cannot break mathematically sound encryption without access to passwords, attack live network services, or exploit flaws in cryptographic implementations. Its strengths lie in

unmatched password recovery capabilities, broad algorithm support, and GPU-accelerated performance, making it a specialized tool for cracking password hashes and encrypted files rather than attacking network protocols or cryptographic weaknesses.

Rather than replacing network-based tools such as Hydra, Hashcat focuses on offline attacks against captured password hashes or encrypted files, while Hydra targets live authentication services by attempting to guess credentials in real time. Hashcat operates independently of network access, working in the dark to recover passwords from stored data. Once successful, the recovered credentials can be used to access systems without further brute force attempts.

2.2.1 Strengths and Weaknesses

Strengths:

- Unmatched password recovery capabilities
- Supports 450+ password hash algorithms
- GPU-accelerated performance for rapid attacks
- Effective for encrypted file formats and offline authentication tokens

Limitations:

- Requires access to password-protected material (hashes, encrypted files)
- Cannot break mathematically sound encryption without passwords
- Not suitable for attacking live network services
- Does not exploit cryptographic implementation flaws

2.2.2 Use Cases

- Cracking password hashes extracted from sources such as Windows “Ntds.dit” or “SAM” files, Linux “/etc/shadow”, or other stored hash values supported by Hashcat’s extensive algorithm coverage.
- Recovering lost passwords for encrypted files or authentication tokens

2.3 Hydra

Hydra is a versatile tool for conducting password-based attacks against live network services. Unlike Hashcat, which focuses on offline password recovery from hashes or encrypted files, Hydra targets active authentication endpoints by systematically testing username and password combinations in real time. It supports more than 50 protocols, including web services (HTTP, HTTPS), remote access (SSH, Telnet, RDP), file sharing (FTP, SMB), databases (MySQL, PostgreSQL), and email (IMAP, SMTP)[8]. Hydra is commonly used for brute force, password spraying, and credential stuffing attacks, providing immediate feedback on successful logins.

For this research, Hydra was chosen over Medusa[9] due to Medusa’s lack of recent git commits and lower comparative popularity on GitHub, indicating less active development and community support. Medusa offers functionality comparable to Hydra, with a modular architecture that enables consistent command usage across various protocols. However, its lower popularity and less active development made it a secondary choice for this research.

2.3.1 Strengths and Weaknesses

Strengths:

- Directly tests live authentication systems
- Supports a wide range of network protocols
- No need for hash extraction
- Immediate identification of valid credentials
- Flexible attack modes (brute force, spraying, credential stuffing)
- Custom wordlist and username/password combinations

Limitations:

- Generates network traffic that can be detected and logged
- May trigger account lockout or security alerts
- Network speed and server response time can affect performance
- Cannot bypass multi-factor authentication or modern protocols (OAuth, SAML)
- Requires network connectivity to the target

2.3.2 Use Cases

- Testing the strength of passwords for web applications, remote access, and file sharing services
- Simulating password spraying attacks to evaluate organizational defenses
- Assessing exposure to credential stuffing

2.4 John the Ripper

John the Ripper is a foundational password cracking and security auditing tool that established many baseline techniques in the field. As the “original” password cracker[10], it operates primarily through offline hash cracking similar to Hashcat, while also offering limited online attack capabilities. John the Ripper exists in two main variants: the classic mode with traditional password cracking algorithms, and the community-enhanced “Jumbo” version that supports over 200 hash formats including Unix/Linux systems, Windows environments, applications, databases, and cryptocurrency wallets[11].

John the Ripper distinguishes itself through its sophisticated rule engine for password transformations and unique “single mode” that leverages account information to generate targeted password candidates. While it shares offline hash cracking capabilities with Hashcat, John the Ripper’s historical significance and educational value make it valuable for understanding classical password cracking techniques, though it operates at significantly slower speeds on modern GPU hardware.

