

HO#2.3

Scanning & Vulnerability Analysis: Part 1

Phase 1- Reconnaissance and Information Gathering

Dear students we have covered the Information gathering phase (reconnaissance) in HO#2.2, that involves collecting as much public information as possible about the organization, systems, networks, applications, and employees to identify potential vulnerabilities and formulate a strategy for further testing. Passive information gathering (reconnaissance) involves collecting data without directly interacting with the target system, reducing the risk of detection. Gathering information from publicly available sources like news outlets, blogs and social media platforms (Twitter, Facebook, LinkedIn) is named as Open-Source Intelligence (OSINT). The techniques used for OSINT are Web Scraping, Google Dorking, and social media profiling. The tools that we have used for this in HO#2.2 were host, nslookup, dig, whois, knockpy, netdiscover, traceroute, whatweb, theHarvester, sherlock, wfw00f, Google Dorking, OSINT framework.

Phase 2- Scanning and Vulnerability Analysis

Scanning and vulnerability analysis is the second phase of penetration testing in which we scan the Network, ports, and OS services and determine if any of these are vulnerable. In cybersecurity, scanning and vulnerability analysis are closely related but differ in terms of purpose, depth, and focus. Scanning is broader and focuses on identifying what is present (systems, ports, services), while vulnerability analysis digs deeper to determine what is wrong with those systems (misconfigurations, unpatched software, exploitable flaws).

- **Scanning:** The objective of scanning is to identify systems, services and potential entry points in a network by performing port scanning, NW scanning and Services detection using tools like nmap, zenmap, unicorn, nikto and so on. Its primary focus is to map the target's environment and identify what is running and reachable. Unlike reconnaissance and information gathering, *Scanning is Active information gathering*, because the tools used in this phase directly interact with the target network, hosts, ports, employees, and so on to collect data. So DONOT perform active network scanning unless you have written permission of the system owner to perform that testing. The *tools that we normally use for scanning* are nmap, zenmap, unicornscan, nikto and so on. There can be different types of scanning like:

- Network Scanning: Identifies live hosts, devices, and IP addresses within a network.
- Port Scanning: Detects which ports are open and which services are running on those ports.
- Service/OS Detection: Determines which operating systems and services are running on discovered hosts.

Scanning results provide a list of systems, open ports, and running services. However, it doesn't necessarily reveal whether these are vulnerable or not.

- **Vulnerability Analysis (or Vulnerability Assessment):** The objective of vulnerability analysis is to dig deeper and perform an in-depth examination to uncover known vulnerabilities and weaknesses in the systems, applications, and their configurations. Its primary focus is to evaluate the specific risks associated with the discovered systems and services by doing an in-depth examination to uncover known vulnerabilities, misconfigurations, or weaknesses. The *tools that we normally use for vulnerability analysis* are nessus, searchsploit, OpenVAS, MSF, Burp-Suite, SQLMap and so on. The steps that we normally perform during vulnerability analysis are:

- Scanning the target for known vulnerabilities using databases like CVE
- Assessing the severity of discovered vulnerabilities using metrics like CVSS
- Submit report highlighting the vulnerability, risk levels, and mitigation steps

Common Vulnerabilities Exposures (Home Task):

Common Vulnerabilities and Exposures (CVE) is a program that is managed by cybersecurity community to identify, define and catalog publicly disclosed cybersecurity vulnerabilities in software and hardware. A CVE is a security flaw in software or hardware that can be exploited to compromise systems, e.g., buffer overflow, SQL injection, and cross-site scripting (XSS) are some famous vulnerabilities. Enterprises typically use CVE, and corresponding CVSS scores, for planning and prioritization in their vulnerability management programs. For details visit: <https://nvd.nist.gov/> and <https://www.cve.org/>

- **Structure of CVE Entries**
 - CVE ID: A unique identifier for the vulnerability, formatted as CVE-YYYY-NNNN. For example, CVE-2024-12345.
 - Description: A brief description of the vulnerability or exposure, including its impact and affected systems or software.
 - References: Links to additional information, such as advisories, patches, and reports. These may include vendor-specific details, security bulletins, and technical documentation.
- **Common Vulnerability Scoring System**: Every CVE has a corresponding CVSS score based on factors such as exploitability, impact, and complexity. CVSS provides a numeric score (ranging from 0 to 10) along with a *severity level rating* to help organizations prioritize their responses to vulnerabilities.
 - **Critical (9.0 – 10.0)**: Vulnerabilities that are extremely easy to exploit and lead to complete compromise of systems or data. These require immediate attention. An example is CVE-2011-2523, which refers to a backdoor vulnerability in vsftpd version 2.3.4, with a CVSS score of 9.8. This vulnerability allows an attacker to open a shell on port 6200/TCP, effectively providing unauthorized access to the system.
 - **High (7.0 – 8.9)**: These vulnerabilities are more easily exploitable and have a significant impact on confidentiality, integrity, or availability. An example is CVE-2014-6271 (Shellshock), which has a CVSS score of 7.5. Shellshock is a vulnerability in the bash shell program, that allows an attacker to inject and execute arbitrary commands through specifically crafted environment variables. Another example is CVE-2017-0144 (EternalBlue), which has a CVSS score of 8.1. EternalBlue is a vulnerability in Microsoft SMB protocol and was used by the famous WannaCry ransomware.
 - **Medium (4.0 – 6.9)**: Vulnerabilities that can be exploited but typically require some conditions, and the impact is moderate. An example is CVE-2015-0235 (GHOST), which has a CVSS score of 6.8. It is the vulnerability in the glibc function gethostbyname(), which allows attackers to remotely take control of the system via crafted DNS request.
 - **Low (0.1 – 3.9)**: Vulnerabilities that have limited impact or require complex conditions to exploit. An example is CVE-2019-3462 (APT Vulnerability), which has a CVSS score of 3.1. This vulnerability is in the Advanced Packaging Tool (apt) used by Debian based systems. It allows a man-in-the-middle (MiTM) attacker to inject content into a package installation process by tempering with repository metadata.
 - **None (0.0)**: No impact or exploitation potential. An example is CVE-2015-1235 (Google Chrome Crash), which has a CVSS score of 0.0. It is a vulnerability in Google Chrome that allowed attackers to cause a browser crash via a crafted web page. However, no code execution or data compromise was possible, leading to its 0.0 score.

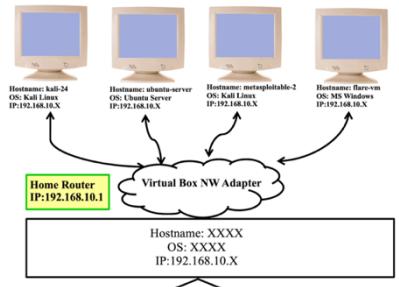
- **CVE Process:** The process for a CVE entry typically involves several steps:
 - Discovery: A vulnerability or exposure is discovered by a security researcher, vendor, or another entity.
 - Reporting: The issue is reported to a CVE Numbering Authority (CNA) or directly to MITRE. CNAs are organizations authorized to assign CVE IDs and manage CVE entries for their respective domains.
 - Review: The reported issue is reviewed for accuracy and completeness. This may involve verifying the details and coordinating with the original reporter or affected vendor.
 - Publication: Once validated, the CVE entry is published in the CVE database and made publicly available.

Student should also explore Common Weakness Enumeration (CWE) at their own, which is a list of specific known security problems in software, e.g., a CWE might describe a general software weakness like improper input validation (CWE-20), which could exist in many different software products. You can think of weaknesses as something that could potentially be exploited but is not necessarily a direct security threat.

Environment Setup

You can use the following machines for a hands-on practice of this handout in which I am using kali Linux as attacker machine and scanning Metasploitable 2:

1. Kali Linux (IP: x.x.x.x)
2. Metasploitable 2 (IP: x.x.x.x)



If you want to login to your Metasploitable2 machine from Kali Linux using ssh, the simple login command might not work. There is a work around in which you need to mention the HostKeyAlgorithms as shown in the following command: ☺

```
$ ssh -oHostKeyAlgorithms=+ssh-dss msfadmin@<ip of M2>
```

Nmap <https://nmap.org>

The **nmap** (Network Mapper) is a free and open-source utility for network discovery and security auditing. **Nmap** uses raw IP packets in novel ways to determine what hosts are available on the network, what services (application name and version) those hosts are offering, what operating systems (and OS versions) they are running, what type of packet filters/firewalls are in use, and dozens of other characteristics. Simply speaking, we can use **nmap** for network scanning, port scanning, and vulnerability scanning. Some of the most useful tasks that **nmap** can perform, are mentioned below:

- **Host Discovery:** Identifying live hosts on a network. This can be done using various techniques such as ICMP echo requests, TCP/UDP packets, and ARP requests.
- **Port Scanning:** Determining which ports on a target are open, closed, or filtered. Different types of scans include SYN scan, TCP connect scan, UDP scan, and FIN scan.
- **Service Version Detection:** Identifying the versions of services running on open ports. This helps in determining specific software vulnerabilities.
- **Operating System Detection:** Fingerprinting the target's operating system and sometimes even determining the OS version and device type.
- **Scriptable Interaction:** Using Nmap Scripting Engine (NSE) to perform advanced network tasks such as vulnerability detection, backdoor detection, and more. NSE scripts can also be customized or created to meet specific needs.
- **Stealth Scanning:** Performing scans in a way that minimizes detection by firewalls and intrusion detection systems (IDS).

