LAB MANUAL
ON
A PRACTICAL APPROACH TO NETWORK MONITORING

ESTABLISHMENT OF ADVANCED LABORATORY FOR CYBER SECURITY TRAINING TO TECHNICAL TEACHERS

DEPARTMENT OF INFORMATION MANAGEMENT AND EMERGING ENGINEERING

MINISTRY OF ELECTRONICS AND INFORMATION TECHNOLOGY

GOVERNMENT OF INDIA

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Table of Contents

MANUAL-1:

A Practical Approach to Network Monitoring

INTRODUCTION TO NMAP

- Nmap ("Network Mapper") is an open source tool [1] that is freely available for network discovery and vulnerability scanning.
- Nmap tool helps network administrators in identifying the devices running on the systems, discovering the accessible hosts and their services such as finding open ports and detecting security risks.
- Nmap utilizes IP packets to determine the available hosts on the network, the services provided by them, operating systems on which they are running as well as other characteristics such as packet filters/firewalls.
- Nmap sends the special crafted packets to the target hosts and received responses are analyzed by it.
- The output from Nmap is a list of scanned targets, with additional information such as port number and protocol, service name, and state(open, filtered, closed, or unfiltered).
  - Open state signifies that an application on the target machine is listening for connections on that port.
  - Filtered state implies that firewall is blocking the port and restricting Nmap to check whether it is open or closed.

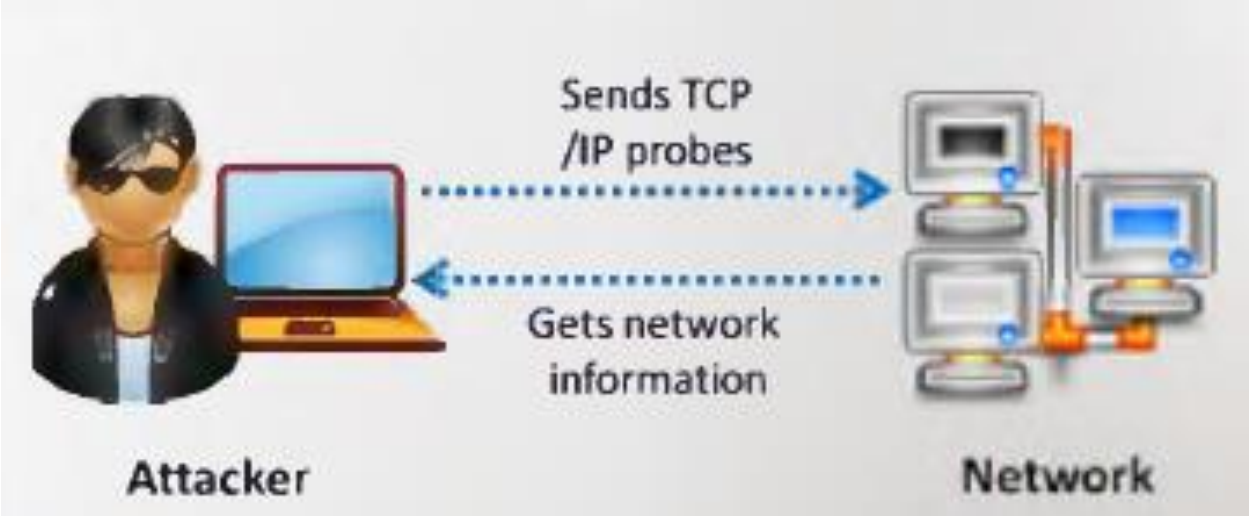
- Closed ports could open up at any time and have no application listening on them.

FEATURES OF NMAP

- **HOST DISCOVERY**: To identify hosts on a network. For example, listening the hosts that acknowledges to crafted TCP and/or ICMP requests or the specific port open.
- **PORT SCANNING**: To identify open ports on target hosts.
- **VERSION DETECTION**: To identify application name and version number by examining network services on remote devices
- **OS DETECTION:** To identify the operating system and hardware characteristics of network devices.