2.4.1 Strengths and Weaknesses

Strengths:

- Historical significance with established algorithms and techniques
- Sophisticated rule engine for password transformation
- Unique single mode using account information for targeted attacks
- Broad compatibility with older and limited hardware
- Educational value with well-documented classical algorithms
- Dual architecture supporting both classic and enhanced modes

Limitations:

- Significantly slower GPU performance compared to Hashcat
- Slower development pace and update cycle
- More complex configuration than modern tools
- Less optimized memory efficiency for large-scale attacks
- Limited online attack capabilities compared to dedicated network tools

2.4.2 Use Cases

- Educational environments for learning password cracking fundamentals
- Legacy system auditing where modern tools may not be compatible
- Specialized rule-based attacks leveraging account information
- Cryptocurrency wallet password recovery for older formats
- Cross-platform password auditing on resource-constrained systems

2.5 NetExec

NetExec is a network penetration testing tool designed to identify security vulnerabilities within enterprise networks by systematically testing credentials across multiple services and protocols. Operating under the philosophy that “you’re only as strong as your weakest point,” NetExec performs comprehensive credential validation across network infrastructure to locate authentication weaknesses[12]. The tool primarily targets Windows-specific protocols commonly used in enterprise environments, making it particularly effective for Active Directory assessments and post-exploitation activities.

NetExec distinguishes itself from single-protocol tools like Hydra through its multi-protocol approach and specialized Windows/Active Directory focus. While Hydra targets individual services, NetExec provides a comprehensive network-wide assessment capability, automatically testing credentials against discovered services and integrating with tools like BloodHound for attack path visualization[13]. This makes it valuable for both initial network reconnaissance and post-compromise lateral movement scenarios.

2.5.1 Strengths and Weaknesses

Strengths:

- Supports multiple protocols (SMB, LDAP, WINRM, MSSQL, SSH, FTP, RDP, WMI, NFS)
- Integrated BloodHound support for network mapping and attack path visualization
- Automated credential validation across entire network infrastructure
- Specialized Windows/Active Directory enumeration capabilities
- Post-exploitation lateral movement through advanced credential attacks
- Support for pass-the-hash, Kerberos abuse, and LAPS integration

Limitations:

- Primarily Windows/Active Directory focused, limiting applicability to Linux-only environments
- Requires existing network access for post-exploitation activities
- May trigger security alerts due to multiple authentication attempts
- Cannot bypass multi-factor authentication or modern OAuth/SAML protocols
- Dependent on network connectivity and target system availability

2.5.2 Use Cases

- Enterprise Active Directory assessment for automating credential validation and security posture evaluation across large Windows networks
- Post-compromise lateral movement through advanced credential attacks including pass-the-hash and Kerberos abuse
- Comprehensive domain security validation including delegation detection and Certificate Services enumeration
- Automated BloodHound data collection for attack path visualization and privilege escalation planning

2.6 Attack Tool Selection and Summary

After evaluating the four authentication attack tools, **Hydra** emerged as the most suitable choice for this research assignment. This selection was critical to establish before proceeding to defensive tool analysis, as it provides the foundation for understanding what threats need to be mitigated.

Hydra offers the ideal balance of capabilities for this assignment's scope. Its support for over 50 network protocols, real-time authentication testing, and immediate feedback mechanisms make it particularly valuable for understanding live network attack scenarios. The tool's ability to perform brute force, password spraying, and credential stuffing attacks directly aligns with the authentication threat landscape identified in the threat analysis section.

3 Overview of Defender Tools

3.1 Comparison Table

3.2 Fail2ban

Fail2ban is a UNIX based system (sorry windows), that operates by scanning log files and systemd journals using specified regular expressions (filter-rules) to detect authentication failures and other suspicious activities[14]. When failures exceed configured thresholds, fail2ban executes actions to ban the offending sources, typically by updating system firewall rules to reject new connections from those IP addresses for a configurable duration. The system operates through "jails" - configuration units that define which log files to monitor, what patterns constitute failures, and how many attempts within a specified time window trigger bans.

Fail2ban comes pre-configured to monitor standard log files for services like SSH and Apache, but can be easily customized to read any log file and detect any error pattern.

3.2.1 Strengths and Weaknesses

Strengths:

- Automated real-time response eliminates manual monitoring requirements
- Lightweight operation with minimal system resource consumption
- Cross-protocol support covering Hydra's entire attack surface
- Highly configurable detection thresholds and response parameters
- Built-in integration with standard system logs and firewall mechanisms

Tool	Attack Type Defended	Primary Use Case	Key Strengths
Fail2ban	Brute force, password spraying	Automated banning of IPs after failed logins	Real-time response, lightweight, highly configurable, persistent bans
Wazuh	Distributed brute force, credential stuffing, coordinated attacks	Centralized security event correlation and automated response	Unified XDR/SIEM, behavioral analysis, threat intelligence, scalable, open source
pfSense	Network-level brute force, high-volume attacks, external threats	Perimeter firewall, traffic filtering, threat intelligence integration	Network-wide protection, geographic/reputation IP blocking, real-time analysis, open source
Suricata	Automated credential attacks, rapid connection attempts, protocol abuse	Deep packet inspection, real-time threat detection	High-performance, passive/active modes, SIEM integration, rapid response