Basic Usage of nmap

```
$ nmap --version  
$ nmap -h  
$ man nmap  
$ nmap <IP/hostname/NW Addr>
```

Command	Description
\$ nmap 192.168.1.1	Scanning a single IP (By default nmap scans first 1000 commonly used ports)
\$ nmap www.domain.com	Scanning a hostname
\$ nmap 192.168.1.1-100	Scanning an IP range
\$ nmap 192.168.1.1/24	Scanning an entire subnet
\$ nmap -iL list.txt	Scanning from a predefined list

Command	Description
\$ nmap -p 22 192.168.1.1	Scanning a single port
\$ nmap -p 20-80 192.168.1.1	Scanning a range of ports
\$ nmap 20-25,80,443 192.168.1.1	Scanning a range and individual ports
\$ nmap -p- 192.168.1.1	Scanning all 65535 ports
\$ nmap -F 192.168.1.1	Scanning first 100 ports (Fast Scan)
\$ nmap -A 192.168.1.1	Aggressive Scan enables OS detection, version detection, script scanning and traceroute

```
$ nmap <IP of Metasploitable2>
```

```
dartsec$ nmap 10.0.2.4
Starting Nmap 7.94SVN ( https://nmap.org ) at 2024-07-08 12:29 EDT
Nmap scan report for 10.0.2.4
Host is up (0.010s latency).
Not shown: 977 closed tcp ports (conn-refused)
PORT      STATE SERVICE
21/tcp    open  ftp
22/tcp    open  ssh
23/tcp    open  telnet
25/tcp    open  smtp
53/tcp    open  domain
80/tcp    open  http
111/tcp   open  rpcbind
139/tcp   open  netbios-ssn
445/tcp   open  microsoft-ds
512/tcp   open  exec
513/tcp   open  login
514/tcp   open  shell
1099/tcp  open  rmiregistry
1524/tcp  open  ingreslock
2049/tcp  open  nfs
2121/tcp  open  ccproxy-ftp
3306/tcp  open  mysql
5432/tcp  open  postgresql
5900/tcp  open  vnc
6000/tcp  open  X11
6667/tcp  open  irc
8009/tcp  open  ajp13
8180/tcp  open  unknown

Nmap done: 1 IP address (1 host up) scanned in 1.56 seconds
```

Description of output: Although the STATE of all the ports in this screenshot is open, however, in the output of **nmap** scan, a port can be in one of the following six states:

- **Open:** This indicates that an application is accepting connections on this port and is reachable.
- **Closed:** This indicates that the port is reachable but not currently in use, i.e., no application is listening on it.
- **Filtered:** Nmap cannot determine whether the port is open because packet filtering prevents its probes from reaching the port. This is often due to a firewall or other NW security devices.
- **Unfiltered:** The port is accessible, but Nmap cannot determine if it is open or closed.
- **Open|Filtered:** Nmap cannot determine whether the port is *open* or *filtered*. This happens when Nmap does not receive enough information to decide between the two states.
- **Closed|Filtered:** Nmap cannot determine whether the port is *closed* or *filtered*. This is a less common state, indicating ambiguous results.

Scanning the Famous <http://scanme.nmap.org>

This is a machine that nmap has setup for the folks to test and make sure that their Nmap installation (or Internet connection) is working properly. You are authorized to scan this machine with Nmap or other port scanners. Try not to hammer on the server too hard.

```
$ nmap -p 20-100 scanme.nmap.org
$ nmap -p 20-100 45.33.32.156
```

Target OS Discovery

Discovering the operating system (OS) of a target host using nmap is a useful feature for network scanning and security assessments. Different operating systems and versions have distinct ways of responding to network probes. By sending probes to both open and closed ports, nmap can gather more varied responses. We can perform OS detection using the `-O` option to nmap:

```
$ sudo nmap -O <ip of M2>
```

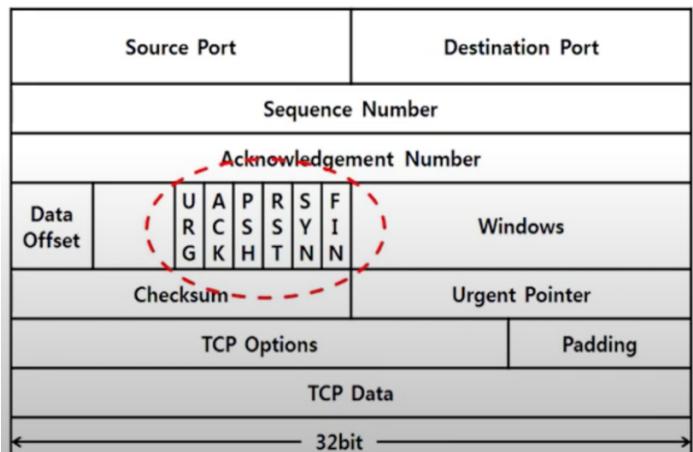
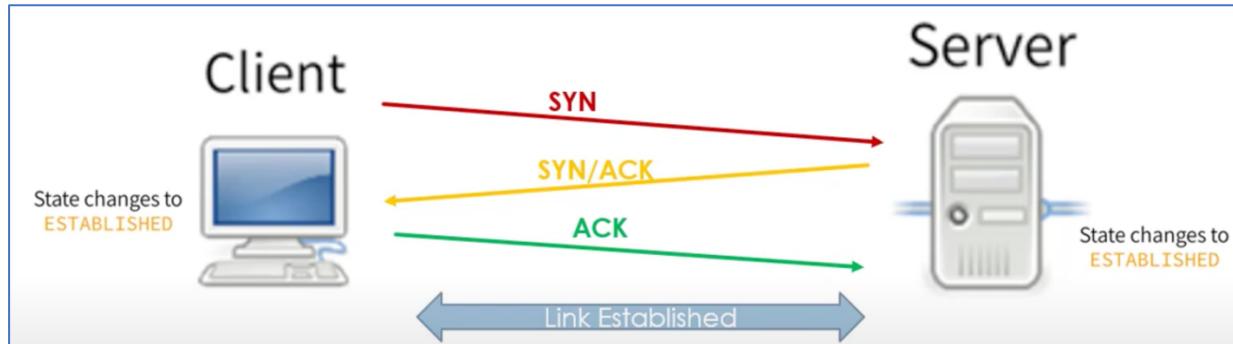
```
dartsec$ sudo nmap -O 10.0.2.4
Starting Nmap 7.94SVN ( https://nmap.org ) at 2024-07-08 08:45 EDT
Nmap scan report for 10.0.2.4
Host is up (0.0078s latency).
Not shown: 977 closed tcp ports (reset)
PORT      STATE SERVICE
21/tcp    open  ftp
22/tcp    open  ssh
23/tcp    open  telnet
25/tcp    open  smtp
53/tcp    open  domain
80/tcp    open  http
111/tcp   open  rpcbind
139/tcp   open  netbios-ssn
445/tcp   open  microsoft-ds
512/tcp   open  exec
513/tcp   open  login
514/tcp   open  shell
1099/tcp  open  rmiregistry
1524/tcp  open  ingreslock
2049/tcp  open  nfs
2121/tcp  open  ccproxy-ftp
3306/tcp  open  mysql
5432/tcp  open  postgresql
5900/tcp  open  vnc
6000/tcp  open  X11
6667/tcp  open  irc
8009/tcp  open  ajp13
8180/tcp  open  unknown
MAC Address: 08:00:27:7A:FC:20 (Oracle VirtualBox virtual NIC)
Device type: general purpose
Running: Linux 2.6.X
OS CPE: cpe:/o:linux:linux_kernel:2.6
OS details: Linux 2.6.9 - 2.6.33
Network Distance: 1 hop

OS detection performed. Please report any incorrect results at https://nmap.org/submit/ .
Nmap done: 1 IP address (1 host up) scanned in 5.28 seconds
```

The highlighted output in red tells us about the running Linux kernel. The `x` in version numbers like `2.6.x` signifies that nmap has identified the major and minor version of the OS but does not have enough information to determine the exact patch level or sub-version. This shows that nmap scans are not all accurate or give complete information. We need to run more scans with more nmap options to find full information.