SCANNING

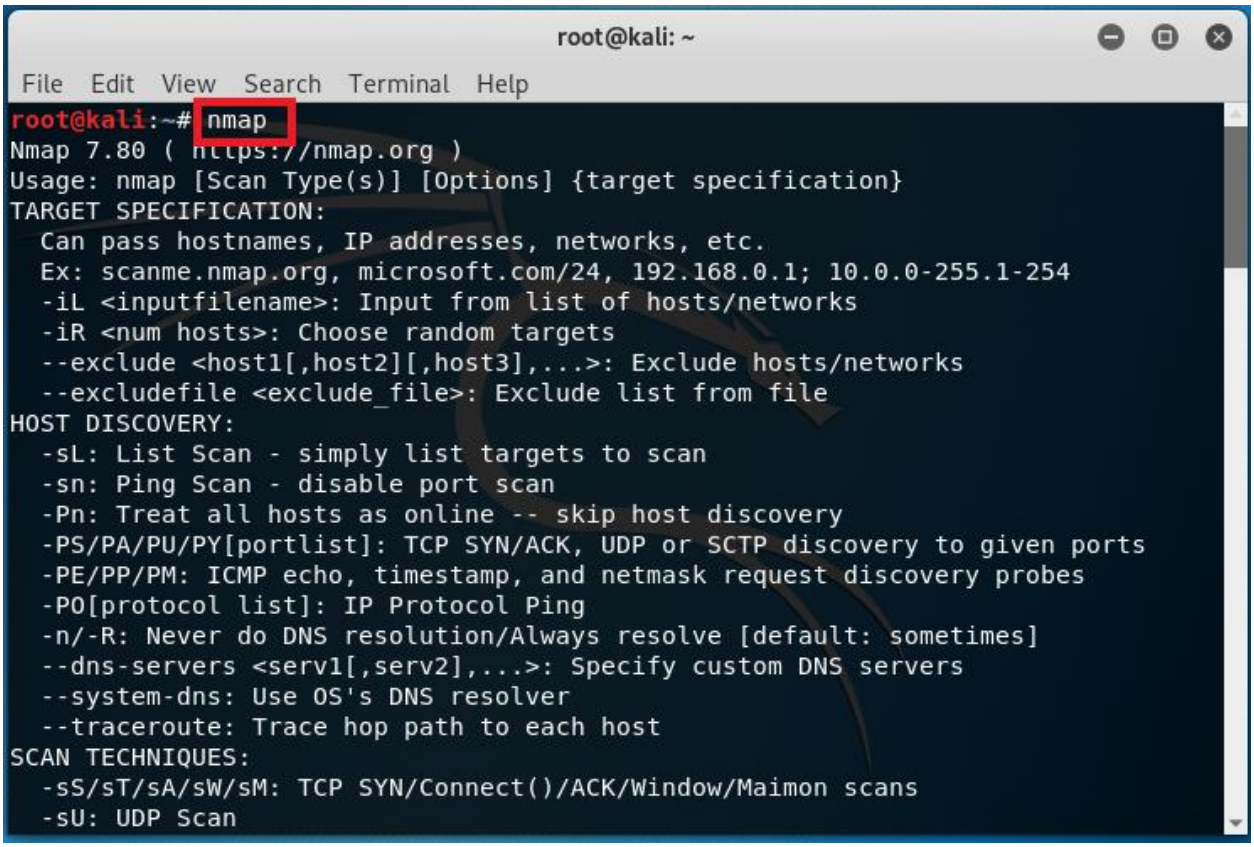
- Scanning is an active mode of information gathering.
- It refers to a set of procedures for identifying machines, open ports, and services running in network.
- The purpose is to find exploitable communication channels by discovering live machines, IP addresses, open ports, and services.
- It also identifies operating system, system architectures, and various vulnerabilities associated with it.



- The NMAP tool performs following steps of scanning:
  - Step 1: Find live machines
  - Step 2: Discover open ports
  - Step 3: Scanning beyond IDS
  - Step 4: Identify vulnerabilities

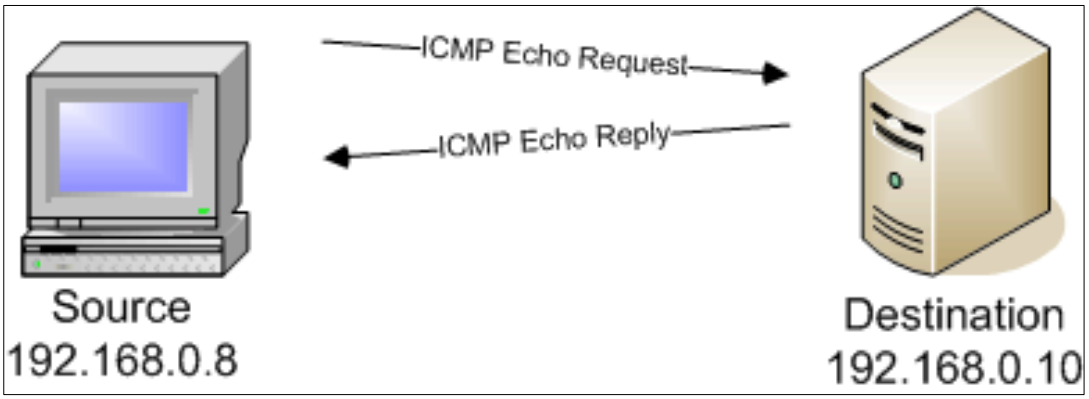
HOW TO OPEN NMAP

Open the Terminal in Kali Linux OS and type *nmap*.



STEP 1: FIND LIVE MACHINES

Introduction: Ping Sweep/Scan (-sP) is used to find live machines from a range of IP addresses. It sends ICMP echo request to multiple machines. In case of ping request, a single packet (56 bytes data + 08 byte header) is sent. It also determines round trip time.

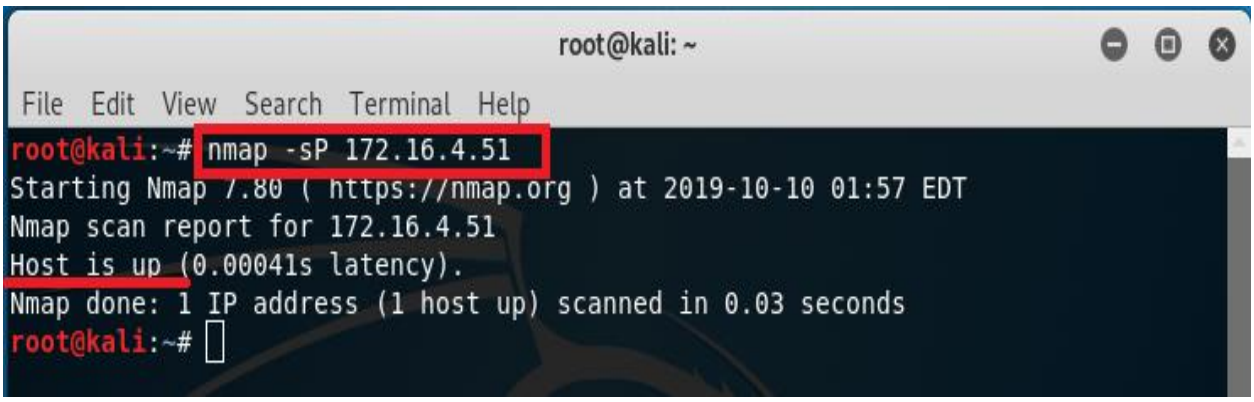


Command:

nmap –sP <target>

For example:

nmap –sP 172.16.4.1-254



STEP 2: DISCOVER OPEN PORTS

Introduction: In computer networking, a port is a communication endpoint. For example, Server Message Block (SMB) is a network file sharing protocol used by Windows machine for file and printer sharing. It operates on TCP port number 138 and 445.