Table 2: Defender Tools Comparison

- Open source, with good community documentation.
- Persistent ban tracking across service restarts and system reboots

Limitations:

- Reactive defense model requires attacks to begin before protection activates
- Vulnerable to distributed attacks using multiple source IP addresses
- Risk of legitimate user lockouts through misconfigured thresholds or false positives
- Log-dependent detection misses network-level attack indicators
- Ineffective against slow, low-threshold attacks designed to evade detection
- Limited threat intelligence integration for proactive source blocking
- Potential for bypass through IP rotation or proxy-based attacks
- Does not have native Windows support

3.2.2 Hydra Defense

Fail2ban could effectively counter Hydra’s authentication attacks by monitoring system logs for failed login patterns and automatically blocking source IP addresses after exceeding configured thresholds. When Hydra conducts brute force or password spraying attacks against SSH, HTTP forms, FTP, or other services, fail2ban detects the repeated authentication failures and implements immediate firewall blocks that terminate the attack session.

3.3 Wazuh

Wazuh is a free and open-source platform that unifies XDR (Extended Detection and Response) and SIEM (Security Information and Event Management) capabilities for protecting workloads across on-premises, virtualized, containerized, and cloud-based environments[15].

Wazuh’s centralized architecture enables enterprise-wide correlation of security events, detecting coordinated attacks that may be missed by isolated systems. By integrating MITRE ATT&CK mapping and threat intelligence, Wazuh identifies complex attack patterns through behavioral analysis and cross-system event relationships. Detected threats trigger automated responses such as firewall updates, security alerts, compliance reporting and other various sets of functionality.

3.3.1 Strengths and Weaknesses

Strengths

- Unified XDR and SIEM capabilities with no licensing costs
- Centralized monitoring and correlation across distributed environments
- Comprehensive security coverage including threat detection, compliance, and incident response
- Open-source platform with active community development

- Scalable architecture supporting enterprise-level deployments
- Integration capabilities with cloud platforms and security tools
- Behavioral analysis and threat intelligence integration

Limitations

- Complex deployment and configuration requirements
- Significant resource consumption for central processing infrastructure
- Steep learning curve for effective implementation and tuning (They sell 3 day tutorial sessions for \$1800)
- Potential for alert overload without proper configuration
- Dependency on network connectivity and agent deployment
- Performance considerations with large-scale log processing
- Limited real-time blocking compared to dedicated prevention tools

3.3.2 Hydra Defense

Wazuh can help defend against Hydra's authentication attacks by monitoring security events from many systems at once. This means it can spot brute force attacks that use multiple computers to avoid detection. Wazuh looks for patterns like repeated failed logins or attempts to guess passwords quickly. When it finds suspicious activity, it can automatically alert security staff, block the attacker's access, or record the incident for review.

3.4 pfSense

pfSense is a FreeBSD-based open-source firewall and router platform designed for network perimeter security[16]. Acting as a gateway, it proactively filters traffic and blocks threats before they reach internal systems. With integrated threat intelligence, geographic IP filtering, and reputation databases, pfSense can preemptively block known malicious sources. Its connection rate limiting and automated rule enforcement help prevent brute force and high-volume attacks at the network boundary, providing organization-wide protection through real-time traffic analysis.

3.4.1 Strengths and Weaknesses

Strengths

- Open-source platform with no licensing costs and active community development
- Network perimeter positioning providing organization-wide protection before attacks reach internal systems
- Geographic and reputation-based IP blocking through threat intelligence integration
- Comprehensive network services combining firewall, VPN, routing, and monitoring capabilities
- Real-time traffic analysis and logging for forensic investigation and compliance reporting

Limitations

- Network perimeter focus limits visibility into internal threats and application-layer authentication details
- Requires dedicated hardware or virtual machine resources, increasing infrastructure costs
- Advanced configuration and management demand significant networking expertise
- Geographic IP blocking may inadvertently affect legitimate users using VPNs or traveling
- Performance bottlenecks can occur on lower-spec hardware when handling high traffic volumes

3.4.2 Hydra Defense

pfSense can help protect against Hydra attacks by blocking traffic from suspicious locations and known bad IP addresses before it reaches your network. Its ability to limit the number of connection attempts and automatically block sources that try to log in too quickly makes it effective at stopping brute force attacks.