TCP Three Way Hand Shake (A Recap)

Before we describe **nmap** Ping/NW Scan (-sn), SYN Scan (-sS), TCP Scan (-sT), FIN Scan (-sF), ACK Scan (-sA), Version Scan (-sV), we need to talk about how TCP connections are established. The connections are scanned using a 3-way handshake. The 3-way handshake is a fundamental process used in the TCP/IP protocol suite to establish a reliable connection between a client and a server. It ensures that both parties are ready to communicate and can establish a connection with synchronized parameters. Steps in a handshake are mentioned below:



- **SYN (Synchronize):**
 - The client initiates the connection by sending a TCP segment with the SYN (synchronize) flag set to the server. This segment includes an initial sequence number (ISN), which is a random value used to synchronize the sequence numbers between the client and the server.
- **SYN-ACK (Synchronize-Acknowledge):**
 - The server responds to the client's SYN segment with a TCP segment that has both the SYN and ACK (acknowledge) flags set. The server's segment also includes its own initial sequence number (SYN) and acknowledges the client's SYN by setting the ACK number to the client's ISN + 1.
- **ACK (Acknowledge):**
 - The client sends a final acknowledgment (ACK) to the server. This segment acknowledges the server's SYN by setting the acknowledgment number to the server's ISN + 1.
 - At this point, the connection is established, and both parties are ready to exchange data. The ports on both client and server side are now in established state.

Ping/Network Scan

The nmap ping scan is used for network discovery, i.e., what all machines are running in the Local Area Network. It sends various probes (like ICMP echo request, TCP SYN to port 443, or ICMP timestamp request) to check if the target is up. By default, it won't scan any ports, only determining whether the host is active. In older versions of Nmap (before version 4.0), **-sp** was used to perform a ping scan. However, in recent versions, it has been deprecated in favour of **-sn** option.

```
$ nmap -sn 10.0.2.0/24
```

```
dartsec$ nmap -sp 10.0.2.0/24
Starting Nmap 7.94SVN ( https://nmap.org ) at 2024-07-08 12:51 EDT
Nmap scan report for 10.0.2.1
Host is up (0.0036s latency).
Nmap scan report for 10.0.2.2
Host is up (0.0034s latency).
Nmap scan report for 10.0.2.4
Host is up (0.0026s latency).
Nmap scan report for 10.0.2.15
Host is up (0.0015s latency).
Nmap done: 256 IP addresses (4 hosts up) scanned in 2.99 seconds
```

TCP SYN Scan

TCP SYN scan, often referred to as a "**half-open**" scan, is one of the most common and efficient scanning techniques used by nmap. It works by sending SYN packets to the target ports and analysing the responses. This type of scan is called "half-open" because it does not complete the full TCP handshake. Here's how it works:

```
$ sudo nmap -sS <ip of M2>
```

- **SYN Packet Sent:** nmap sends a SYN packet to the target port.
- **Response Analysis:**
 - **SYN/ACK Received:** If the target port is open, it responds with a SYN/ACK packet. Instead of ACK, Nmap sends an RST (reset) packet to terminate the connection before the handshake completes, which prevents the connection from being logged.
 - **RST Received:** If the target port is closed, it responds with an RST packet.
 - **No Response/Filtered:** If there is no response or if a packet filtering device (like a firewall) is present, the port is marked as filtered.

TCP Connect Scan

A TCP Connect scan performs full 3-way handshake and so do not require root privileges. It is easily detected by the target machine administrator as it leaves quite a bit of footprint. This is the default nmap scan, i.e., if you do not use any option the scan that is performed is TCP connect scan. TCP Scan works in the following way:

```
$ nmap -sT <ip of M2>
```

- **SYN Packet Sent:** Nmap sends a SYN packet to the target port.
- **SYN/ACK Received:** If the target port is open, it responds with a SYN/ACK packet.
- **ACK Sent:** Nmap sends an ACK packet to complete the TCP three-way handshake, establishing a connection.
- **RST Packet Sent:** Immediately after establishing the connection, Nmap sends an RST (reset) packet to close the connection.

UDP Scan

A UDP scan is a type of network scan performed by Nmap to identify open UDP ports on a target system. Unlike TCP, UDP (User Datagram Protocol) is connectionless, which makes it more challenging to scan. However, it is crucial for identifying services that run over UDP, such as DNS (53), DHCP(67), and TFTP (69) and SNMP.

\$ nmap -sU <ip of M2>

- **UDP Packet Sent:** Nmap sends a UDP packet to the target port. The default payload for the UDP packet is empty, but Nmap can use more specific probes for well-known services.
- **Response Analysis:**
 - **No Response:** If there is no response, the port is assumed to be open or filtered. Many UDP services do not respond unless they receive a valid request, which can make definitive detection challenging.
 - **ICMP Port Unreachable:** If the target sends back an ICMP Port Unreachable message (Type 3, Code 3), the port is closed.
 - **Other ICMP Responses:** Different ICMP responses may indicate that the port is filtered or unreachable for other reasons.

Retries: Nmap may send multiple probes and use different payloads to increase accuracy. This is because UDP scanning is prone to packet loss and other issues that can cause false positives or negatives.

Finding Versions of Services

To tell nmap to display the version of different services running on different ports we can use the **-sV** option. Remember for this to work we need to be root or in the sudoer file.

\$ sudo nmap -sV <ip of M2>

```
dartsec$ sudo nmap -sV 10.0.2.4
Starting Nmap 7.94SVN ( https://nmap.org ) at 2024-07-08 08:52 EDT
Nmap scan report for 10.0.2.4
Host is up (0.0039s latency).
Not shown: 977 closed tcp ports (reset)
PORT      STATE SERVICE      VERSION
21/tcp    open  ftp          vsftpd 2.3.4
22/tcp    open  ssh          OpenSSH 4.7p1 Debian 8ubuntu1 (protocol 2.0)
23/tcp    open  telnet        Linux telnetd
25/tcp    open  smtp         Postfix smtpd
53/tcp    open  domain       ISC BIND 9.4.2
80/tcp    open  http         Apache httpd 2.2.8 ((Ubuntu) DAV/2)
111/tcp   open  rpcbind     2 (RPC #100000)
139/tcp   open  netbios-ssn Samba smbd 3.X - 4.X (workgroup: WORKGROUP)
445/tcp   open  netbios-ssn Samba smbd 3.X - 4.X (workgroup: WORKGROUP)
512/tcp   open  exec         netkit-rsh rexecd
513/tcp   open  login        OpenBSD or Solaris rlogind
514/tcp   open  tcpwrapped
1099/tcp  open  java-rmi   GNU Classpath grmiregistry
1524/tcp  open  bindshell   Metasploitable root shell
2049/tcp  open  nfs         2-4 (RPC #100003)
2121/tcp  open  ftp         ProFTPD 1.3.1
3306/tcp  open  mysql       MySQL 5.0.51a-3ubuntu5
5432/tcp  open  postgresql PostgreSQL DB 8.3.0 - 8.3.7
5900/tcp  open  vnc         VNC (protocol 3.3)
6000/tcp  open  X11         (access denied)
6667/tcp  open  irc         UnrealIRCd
8009/tcp  open  ajp13      Apache Jserv (Protocol v1.3)
8180/tcp  open  http        Apache Tomcat/Coyote JSP engine 1.1
MAC Address: 08:00:27:7A:FC:20 (Oracle VirtualBox virtual NIC)
Service Info: Hosts: metasploitable.localdomain, irc.Metasploitable.LAN; OSs: Unix, Linux; CPE: cpe:/o:linux:linux_kernel

Service detection performed. Please report any incorrect results at https://nmap.org/submit/ .
Nmap done: 1 IP address (1 host up) scanned in 16.37 seconds
```

As we can see along with services, we can now also see the version of each service. We can see that nmap has failed to find the versions of some of the services. This can be solved by **--version-intensity** that allows you to control the aggressiveness or intensity of version detection when scanning target services. It determines how much effort nmap puts into identifying the version details of the services running on open ports. The higher the intensity the more time it takes, but more

detailed and accurate information about the services running on the specified target. We can specify a level of intensity from 0 to 9:

- **0**: Disable version detection.
- **1-4**: Low to moderate intensity, suitable for quick scans with less detailed version information.
- **5 (default)**: Balanced intensity, providing a good compromise between speed and accuracy.
- **6-9**: Higher intensity levels, which increase the accuracy of version detection but might take longer and be more intrusive.