Attackers can exploit the vulnerabilities associated with SMB protocol if these ports are open. Microsoft released a patch for SMB v1 vulnerability but most of the users installed pirated version of operating system which will never be updated.

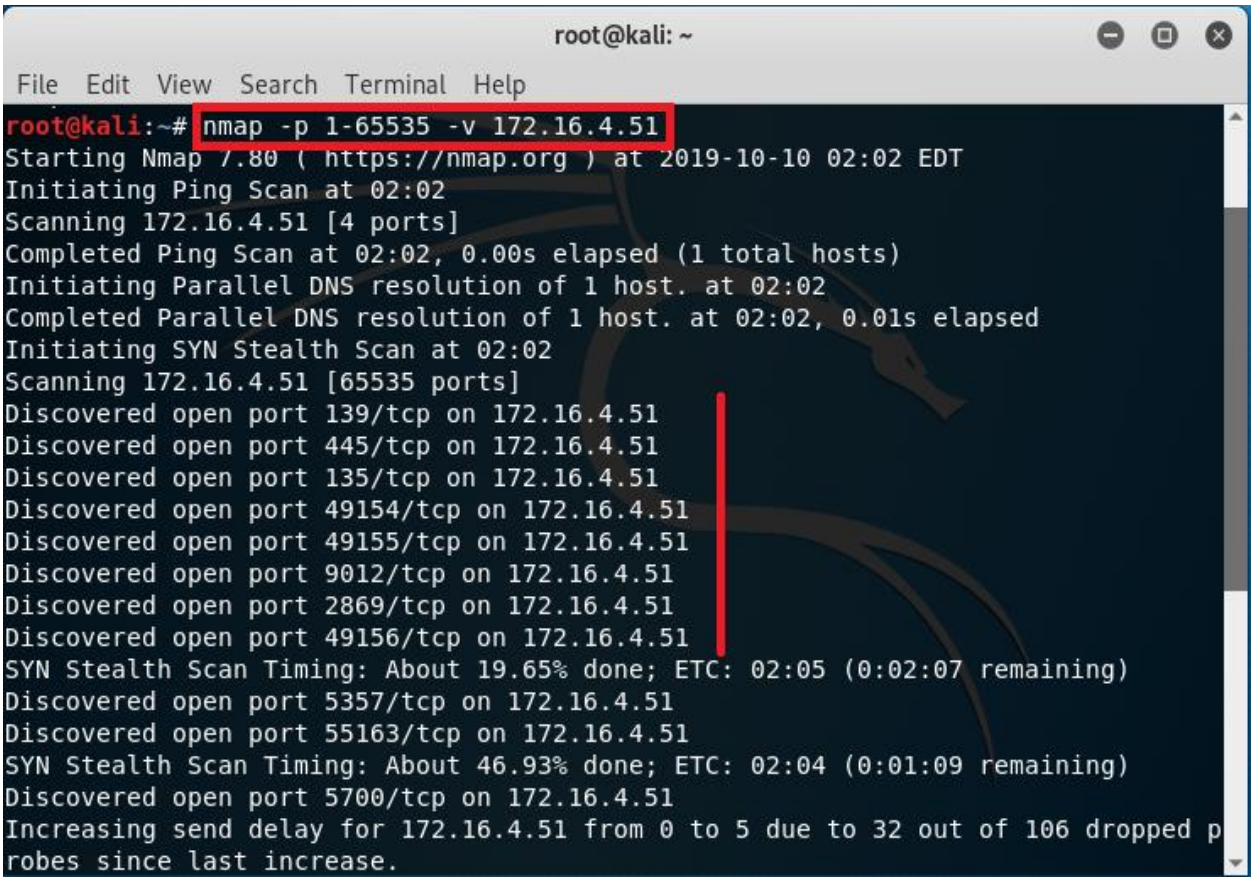
Command:

nmap –p <port> -v <target>

(-v is the verbose output to display extended information)

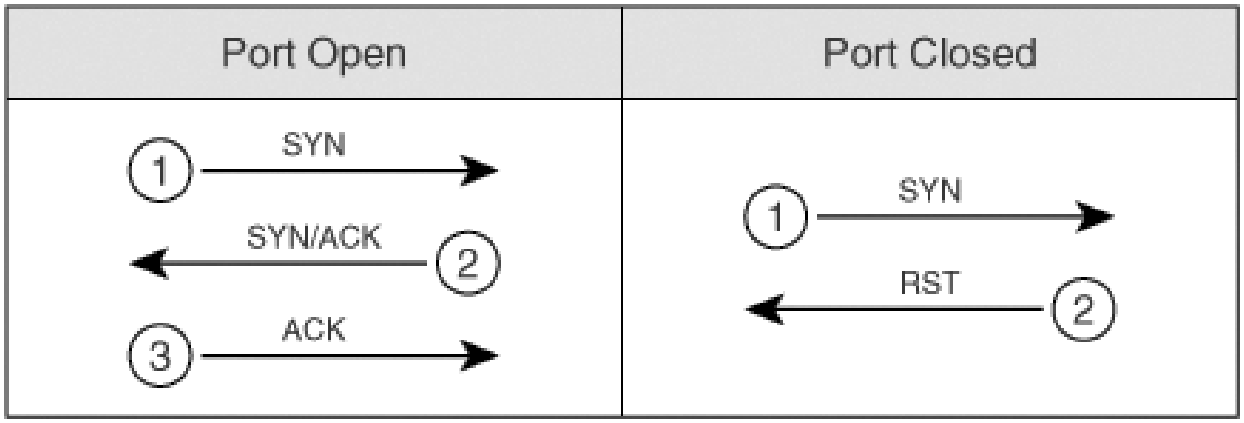
For example:

nmap –p 1-65535 –v 172.16.4.51


root@kali: ~
File Edit View Search Terminal Help
root@kali:~# nmap -p 1-65535 -v 172.16.4.51
Starting Nmap 7.80 (https://nmap.org) at 2019-10-10 02:02 EDT
Initiating Ping Scan at 02:02
Scanning 172.16.4.51 [4 ports]
Completed Ping Scan at 02:02, 0.00s elapsed (1 total hosts)
Initiating Parallel DNS resolution of 1 host. at 02:02
Completed Parallel DNS resolution of 1 host. at 02:02, 0.01s elapsed
Initiating SYN Stealth Scan at 02:02
Scanning 172.16.4.51 [65535 ports]
Discovered open port 139/tcp on 172.16.4.51
Discovered open port 445/tcp on 172.16.4.51
Discovered open port 135/tcp on 172.16.4.51
Discovered open port 49154/tcp on 172.16.4.51
Discovered open port 49155/tcp on 172.16.4.51
Discovered open port 9012/tcp on 172.16.4.51
Discovered open port 2869/tcp on 172.16.4.51
Discovered open port 49156/tcp on 172.16.4.51
SYN Stealth Scan Timing: About 19.65% done; ETC: 02:05 (0:02:07 remaining)
Discovered open port 5357/tcp on 172.16.4.51
Discovered open port 55163/tcp on 172.16.4.51
SYN Stealth Scan Timing: About 46.93% done; ETC: 02:04 (0:01:09 remaining)
Discovered open port 5700/tcp on 172.16.4.51
Increasing send delay for 172.16.4.51 from 0 to 5 due to 32 out of 106 dropped p
robes since last increase.

a) TCP Connect Scan [-sT]

Introduction: TCP Connect scan detects open ports by three way handshake. It is also referred as FULL OPEN Scan.

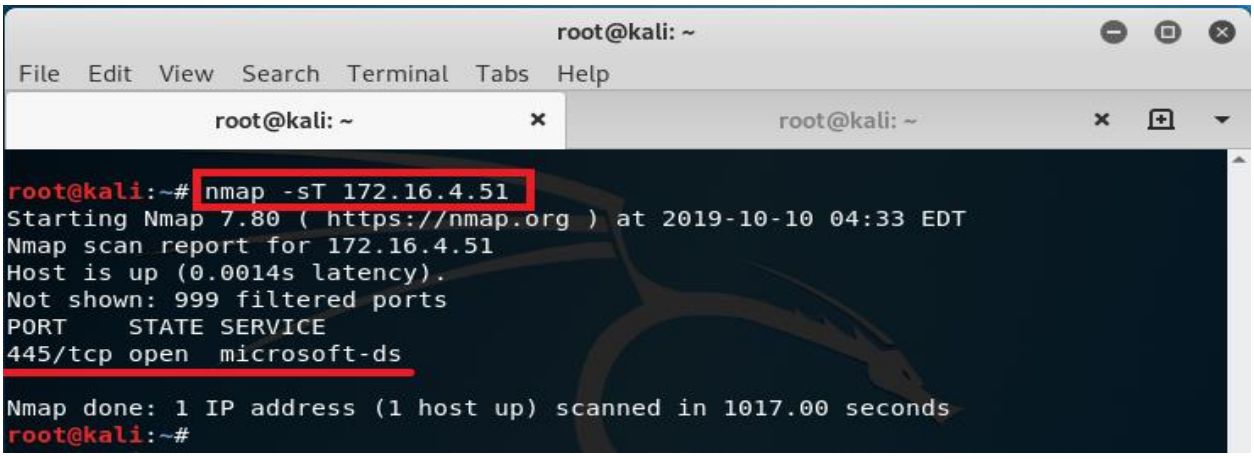


Command:

nmap –sT <target>

For example:

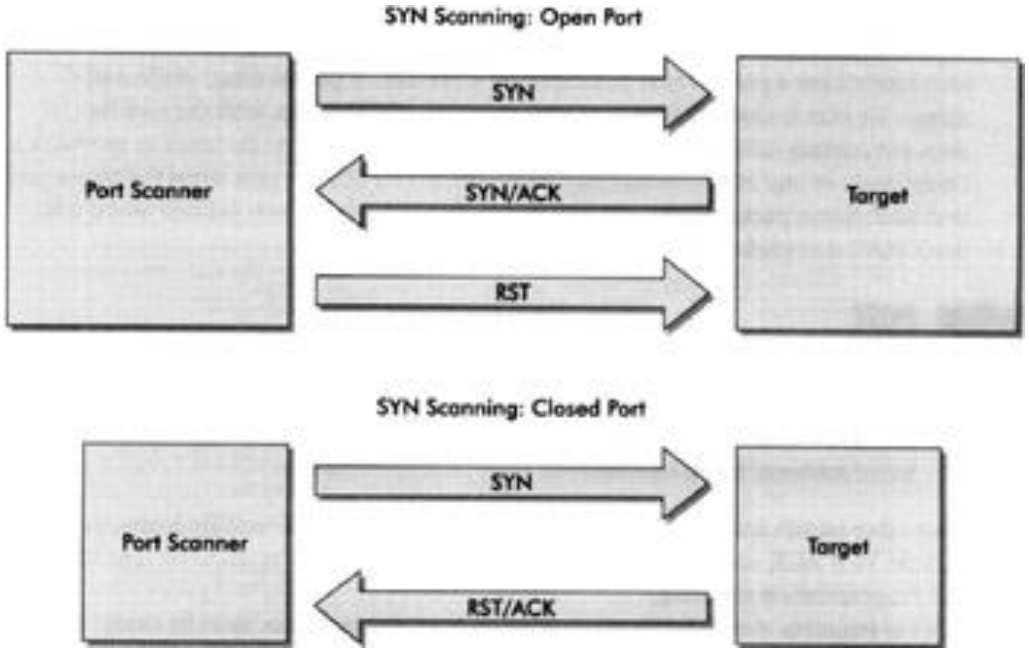
nmap –sT 172.16.4.51



b) SYN Stealth Scan [-sS]

Introduction: It is based upon TCP handshake. It is also referred as HALF OPEN Scan. In this type of scan, Nmap sends SYN packet:

- If port is open - it responds with ACK.
- If port is closed - it responds with RST.
- If port is filtered - it simply drops SYN packet.