3.5 Suricata

Suricata is a network security tool that inspects data packets in real time to detect threats and suspicious activity. It uses predefined rules and signatures to spot attacks, unusual protocol behavior, and malicious content as traffic passes through the network. Suricata can work passively to monitor and log network activity for later analysis, or actively block threats when deployed inline. Its focus on analyzing network traffic at the packet level allows for quick detection and detailed investigation of attacks that may not show up in standard system logs.

3.5.1 Strengths and Weaknesses

Strengths

- Deep packet inspection for detailed network protocol and content analysis
- Supports both passive IDS monitoring and active IPS prevention
- High-performance processing for multi-gigabit traffic loads
- Real-time threat detection with rapid response to network attacks
- Integration with SIEM platforms and threat intelligence feeds

Limitations

- Requires specialized expertise for deployment and rule tuning
- High resource usage for deep packet inspection can impact performance
- Needs frequent rule updates to stay effective against new threats
- Limited visibility into encrypted traffic
- Potential for false positives without careful configuration

3.5.2 Hydra Defense

Suricata could potentially detect Hydra attacks through deep packet inspection that identifies rapid TCP connection sequences and systematic authentication patterns characteristic of automated credential testing tools. When deployed in IPS mode, the platform might actively block detected attack traffic in real-time, though effectiveness could be limited against encrypted authentication protocols and distributed attacks that blend with legitimate network traffic.

3.6 Defender Tool Selection and Summary

Fail2ban was selected as the defensive tool for this assignment because it provides simple, automated protection against brute force authentication attacks like those performed by Hydra. It is lightweight, easy to configure, and works directly with standard Linux logs, making it ideal for small business or single-server environments. Unlike more complex or resource-intensive solutions, Fail2ban offers effective real-time blocking without requiring advanced expertise or additional hardware.

4 Scenario Design

4.1 Defender

A small, up-and-coming web development team fresh out of Swinburne operates with a single Linux server to keep costs low and offer competitive pricing. Without dedicated IT staff, the team members each have varying levels of technical expertise and share basic system administration duties. Their focus on affordability has resulted in limited security measures, exposing the business to risks while they strive to maintain essential services for customer orders and revenue.

4.1.1 Key Points

- Single Linux server directly exposed to the internet via a residential ISP using a generic home modem/router, no DMZ or dedicated firewall
- Router port forwarding: 22 (SSH), 80 (HTTP), 3306 (MariaDB) directly to server
- Flat network topology with server on same subnet as personal devices (192.168.1.0/24)
- Default service configurations with weak password policies
- Shared credentials and password reuse across team members No centralized logging or security monitoring capabilities

4.2 Attacker

A former classmate and friend of the students, feeling betrayed after discovering that the team is using his original business idea without credit, becomes determined to take revenge. Motivated by anger and a sense of injustice, he leverages his technical knowledge to conduct reconnaissance against his former friends' business. After seeing their company advertised on social media, he uses the website's domain name to identify their server's IP address through DNS lookups. Port scanning reveals multiple exposed services, confirming his suspicions about their poor security practices from their time together at university.

4.2.1 Key Points

- Target identified via company website and social media
- Server IP address discovered through DNS lookup
- Port scanning exposed SSH, HTTP, and MariaDB services
- Weak passwords and shared credentials increase risk of unauthorized access
- Personal knowledge of team members aids password guessing
- Valuable customer data and business disruption motivate attack