Evading Firewalls/IDS using nmap

A Firewall is a NW security device or software that monitors and controls incoming and outgoing network traffic based on predetermined security rules. The two main types are Network firewall that protects an entire network by filtering traffic at the network level and Host-based firewall that protects individual devices (like computers or servers) by filtering traffic at the operating system or application level. An Intrusion Detection System (IDS), on the other hand is a security tool that monitors network or system activities for malicious or suspicious activities and alerts administrators or takes automated actions in response. The two main types are Network-based IDS (NIDS) that monitors network traffic in real-time, analysing packets and patterns to detect suspicious activities across the network and Host-based IDS (HIDS) that runs on individual devices or hosts, monitoring activities. Firewalls are unpredictable as we don't know the rules applied to the firewall. So, we don't know what kind of scan to perform.

The **-f** option in **nmap** is used to fragment packets. This means nmap splits the probes into smaller IP fragments rather than sending them as one complete packet. The goal of using packet fragmentation is to evade detection by firewalls, intrusion detection systems (IDS), and intrusion prevention systems (IPS) that may be set up to detect and block standard nmap scanning patterns.

```
$ nmap -f 10.0.2.4          // splits packets into 8-bytes fragments
$ nmap -f -f 10.0.2.4        // splits packets into 16-bytes fragments
$ nmap -mtu 32 10.0.2.4      // specify the exact size of packets
```

Decoy Scanning

The **-D** option in **nmap** is used to perform decoy scanning, which helps to obscure the true source of the scan by making it appear as if multiple hosts (decoys) are scanning the target. This technique can be useful for evading detection and confusing firewalls, intrusion detection systems (IDS), and intrusion prevention systems (IPS).

```
$ nmap -D RND:5 10.0.2.4
```

The above command will make 5 random decoys and will scan the target machine along with the original source machine.

Using Proxies to Redirect your Nmap Scans

In our previous handout we have already seen and understood different techniques like proxies and Tor browser to anonymize our traffic on the Internet. Following command will use proxy chains to redirect our **nmap** scans in order to mask our original IP address:

```
$ proxychains nmap -F scanme.nmap.org
```

Using Nmap Scripts

- The **nmap** scripts are part of the Nmap Scripting Engine (NSE), which has extended the capabilities of nmap beyond just network scanning and port discovery. These scripts are used to perform more detailed scanning and automate a wide range of tasks, from vulnerability detection to network auditing. These scripts can automate various network tasks, perform complex network reconnaissance, vulnerability detection, exploitation, and more. On Linux machine, these scripts are located at `/usr/share/nmap/scripts/` directory containing over 600 different scripts with each script belonging to a specific category. Visit this directory to check out the available scripts on your Kali Linux machine and practice running different scripts on Metasploitable2 machine.
- Check out what a specific script does:** Some scripts are very noisy, some not at all. So, it is important to read what each script does and if it is easily detectable by the target or not. Let us check what `ftp-anon.nse` script do by using the `--script-help` option of nmap as shown below:

```
$ nmap --script-help ftp-anon.nse
```

- Running single script:** We can run single script of our choice using the following command:

```
$ nmap --script ftp-anon.nse <IP of M2>
```

```
(kali㉿kali)-[~/arif/spvl/os]
$ nmap --script ftp-anon.nse 192.168.8.110
Starting Nmap 7.94SVN ( https://nmap.org ) at 2024-09-18 01:04 EDT
Nmap scan report for 192.168.8.110
Host is up (0.0023s latency).
Not shown: 977 closed tcp ports (conn-refused)
PORT      STATE SERVICE
21/tcp    open  ftp
|_ftp-anon: Anonymous FTP login allowed (FTP code 230)
22/tcp    open  ssh
23/tcp    open  telnet
```

From the output of above command, we see that Metasploitable2 has anonymous FTP vulnerability, i.e., it allows to login using anonymous username and blank password. Let us try it:

```
$ ftp 192.168.8.110
Connected to 192.168.8.110.
220 (vsFTPD 2.3.4)
Name: anonymous
Password:
230 Login successful.
Remote system type is UNIX.
Using binary mode to transfer files.
```

ftp>

You get the FTP prompt, now give the help command to get the available ftp commands and enjoy ☺

Categories/Groups of NSE Scripts:

To check out the usage of different script groups visit: <https://nmap.org/book/nse-usage.html>

- **auth:** These scripts deal with authentication credentials (or bypassing them) on the target system. For example, `ftp-anon.nse` script attempts to guess FTP login credentials
 - **brute:** These scripts use brute force attacks to guess authentication credentials of a remote server. Nmap contains scripts for brute forcing dozens of protocols, including `http-brute-nse`, `oracle-brute.nse`, `snmp-brute.nse` and so on.
 - **malware:** These scripts test whether the target platform is infected by malware or backdoors. An example script in this category is `smb-vuln-ms17-010.nse` that checks for the MS17-010 vulnerability exploited by WannaCry.
 - **vuln:** These scripts check for specific known vulnerabilities and generally only report results if they are found. Examples include `realvnc-auth-bypass` and `afp-path-vuln`.
 - **exploit:** These scripts exploit vulnerabilities to confirm their existence. An example script in this category is `http-sql-injection.nse` that checks for the SQL injection vulnerabilities. Other example include `http-shellshock.nse`
 - **default:** These scripts are the default, and are run using using `--script default` or using simply the `-A` option.
-
- **Running a Script Group:** Try running the following script groups and from their output understand different vulnerabilities in the Metasploitable2 machine that they come up with.

```
$ nmap --script vuln <ip>
```

Searchsploit

We have already seen that we can use the nmap -sV option to check for the versions of different services along with their state and port numbers as shown in the following screenshot.

```
dartsec$ sudo nmap -sV 10.0.2.4
Starting Nmap 7.94SVN ( https://nmap.org ) at 2024-07-08 08:52 EDT
Nmap scan report for 10.0.2.4
Host is up (0.0039s latency).

Not shown: 977 closed tcp ports (reset)
PORT      STATE SERVICE      VERSION
21/tcp    open  ftp          vsftpd 2.3.4
22/tcp    open  ssh          OpenSSH 4.7p1 Debian 8ubuntu1 (protocol 2.0)
23/tcp    open  telnet       Linux telnetd
25/tcp    open  smtp         Postfix smtpd
53/tcp    open  domain      ISC BIND 9.4.2
80/tcp    open  http         Apache httpd 2.2.8 ((Ubuntu) DAV/2)
111/tcp   open  rpcbind     2 (RPC #100000)
139/tcp   open  netbios-ssn Samba smbd 3.X - 4.X (workgroup: WORKGROUP)
445/tcp   open  netbios-ssn Samba smbd 3.X - 4.X (workgroup: WORKGROUP)
512/tcp   open  exec        netkit-rsh rexecd
513/tcp   open  login       OpenBSD or Solaris rlogind
514/tcp   open  tcpwrapped
1099/tcp  open  java-rmi   GNU Classpath grmiregistry
1524/tcp  open  bindshell   Metasploitable root shell
2049/tcp  open  nfs         2-4 (RPC #100003)
2121/tcp  open  ftp         ProFTPD 1.3.1
3306/tcp  open  mysql       MySQL 5.0.51a-3ubuntu5
5432/tcp  open  postgresql PostgreSQL DB 8.3.0 - 8.3.7
5900/tcp  open  vnc         VNC (protocol 3.3)
6000/tcp  open  X11         (access denied)
6667/tcp  open  irc         UnrealIRCd
8009/tcp  open  ajp13      Apache Jserv (Protocol v1.3)
8180/tcp  open  http        Apache Tomcat/Coyote JSP engine 1.1
MAC Address: 08:00:27:7A:FC:20 (Oracle VirtualBox virtual NIC)

Service Info: Hosts: metasploitable.localdomain, irc.Metasploitable.LAN; OSs: Unix, Linux; CPE: cpe:/o:linux:linux_kernel

Service detection performed. Please report any incorrect results at https://nmap.org/submit/ .
Nmap done: 1 IP address (1 host up) scanned in 16.37 seconds
```