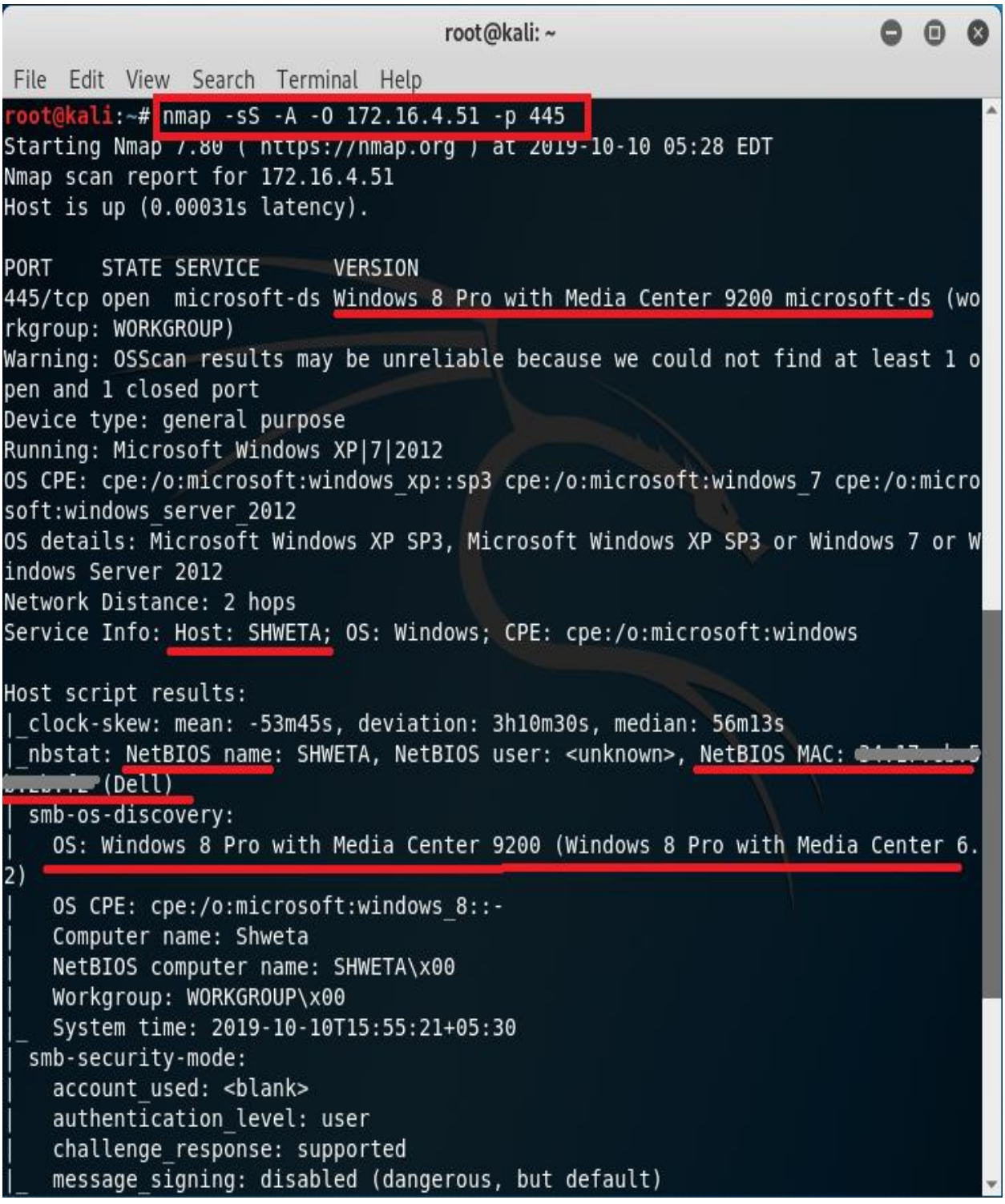
Command:

nmap –sS –A –O <target> –p <port>

(where –A is Aggressive scan, -O is operating system)

For example:

nmap –sS –A –O 172.16.4.51 –p 445


root@kali: ~
File Edit View Search Terminal Help
root@kali:~# nmap -sS -A -O 172.16.4.51 -p 445
Starting Nmap 7.80 (https://nmap.org) at 2019-10-10 05:28 EDT
Nmap scan report for 172.16.4.51
Host is up (0.00031s latency).
PORT STATE SERVICE VERSION
445/tcp open microsoft-ds Windows 8 Pro with Media Center 9200 microsoft-ds (workgroup: WORKGROUP)
Warning: OSScan results may be unreliable because we could not find at least 1 open and 1 closed port
Device type: general purpose
Running: Microsoft Windows XP|7|2012
OS CPE: cpe:/o:microsoft:windows_xp::sp3 cpe:/o:microsoft:windows_7 cpe:/o:microsoft:windows_server_2012
OS details: Microsoft Windows XP SP3, Microsoft Windows XP SP3 or Windows 7 or Windows Server 2012
Network Distance: 2 hops
Service Info: Host: SHWETA; OS: Windows; CPE: cpe:/o:microsoft:windows
Host script results:
|_clock-skew: mean: -53m45s, deviation: 3h10m30s, median: 56m13s
|_nbstat: NetBIOS name: SHWETA, NetBIOS user: <unknown>, NetBIOS MAC:
(Dell)
| smb-os-discovery:
| OS: Windows 8 Pro with Media Center 9200 (Windows 8 Pro with Media Center 6.2)
| OS CPE: cpe:/o:microsoft:windows_8::-
| Computer name: Shweta
| NetBIOS computer name: SHWETA\x00
| Workgroup: WORKGROUP\x00
|_ System time: 2019-10-10T15:55:21+05:30
| smb-security-mode:
| account_used: <blank>
| authentication_level: user
| challenge_response: supported
|_ message_signing: disabled (dangerous, but default)