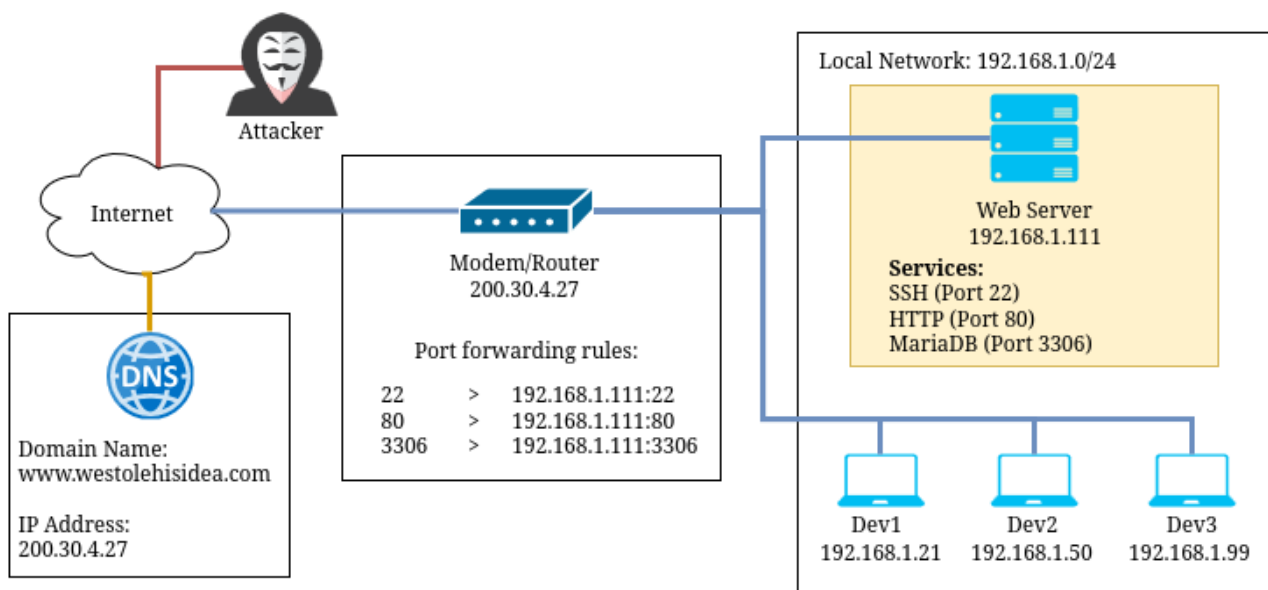


Figure 1: Visual representation of scenario

5 Enviroment Setup

5.1 Technical Details

5.1.1 Passwords

- A random selection of 500 passwords were sourced.
- Kali Linux's `rockyou.txt` password list was used. It can be accessed via the `wordlists` command.
- Using an existing password list was done to maintain focus on tool usage rather than password list generation, which easily has enough depth to have a whole seprate report written about it.
- In real-world scenarios, attackers rarely have a guaranteed password list, but for testing purposes, a known list ensures tool functionality.
- I used the `shuf` tool to randomly select passwords for the user profiles. I then created the users "bob, jim and harold" with the passwords.
- Database passwords were made similar to SSH passwords to highlight typical credential reuse, making it easier for attackers to guess passwords across services.
- It is assumed that the attacker knows the usernames, which is plausible within they were friends in the context of this exercise.

Service	Username	Password
mariadb	root	neyo24
mariadb	bob	all4mine
mariadb	jim	ilovepico
mariadb	harold	angelica
ssh	root	neyo25
ssh	bob	all5mine
ssh	jim	ilovepicodepuppy
ssh	harold	angelcha

Table 3: Generated Password List

5.1.2 Permissions

- root privileges had to be given to be given to bob's user account to progress past "step 1" of the scenario.
- bob, jim and harold have been given **SELECT**, **INSERT** and **UPDATE** permissions.
- root can only be accessed from a root account, so to access the account the root user password will first need to be discovered.

5.1.3 Virtual Network

- In the scenario, the attacker discovered the server's IP address by resolving the domain name, which was publicly shared in a social media post. This could have been virtually implemented but was not required for the scope of the scenario.
- Both machines were placed on the same virtual network to meet the assignment's requirement of a non-internet-facing environment. A diagram that references this can be seen in Figure 2.