Now a \$100 question is how can we find out, which out of these services has some vulnerability without using any tool. One way is open a browser and type the `service name` followed by `exploit` keyword and press enter (e.g., “vsftpd 2.3.4 exploit” or “Apache httpd 2.2.8 exploit”). Visit some links and try to find whether these are vulnerable applications, and if yes try finding exploits for these vulnerable applications. Do visit <https://www.cve.org/>

The **searchsploit** is a Linux command-line search tool to search the Exploit Database (EDB), while staying offline. It is used to search for known vulnerabilities and exploits related to hardware, software, operating systems, web applications, and configurations. These exploits are already indexed in the Exploit Database. It allows you to quickly find exploits based on various criteria like software names, CVE identifiers, or platform types. The most common use cases of searchsploit are:

Installing and using searchsploit:

- An easy way to install exploitdb and use searchsploit on your Kali Linux machine use following command:
\$ sudo apt-get install exploitdb
- You can also install from source, available at <https://gitlab.com/exploit-database/exploitdb>
- Do check out /usr/share/exploitdb directory for available exploits and shellcodes for different OSs and different architectures.
- Before you start using the tool, you must update the Exploit Database (EDB), using the following command:
\$ searchsploit -u

- Let us now find out if vsftpd 2.3.4 is vulnerable service, and if there exist an exploit for this vulnerability. To searchsploit, we just need to give the name of the service along with its version, and it searches in the local Kali Linux exploitdb directory for all the exploits that Kali Linux has and tries to find an exploit that will work for that specific version.

```
$ searchsploit vsftpd 2.3.4
```

Exploit Title	Path
vsftpd 2.3.4 - Backdoor Command Execution	unix/remote/49757.py
vsftpd 2.3.4 - Backdoor Command Execution (Metasploit)	unix/remote/17491.rb
Shellcodes: No Results	

From the output of the above command, you can see that it also suffers with the Backdoor Command Execution vulnerability and we have two exploits for it one written in Python and other in Ruby. To check the absolute path of these exploits, we can use the locate command:

```
$ locate 49757.py  
/usr/share/exploitdb/exploits/unix/remote/49757.py
```

- Let us now try to find out if UnrealIRCd (Internet Relay Chat daemon) is a vulnerable service and if there is an exploit available for it.

```
$ searchsploit unrealircd
```

Exploit Title	Path
UnrealIRCd 3.2.8.1 - Backdoor Command Execution (Metasploit)	linux/remote/16922.rb
UnrealIRCd 3.2.8.1 - Local Configuration Stack Overflow	windows/dos/18011.txt
UnrealIRCd 3.2.8.1 - Remote Downloader/Execute	linux/remote/13853.pl
UnrealIRCd 3.x - Remote Denial of Service	windows/dos/27407.pl
Shellcodes: No Results	

From the output of the above command, you can see that there exists an exploit with the name of Backdoor Command Execution, that can be used in MSF.

```
$ locate 16922.rb  
/usr/share/exploitdb/exploits/linux/remote/16922.rb
```

- **Tips for Filtering your search Results:**

- **Filtering by version:**

```
$ searchsploit apache  
$ searchsploit apache 2.4.49
```

- **Removing Unwanted Results using Pipe and grep:**

```
$ searchsploit apache | grep unix
```

- **Searching by CVE:** You can also search using the CVE ID as shown below:

```
$ searchsploit CVE-2017-0144
```

- **Searching multiple terms:** You can add any number of search terms. But remember, searchsploit uses an AND operator, not an OR operator. The more terms that are used, the more results will be filtered out:

```
$ searchsploit afd windows local
```

- **Title Searching:** By default, searchsploit will check BOTH the title of the exploit as well as the path. Depending on the search criteria, this may bring up false positives (especially when searching for terms that match platforms and version numbers). Searches can be restricted to the titles by using the **-t** option:

```
$ searchsploit -t oracle windows
```

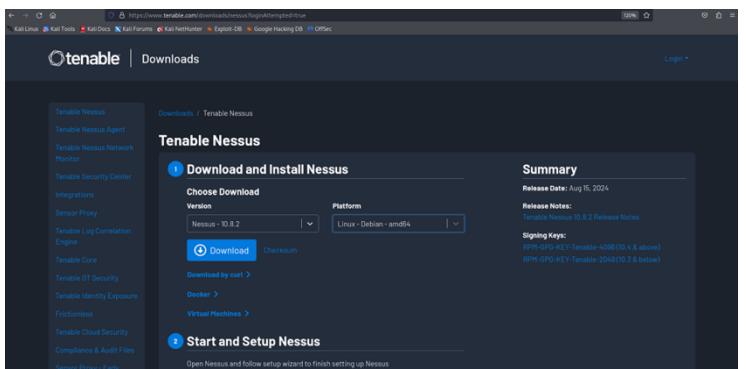
Nessus

Nessus is a platform developed by Tenable that scans for security vulnerabilities in devices, applications, operating systems, cloud services and other network resources. Unlike nmap, it checks for specific vulnerabilities tied to known CVEs along with their CVSS scores. The Professional version has a cost to pay, so we will install and use the free *Nessus Essentials* version, which can work only in a Local Area Network and cannot perform a scan on a machine/website on the Internet. Moreover, with Nessus Essentials version, we can scan up to 16 IP addresses within a LAN. Some common features of Nessus are:

- **Vulnerability scanning:** Nessus scans servers for known vulnerabilities. For example, detecting outdated software versions that may be suspectable to exploits.
- **Credential-based scanning:** Authenticated scans with login credentials provide Nessus deeper access, enhancing the accuracy of vulnerability detection.
- **Web Application scanning:** It identifies the vulnerabilities in web applications such as SQL injection or XSS flaws.
- **Malware detection:** Nessus identifies the potential malware indicators by analyzing the system files and configuration.

Downloading, Installing and Configuring Nessus on Kali Machine:

- Open your browser and search for *download nessus*. Use the Tenable link and download the latest version of Nessus for your platform, i.e., Linux-Debian-amd64, which will download the *Nessus-10.8.2-debian10_amd64.deb* file.



- Now to install it use the following command:

```
$ sudo dpkg -i Nessus-10.8.2-debian10_amd64.deb
```

- After installation is done, you need to start and check status of the service:

```
$ sudo systemctl start nessusd.service
$ systemctl status nessusd.service
```

- In order to configure the Nessus Essential (free version), you need to go to <https://kali:8834> link inside your browser. Perform the steps and finally it will initialize and download all required plugins. This may take a bit of time depending on your Internet speed. Must remember the credentials (username:password) while creating an account on tenable for Nessus Essentials.
- Inside your browser go to <https://kali:8834> login giving your credentials. If you get an error of plugins not installed then use the following command to install plugins:

```
$ sudo systemctl stop nessusd.service
$ sudo /opt/nessus/sbin/nessuscli update
$ sudo systemctl start nessusd.service
```

Basic NW Scan using Nessus:

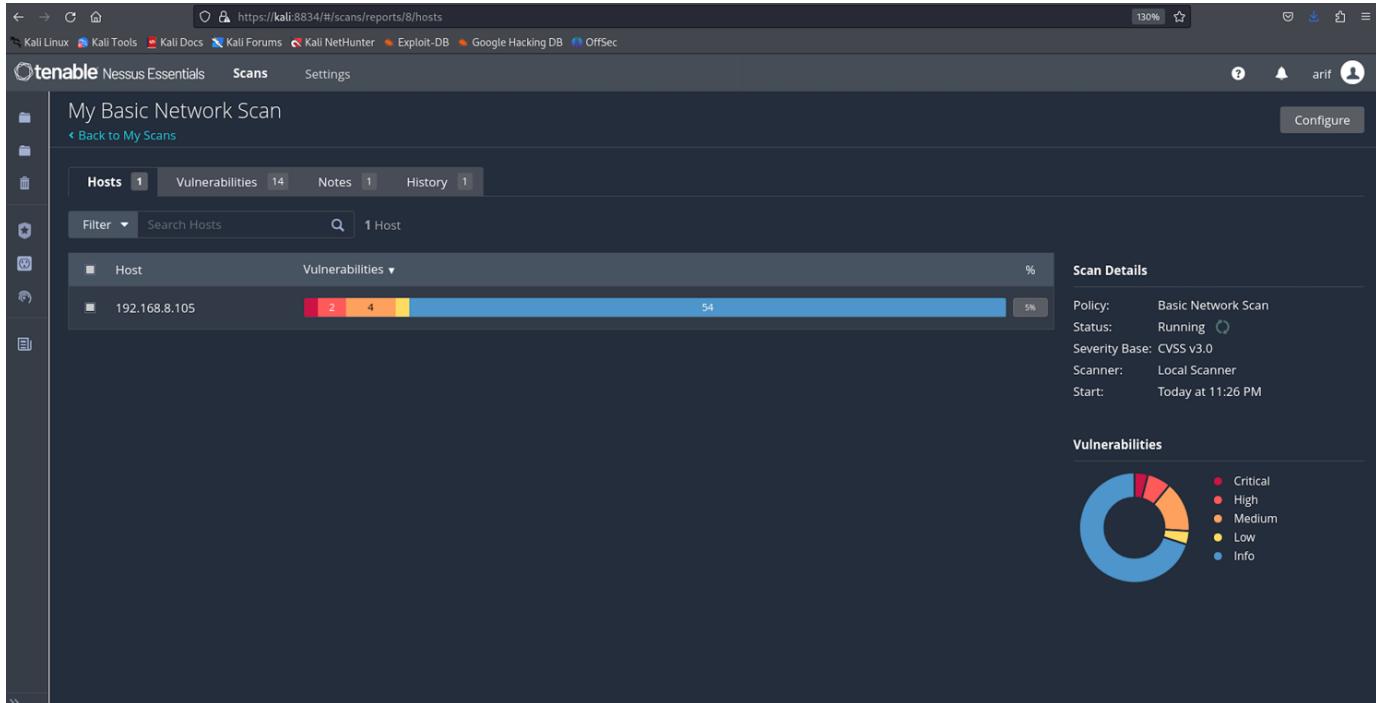
- Now inside your browser go to <https://<ip of kali>:8834> or <https://127.0.0.1:8834> and login giving your credentials, and go ahead with your first scan, by clicking the New Scan button at the top right.

The screenshot shows the Tenable Nessus Essentials web interface. At the top, there's a navigation bar with links to Kali Linux, Kali Tools, Kali Docs, Kali Forums, Kali NetHunter, Exploit-DB, Google Hacking DB, and OffSec. A message says 'There's an error with your feed. Click here to view your license information.' Below the navigation is a header with 'Scans' selected. On the left is a sidebar with icons for Scan Templates, Scans, and Settings. The main area is titled 'Scanner' and shows 'DISCOVERY' and 'VULNERABILITIES' sections. Under 'DISCOVERY', there's a card for 'Host Discovery'. Under 'VULNERABILITIES', there are cards for 'Basic Network Scan' (a full system scan), 'Advanced Scan', 'Advanced Dynamic Scan' (dynamic plugin scan), 'Malware Scan' (Windows and Unix), 'Mobile Device Scan' (MDM), 'Web Application Tests', 'Credentialled Patch Audit' (authenticate hosts and enumerate missing updates), 'Intel AMT Security Bypass' (remote/local checks for CVE-2017-5689), 'Spectre and Meltdown' (remote/local checks for CVE-2017-5753, CVE-2017-5715, and CVE-2017-5754), 'WannaCry Ransomware' (remote/local checks for MS17-010), 'Ripple20 Remote Scan' (fingerprint hosts running the Treck stack), and 'Zerologon Remote Scan' (detect Microsoft Netlogon Elevation of Privilege).

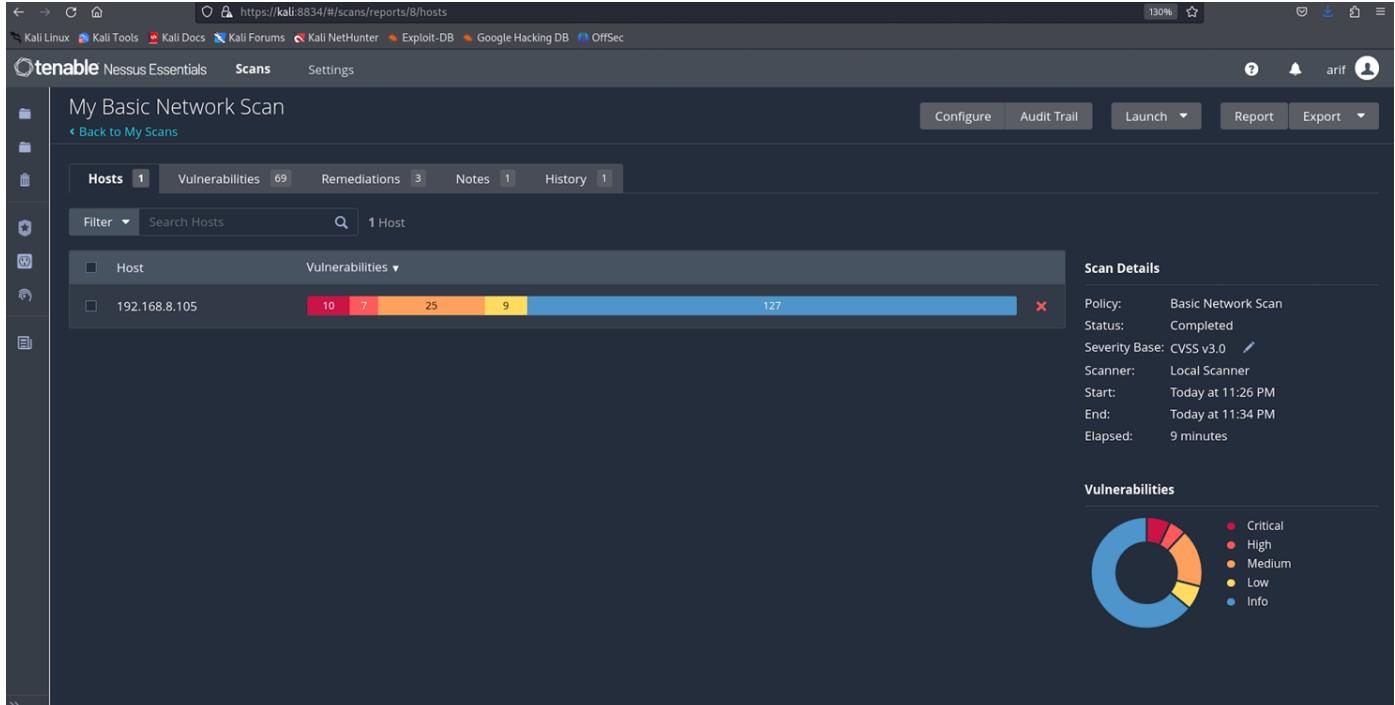
- Let us perform a basic scan by clicking on the Basic Network Scan in the above screenshot and then enter the details about your scan like the IP of your **Metasploitable2** machine. Once done you can click the save button.

The screenshot shows the 'New Scan / Basic Network Scan' configuration page. The URL is https://kali:8834/#/scans/reports/new/731a8e52-3ea6-a291-ec0a-d2ff0619c19d7bd788d6be818b65/settings/basic/general. The page has a header with 'Scans' selected and a message about an error with the feed. It shows a sidebar with 'Settings', 'Credentials', and 'Plugins'. The main form is titled 'New Scan / Basic Network Scan' and has a 'Back to Scan Templates' link. The 'Settings' tab is active. The form fields include 'Name' (REQUIRED), 'Description', 'Folder' (set to 'My Scans'), and 'Targets' (text input field with placeholder 'Example: 192.168.1.1-192.168.1.5, 192.168.2.0/24, test.com' and REQUIRED status). At the bottom are 'Save' and 'Cancel' buttons.

- You can schedule or run your saved scan at time of your convenience. The following screenshot shows the scan in progress. This may take a bit of time.



- Following screenshot shows the output when the scan is completed, showing 10 critical, 7 high, 25 medium and 9 low vulnerabilities and 127 information disclosures.



- You can click the **Vulnerabilities tab** to check the total 69 vulnerabilities that were detected by nessus on Metasploitable2. , can search for a specific one or use filter.