c) UDP Scan [-sU]

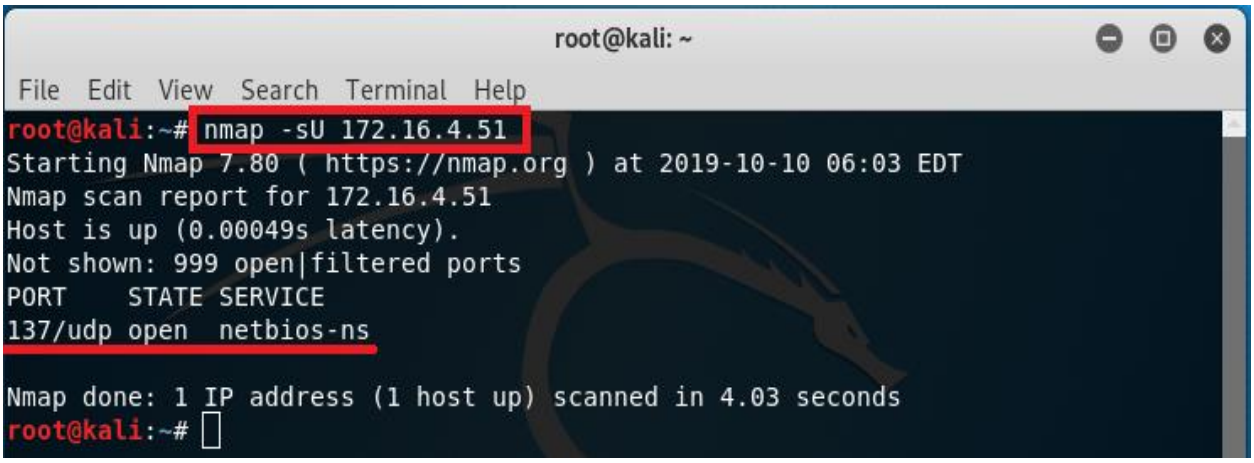
Introduction: This type of scan is used to scan UDP ports. Nmap sends the 0 byte UDP packets. If source receives an ICMP Port Unreachable message, then the Port is closed.

Command:

nmap –sU <target>

For example:

nmap –sU 172.16.4.51



d) Idle Scan [-sI]

Introduction: An idle scan contains three steps that are repeatedly followed for each of the port:

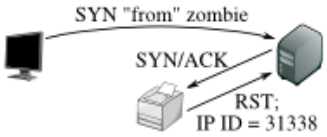
- Step 1: Probe the zombie's IP ID and record it.
- Step 2: Forge a SYN packet from the zombie and send it to the desired port on the target. Depending on the port state, the target's reaction may or may not cause the zombie's IP ID to be incremented.
- Step 3: Probe the zombie's IP ID again. The target port state is then determined by comparing this new IP ID with the previous recorded step.

Idle scan of an open port:

Step 1: Probe the zombie's IP ID.

The attacker sends a SYN/ACK to the zombie. The zombie, not expecting the SYN/ACK, sends back a RST, disclosing its IP ID.

Step 2: Forge a SYN packet from the zombie.



The target sends a SYN/ACK in response to the SYN that appears to come from the zombie. The zombie, not expecting it, sends back a RST, incrementing its IP ID in the process.

Step 3: Probe the zombie's IP ID again.

The zombie's IP ID has increased by 2 since step 1, so the port is open!

Idle scan of a closed port:

Step 1: Probe the zombie's IP ID.

The attacker sends a SYN/ACK to the zombie. The zombie, not expecting the SYN/ACK, sends back a RST, disclosing its IP ID. This step is always the same.

Step 2: Forge a SYN packet from the zombie.

The target sends a RST (the port is closed) in response to the SYN that appears to come from the zombie. The zombie ignores the unsolicited RST, leaving its IP ID unchanged.

Step 3: Probe the zombie's IP ID again.

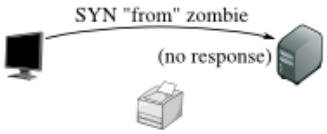
The zombie's IP ID has increased by only 1 since step 1, so the port is not open.

Idle scan of a filtered port:

Step 1: Probe the zombie's IP ID.

Just as in the other two cases, the attacker sends a SYN/ACK to the zombie. The zombie discloses its IP ID.

Step 2: Forge a SYN packet from the zombie.



The target, obstinately filtering its port, ignores the SYN that appears to come from the zombie. The zombie, unaware that anything has happened, does not increment its IP ID.

Step 3: Probe the zombie's IP ID again.

The zombie's IP ID has increased by only 1 since step 1, so the port is not open. From the attacker's point of view this filtered port is indistinguishable from a closed port.