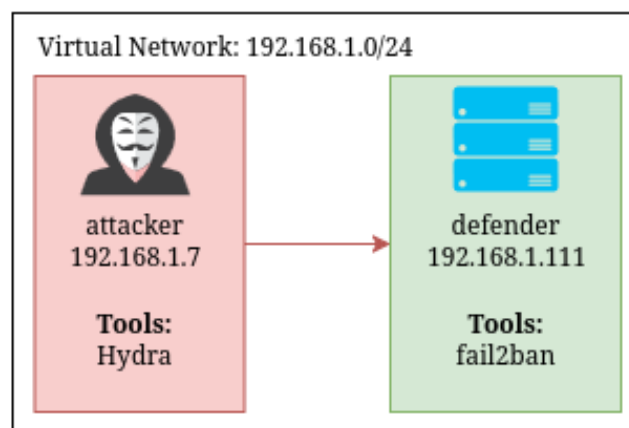


Figure 2: Visual representation of scenario

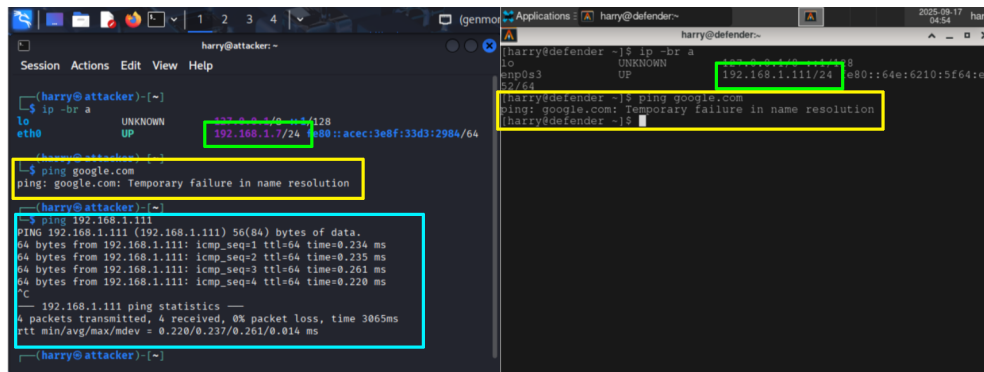
5.1.4 Attacker Machine

The attacker machine was chosen for its comprehensive suite of pre-installed security tools, which suited the requirements of this assignment. The only additional configuration involved updating all tools to their latest versions and manually assigning an IP address, as there was no DHCP server available within the virtual network. This setup provided a reliable and ready-to-use environment for conducting the required tests.

5.1.5 Defender Machine

I selected Arch Linux for the defender machine because it is the Linux distribution I am most familiar with. Its lightweight nature allowed me to efficiently run the assignment on my laptop, and my experience with its package manager made installing and configuring the necessary tools straightforward. Additionally, using Arch Linux ensured that no defense tools or background services would be operating without my knowledge, giving me full control over the environment. This familiarity ensured a smooth setup process and minimized time spent troubleshooting environment issues.

5.1.6 Proof of Virtual Network



```
harry@attacker:~$ ip -br a
lo        UNKNOWN UP          192.168.1.7/24
etho      UP          192.168.1.111/24

harry@attacker:~$ ping google.com
ping: google.com: Temporary failure in name resolution

harry@attacker:~$ ping 192.168.1.111
PING 192.168.1.111 (192.168.1.111) 56(84) bytes of data:
64 bytes from 192.168.1.111: icmp_seq=1 ttl=64 time=0.234 ms
64 bytes from 192.168.1.111: icmp_seq=2 ttl=64 time=0.235 ms
64 bytes from 192.168.1.111: icmp_seq=3 ttl=64 time=0.261 ms
64 bytes from 192.168.1.111: icmp_seq=4 ttl=64 time=0.220 ms
^C
--- 192.168.1.111 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3065ms
rtt min/avg/max/ndev = 0.220/0.237/0.261/0.014 ms

harry@defender:~$ ip -br a
lo        UNKNOWN UP          192.168.1.111/24
etho3     UP          192.168.1.111/24
harry@defender:~$ ping google.com
ping: google.com: Temporary failure in name resolution
```

Figure 3: Green: IP Addresses, Yellow: Unable to ping google.com, Blue: Attacker pinging the defender machine

6 Scenario Breakdown

6.1 Step 1: The Initial Attack



Figure 4: Attackers strategy

- Target MariaDB service (port 3306) with a sample of the “rockyou.txt” with the passwords taken out and shuffled back in.

```
hydra -L usernames.txt -P ./mysql_attack_passwords.txt 192.168.1.111 mysql
```

```
harry@attacker: ~
$ hydra -L usernames.txt -P ./mysql_attack_passwords.txt -t 16 192.168.1.111 mysql -I
Hydra v9.5 (c) 2023 by van Hauser/THC & David Maciejak - Please do not use in military or secret
service organizations, or for illegal purposes (this is non-binding, these ** ignore laws and et
hics anyway).

Hydra (https://github.com/vanhauser-thc/thc-hydra) starting at 2025-09-18 07:03:30
[INFO] Reduced number of tasks to 4 (mysql does not like many parallel connections)
[DATA] max 4 tasks per 1 server, overall 4 tasks, 2000 login tries (l:4/p:500), ~500 tries per ta
sk
[DATA] attacking mysql://192.168.1.111:3306/
[3306][mysql] host: 192.168.1.111 login: root password: neyo24
[3306][mysql] host: 192.168.1.111 login: bob password: all4mine
[3306][mysql] host: 192.168.1.111 login: jim password: ilovepico
[3306][mysql] host: 192.168.1.111 login: harold password: angelica
1 of 1 target successfully completed, 4 valid passwords found
Hydra (https://github.com/vanhauser-thc/thc-hydra) finished at 2025-09-18 07:04:00

harry@attacker: ~
$
```