Sev	CVSS	VPR	EPSS	Name	Family	Count	
Critical	10.0 *	7.4	0.6495	UnrealIRCd Backdoor Detection	Backdoors	1	
Critical	10.0 *	5.9	0.015	NFS Exported Share Information Disclosure	RPC	1	
Critical	10.0 *			VNC Server 'password' Password	Gain a shell remotely	1	
Critical	9.8	9.0	0.9728	Apache Tomcat AJP Connector Request Inject...	Web Servers	1	
Critical	9.8			SSL Version 2 and 3 Protocol Detection	Service detection	2	
Critical	9.8			Bind Shell Backdoor Detection	Backdoors	1	
Critical	SSL (Multiple Issues)	Gain a shell remotely	3	
High	7.5	5.9	0.0358	Samba Badlock Vulnerability	General	1	
High	7.5 *	5.9	0.015	rlogin Service Detection	Service detection	1	

- Click critical vulnerability, [UnrealIRCd Backdoor Detection](#) (CVE-2010-2075) having a CVSS of 10.0, to check out the details about this vulnerability, which exist in Internet Relay Chat server. Moreover, you can Google this vulnerability and check out if there exist an exploit for this specific vulnerability and how to use it. (More on this later)
- Click another critical vulnerability, [NFS Exported Share Information Disclosure](#) (CVE-1999-0629) having a CVSS of 10.0, to check out the details about this vulnerability. Moreover, you can Google this vulnerability and check out if there exist an exploit for this specific vulnerability and how to use it. (More on this later)
- Click [VNC Server 'password' Password](#), (CVE-1999-0503) having a CVSS of 10.0. It says that the VNC server running on the remote host is secured with a weak password. Nessus was able to login using VNC authentication and a password of 'password'. A remote unauthenticated attacker could exploit this to take control of the system. (More on this later)
- Click [Bind Shell Backdoor Detection](#), (CVE-2001-0500) having a CVSS of 9.8. This is a buffer overflow vulnerability, which says that a shell is listening on the remote port without any authentication being required. An attacker may use it by connecting to the remote port and sending commands directly. (More on this later)

To Do:

- Students should visit <https://www.cve.org/> and check out the details of the detected CVEs
- Students are also advised to run a basic nessus scan on some Windows machine as well (which has not been updated for a bit of time).

OpenVAS <https://greenbone.github.io/docs/latest/>

OpenVAS (Open Vulnerability Assessment System) is an open-source framework used for network vulnerability scanning and management. It is designed to identify security vulnerabilities in networked systems and services, providing comprehensive reporting and remediation guidance. OpenVAS is widely used by security professionals for vulnerability assessment, compliance auditing, and network security monitoring.

Installing and Running OpenVAS

Installing OpenVAS on Kali Linux is the fastest and recommended way. On other distributions OpenVAS needs to be compiled from source, that is error prone and cumbersome. On Kali Linux you can install OpenVAS with the following commands:

```
$ sudo apt install gvm -y  
$ sudo apt install openvas -y  
$ sudo gvm-setup // This will do automatic OpenVAS configuration
```

Note: A password will be printed on the screen. Make sure to save that.

```
$ sudo gvm-check-setup // to verify installation
```

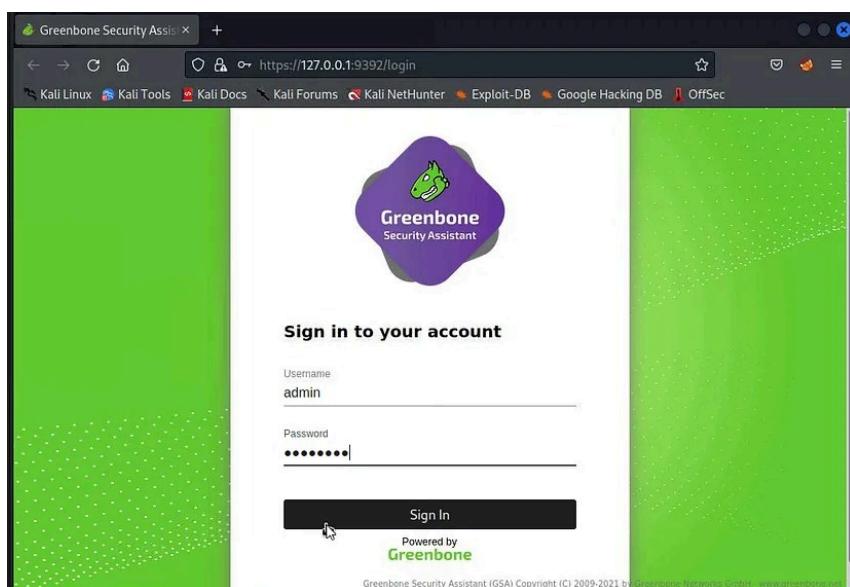
Run OpenVAS using command:

```
$ sudo systemctl start gvmd.service  
$ sudo gvm-start
```

This will start OpenVAS and can be accessed from <https://127.0.0.1:9392>

Login by entering username: admin and password: printed on the screen while gvm-setup is running. In case if you want to change the password to admin, use following command:

```
$ sudo -E -u _gvm -g _gvm gvmd -user=admin -new-password=admin
```



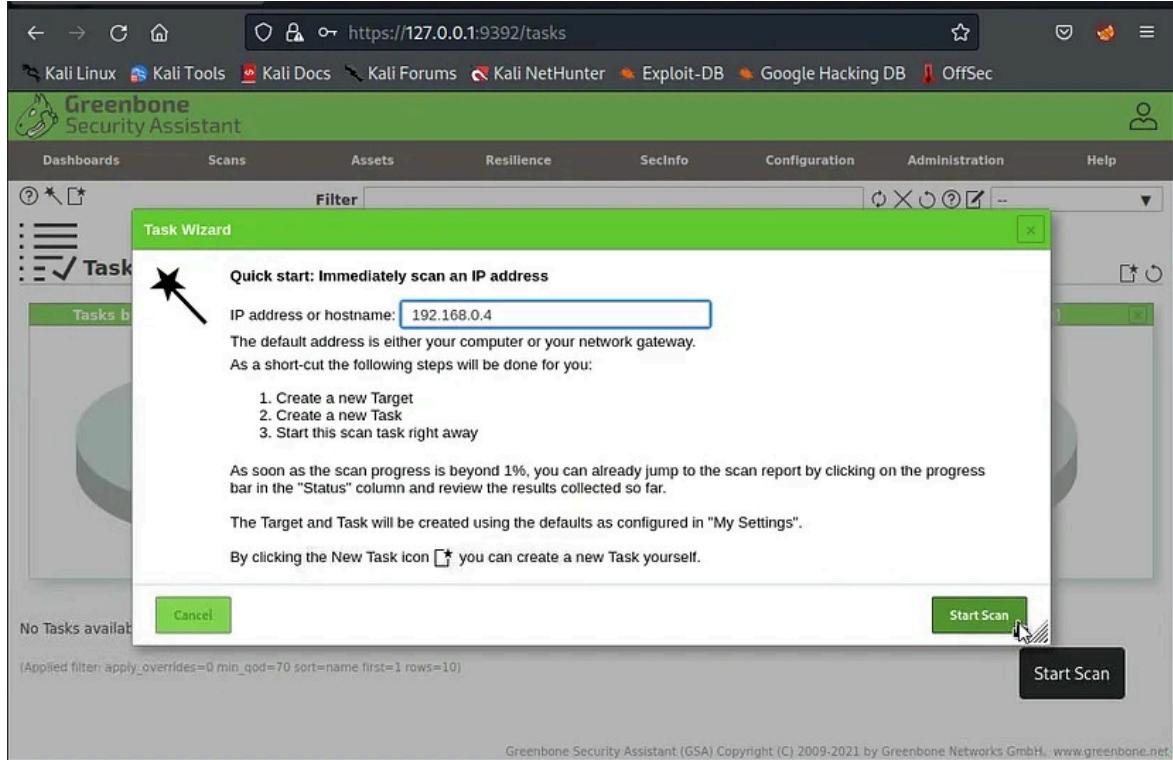
- Click **Scans** menu and select **Tasks**.

The screenshot shows the Greenbone Security Assistant web interface. At the top, there is a navigation bar with links to Kali Linux, Kali Tools, Kali Docs, Kali Forums, Kali NetHunter, Exploit-DB, Google Hacking DB, and OffSec. Below the navigation bar is the main header with the Greenbone logo and "Security Assistant". The "Scans" menu is currently active, with a dropdown menu open showing "Tasks" as the selected option, along with Reports, Results, Vulnerabilities, Notes, and Overrides. The main content area displays four circular charts: "Tasks by Severity Class (Total: 0)", "Tasks by Status (Total: 0)", "CVEs by Creation Time", and "NVTs by Severity Class (Total: 99842)". At the bottom of the screen, the URL "https://127.0.0.1:9392/tasks" is visible in the address bar, along with a log message indicating "Created CVEs".