Figure 5: Hydra successfully accessing all 4 passwords

- Used AI to generate a script that would produce similar passwords.
- Execute Hydra brute force attack against SSH service (port 22) on defender machine (192.168.1.111) using the new password list.

```
harry@attacker: ~
$ hydra -l bob -P ./bob_passwords_50.txt -t 1 -w 30 192.168.1.111 ssh
Hydra v9.5 (c) 2023 by van Hauser/THC & David Maciejak - Please do not use in military or secret
service organizations, or for illegal purposes (this is non-binding, these ** ignore laws and et
hics anyway).

Hydra (https://github.com/vanhauser-thc/thc-hydra) starting at 2025-09-18 07:46:04
[DATA] max 1 task per 1 server, overall 1 task, 50 login tries (l:1/p:50), ~50 tries per task
[DATA] attacking ssh://192.168.1.111:22/
[ERROR] ssh target does not support password auth
[STATUS] 15.00 tries/min, 15 tries in 00:01h, 35 to do in 00:03h, 1 active
[STATUS] 14.50 tries/min, 29 tries in 00:02h, 21 to do in 00:02h, 1 active
[STATUS] 14.67 tries/min, 44 tries in 00:03h, 6 to do in 00:01h, 1 active
1 of 1 target completed, 0 valid password found
Hydra (https://github.com/vanhauser-thc/thc-hydra) finished at 2025-09-18 07:49:30
```

Figure 6: Failed brute force attempt, even with access to the correct password and a small list of 50 passwords.

```
hydra -l bob -P ./bob_passwords_50.txt -t 1 -w 30 192.168.1.111 ssh
```

- For the sake of not failing here I chose to alter the SSH configuration of the ssh service running on the defender machine.

```
#UsePAM yes                # Commented out to disable, enabled in Arch by default

MaxAuthTries 1000          # Allow many attempts per connection
MaxSessions 100             # Allow multiple concurrent sessions
MaxStartups 100:30:200     # Increase connection startup limits
```

```
LoginGraceTime 0          # Disable login timeout (or set to 3600)
ClientAliveInterval 0     # Disable client keepalive checks
ClientAliveCountMax 0     # Disable automatic disconnections
```

6.2 Step 2: The Retaliation

- Install and configure fail2ban on defender machine with SSH and MySQL jails set to detect repeated authentication failures
- Configure detection thresholds (3 failed attempts within 10 minutes) and ban duration (10 minutes) to automatically block attacking IP addresses via iptables rules
- Re-execute identical Hydra attacks from Step 1 to demonstrate fail2ban's ability to detect, log, and block authentication attempts in real-time

6.3 Step 3: Spray Attack

- Implement password spraying technique using Hydra with common passwords against all user accounts to test fail2ban's effectiveness against distributed attack patterns
- Attempt to bypass fail2ban protections by varying attack timing and credential combinations to evaluate defensive tool limitations
- Analyze fail2ban logs, iptables rules, and system authentication logs to determine overall defensive success and identify potential evasion techniques

6.4 MITRE ATT&CK Mapping

- T1110.001 - Brute Force: Password Guessing
 - Systematic password attempts against SSH and MariaDB services
 - Using Hydra with username/password lists to guess valid credentials
- T1021.004 - Remote Services: SSH
 - Leveraging SSH protocol for initial access attempts
 - Targeting remote authentication service for system access
- T1110.003 - Brute Force: Password Spraying
 - Using common passwords across multiple accounts
 - “Low and slow” approach to evade detection thresholds
- T1595.001 - Active Scanning: Scanning IP Blocks
 - Port scanning to identify exposed services (SSH port 22, MariaDB port 3306)
- T1078.003 - Valid Accounts: Local Accounts
 - Using compromised local user credentials for system access
 - Potential for lateral movement within flat network topology