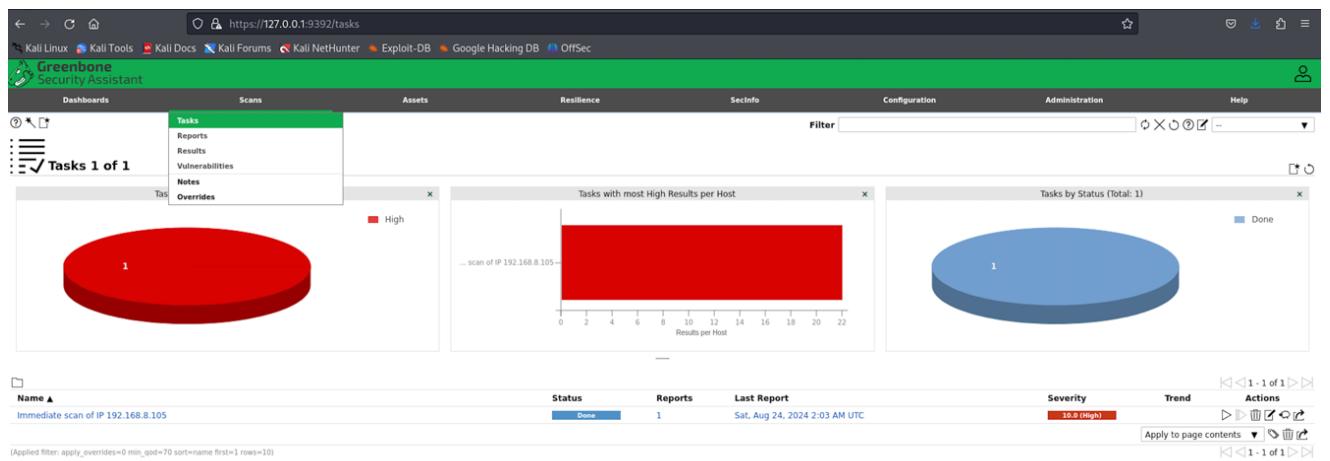
- The Tasks page is displayed. Click Task Wizard on the upper left side.

The screenshot shows the "Tasks" page of the Greenbone Security Assistant. The top navigation bar and header are identical to the previous screenshot. The "Scans" menu is still active, but the dropdown menu now shows "Task Wizard" as the selected option, along with Advanced Task Wizard and Modify Task Wizard. The main content area contains three circular charts: "Tasks by Severity Class (Total: 0)", "Tasks with most High Results per Host", and "Tasks by Status (Total: 0)". Below these charts, a message states "No Tasks available" and includes a note about applied filters: "(Applied filter: apply_overrides=0 min_qod=70 sort=name first=1 rows=10)". At the bottom of the screen, the URL "https://127.0.0.1:9392/tasks" is visible in the address bar, along with the copyright notice "Greenbone Security Assistant (GSA) Copyright (C) 2009-2021 by Greenbone Networks GmbH, www.greenbone.net".

- In the **Task Wizard** pop-up window, enter the following in the IP address or hostname field: <target-IP> and click **Start Scan**



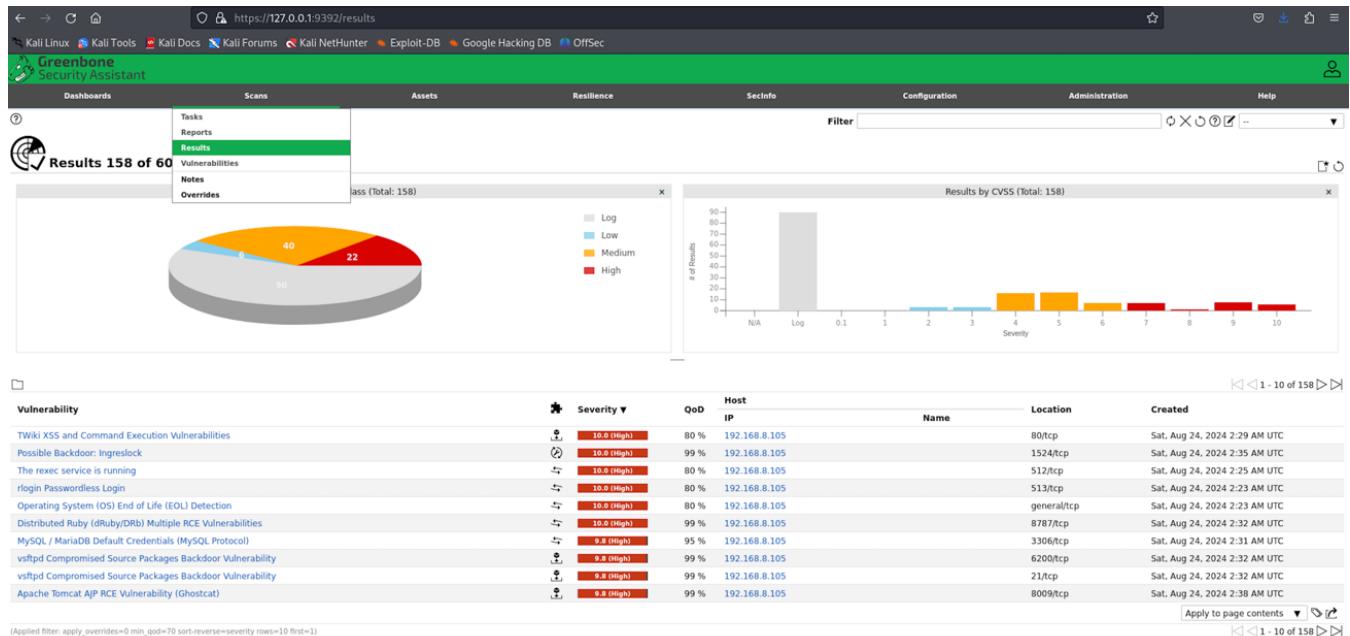
- The task will be created and run. It may take some time to run all the tests. Finally, on Task 1 of 1, under the Scans menu click the **Tasks** field.



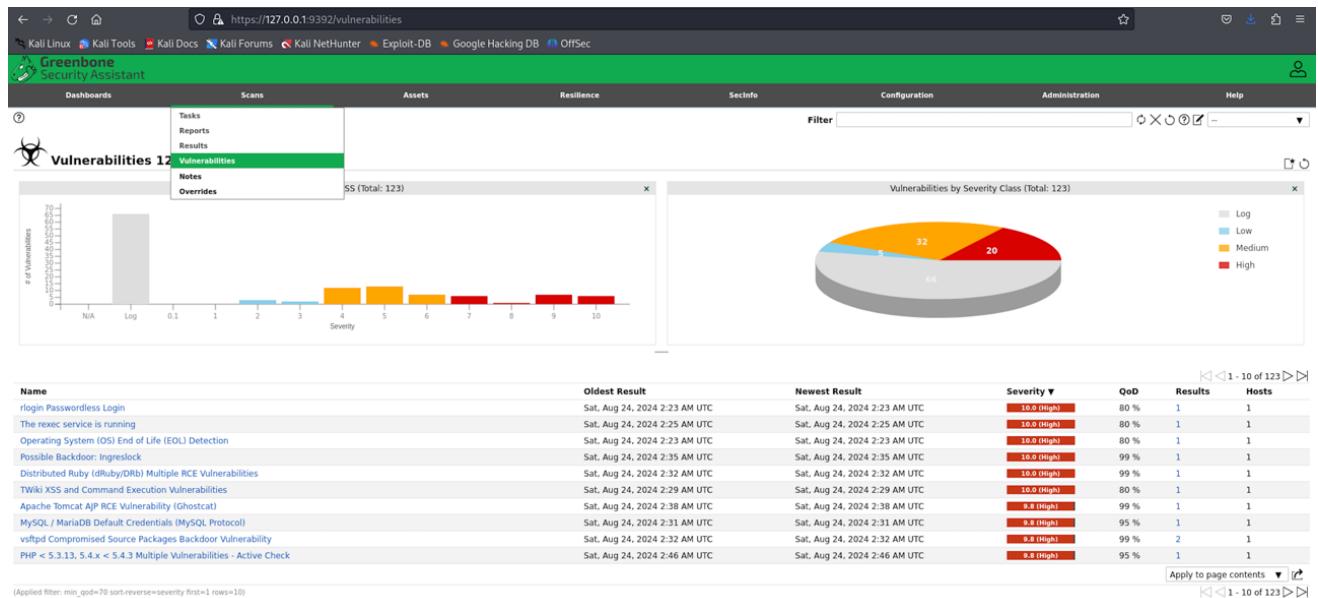
- You click the Done button and it will give you a detailed Report, having multiple tabs. Play with it to learn more about vulnerabilities. This is shown in the following screenshot

- Reports field.**

- Results field.



- Vulnerabilities field.



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