7 Results Analysis

7.1 The Initial

- SSH is tough, it resists brute force attacks heavily.
- When you install SSH on Arch, by default, root login is disabled as well as many other configurations.
- There are many sshd configurations that stand directly in the way of brute force attacks out of the box (MaxAuthTries, MaxStartups, LoginGraceTime, PermitRootLogin, etc. . .) [17]

```
harry@attacker:~$ ip -br a
to UNKNOWN
etho UP
192.168.1.7/24 e80::acec:3e8f:33d3:2984/64

harry@attacker:~$ ping google.com
ping: google.com: Temporary failure in name resolution

harry@attacker:~$ ping 192.168.1.111
PING 192.168.1.111 (192.168.1.111) 56(84) bytes of data:
64 bytes from 192.168.1.111: icmp_seq=1 ttl=64 time=0.234 ms
64 bytes from 192.168.1.111: icmp_seq=2 ttl=64 time=0.235 ms
64 bytes from 192.168.1.111: icmp_seq=3 ttl=64 time=0.261 ms
64 bytes from 192.168.1.111: icmp_seq=4 ttl=64 time=0.220 ms
^C
--- 192.168.1.111 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3065ms
rtt min/avg/max/mdev = 0.220/0.237/0.261/0.014 ms

harry@attacker:~$
```

```
harry@defender:~$ ip -br a
lo UNKNOWN
enp0s3 UP
192.168.1.111/24 e80::64e:6210:5f64:e8

harry@defender:~$ ping google.com
ping: google.com: Temporary failure in name resolution

harry@defender:~$
```

References

- [1] Australian Cyber Security Centre, “Annual cyber threat report 2023-2024,” Australian Signals Directorate, 2024. Available: <https://www.cyber.gov.au/about-us/view-all-content/reports-and-statistics/annual-cyber-threat-report-2023-2024>
- [2] Microsoft Corporation, “Microsoft digital defense report 2024,” Microsoft Corporation, Technical Report, 2024. Available: <https://www.microsoft.com/en-us/security/security-insider/threat-landscape/microsoft-digital-defense-report-2024>
- [3] Microsoft Security Response Center, “Microsoft actions following attack by nation state actor midnight blizzard.” 2024. Available: <https://msrc.microsoft.com/blog/2024/01/microsoft-actions-following-attack-by-nation-state-actor-midnight-blizzard/>
- [4] D. Maguire, “What’s happening with the optus data breach? What we know about the alleged hacker’s ransom, data release and apology,” *ABC News*, 2022, Available: <https://www.abc.net.au/news/2022-09-27/optus-data-breach-cyber-attack-hacker-ransom-sorry/101476316>
- [5] S. Chalmers, “Qantas confirms 5.7 million customers were impacted in cyber attack,” *ABC News*, 2025, Available: <https://www.abc.net.au/news/2025-07-09/qantas-confirms-number-of-customers-impacted-in-cyber-attack/105510654>
- [6] MITRE Corporation, “MITRE ATT&CK technique T1110: Brute force.” 2024. Available: <https://attack.mitre.org/techniques/T1110/>
- [7] J. Steube, “Hashcat: Advanced password recovery.” 2025. Available: <https://hashcat.net/hashcat/>
- [8] van Hauser, “THC-hydra: Online password cracking tool.” 2025. Available: <https://github.com/vanhauser-thc/thc-hydra>
- [9] F. Networks, “Medusa: Parallel network login auditor.” 2025. Available: http://foofus.net/?page_id=51
- [10] S. Designer, “John the ripper: Password cracker.” 2025. Available: <https://github.com/openwall/john>
- [11] KeychainX, “How to recover lost bitcoin passwords.” 2021. Available: <https://keychainx.medium.com/how-to-recover-lost-bitcoin-passwords-c34c42ee6f17>
- [12] NetExec Team, “NetExec wiki.” 2024. Available: <https://www.netexec.wiki/>
- [13] SpecterOps, “BloodHound legacy.” 2024. Available: <https://github.com/SpecterOps/BloodHound-Legacy>
- [14] fail2ban Project, “How fail2ban works.” 2024. Available: <https://github.com/fail2ban/fail2ban/wiki/How-fail2ban-works>
- [15] W. Project, “Wazuh: Security detection, visibility, and compliance.” 2025. Available: <https://github.com/wazuh/wazuh>
- [16] Netgate, “pfSense: Open source firewall and router.” 2025. Available: <https://www.pfsense.org/>
- [17] M. Kerrisk *et al.*, *Sshd_config(5) - linux manual page*. 2024. Available: https://man7.org/linux/man-pages/man5/sshd_config.5.html