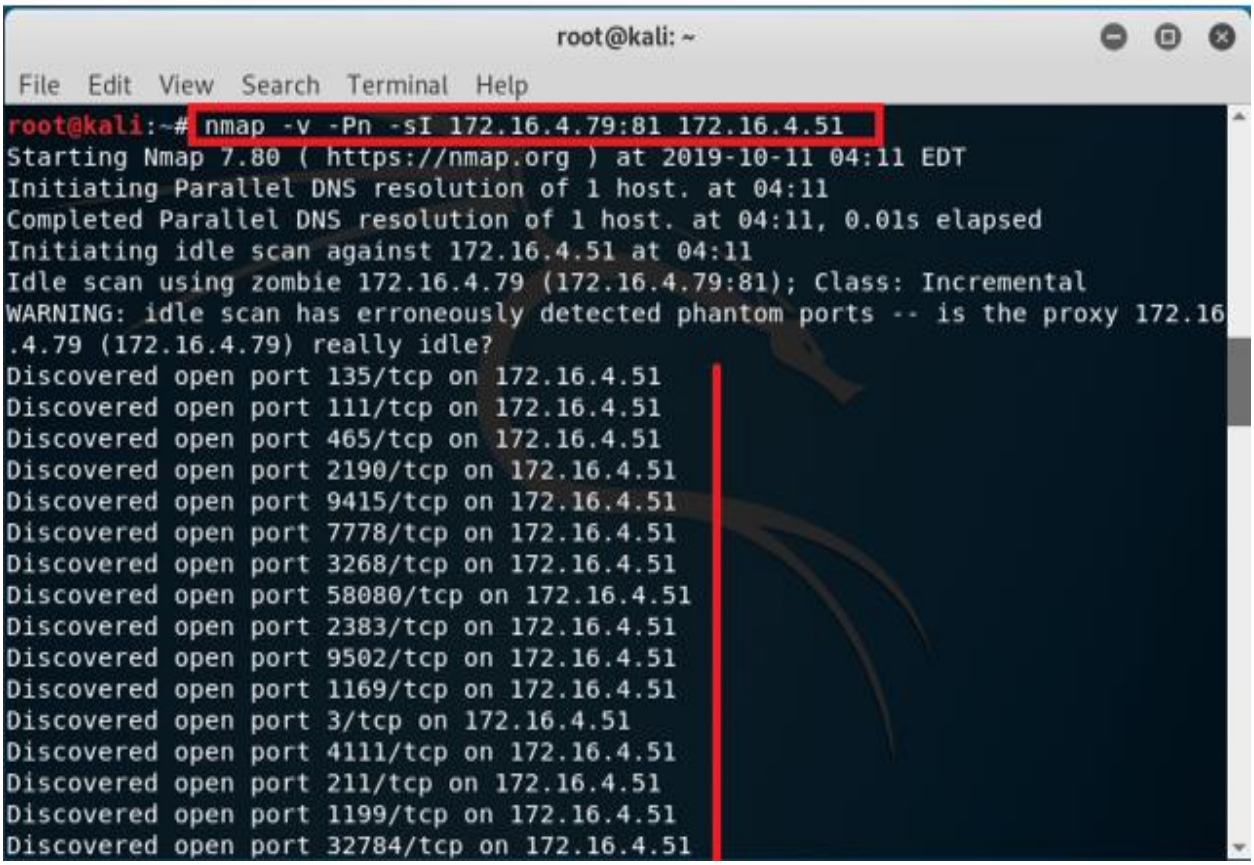
Command:

nmap -V -Pn –sI <zombie-address> :<port no.> <victim's address>

(By default port no. is 80)

For example:

nmap –v –Pn –sI 172.16.4.79:81 172.16.4.51



STEP 3: SCANNING BEYOND FIREWALL

Introduction: Nmap provides feature to control time options– [-T]. The timings are: Paranoid [-T0], Sneaky [-T1], Polite [-T2], Normal [-T3], Aggressive [-T4], and Insane [-T5].

Where –T0 implies 5 minutes wait between each packet to send that make it almost impossible for firewall to detect.

Similarly,

–T1 implies 4 minutes wait between each packet to send.

–T2 implies 3 minutes wait between each packet to send.

–T3 implies 2 minutes wait between each packet to send.

–T4 implies 1 minutes wait between each packet to send.

–T5 implies no wait between each packet to send.

Command:

nmap -T[0-5] [target]

For example:

nmap –T5 172.16.4.51

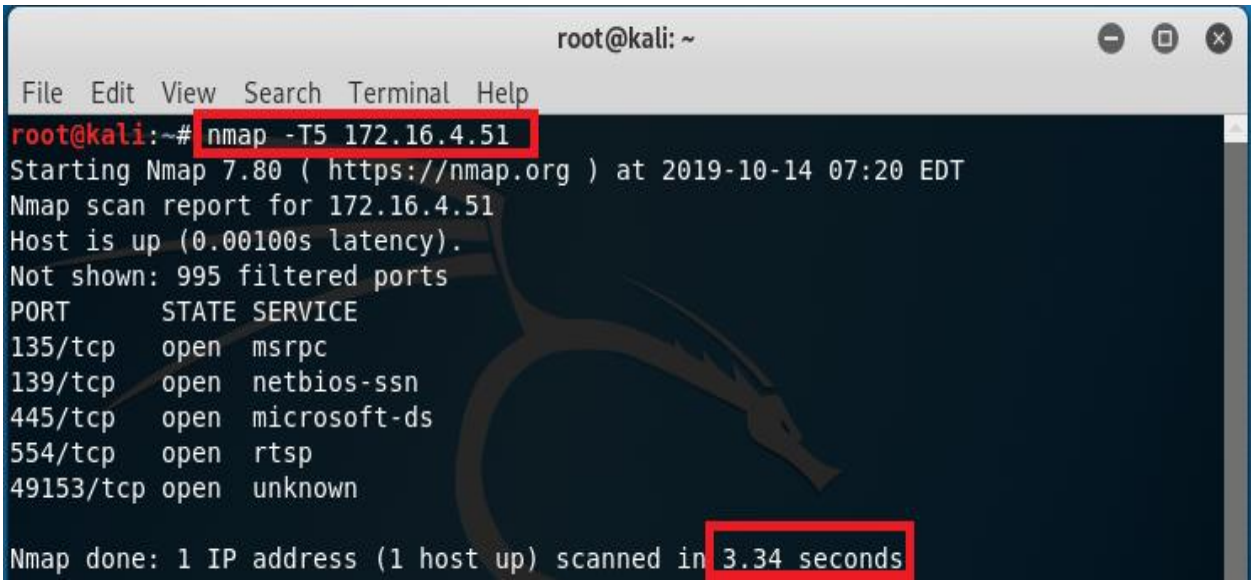
nmap –T4 172.16.4.51

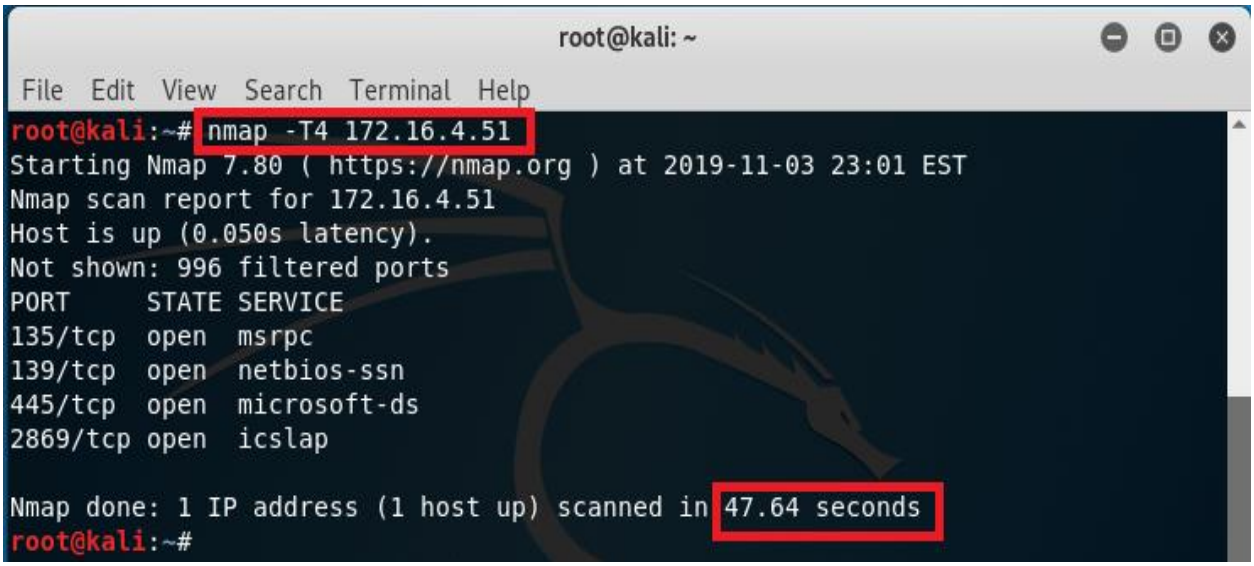
nmap –T3 172.16.4.51

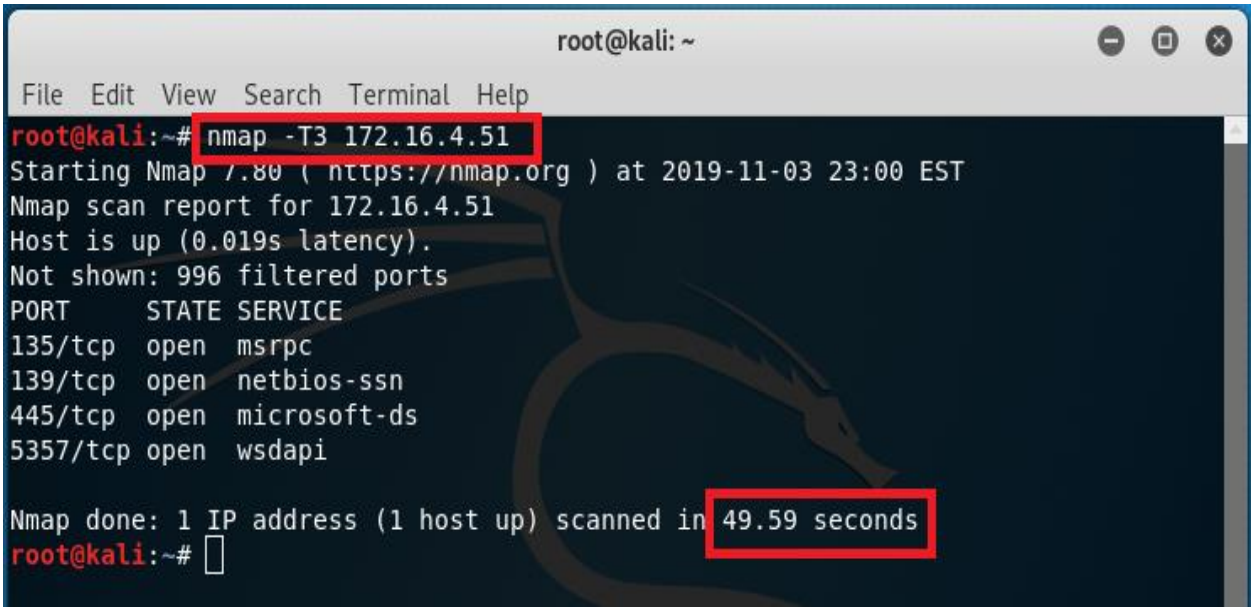
nmap –T2 172.16.4.51

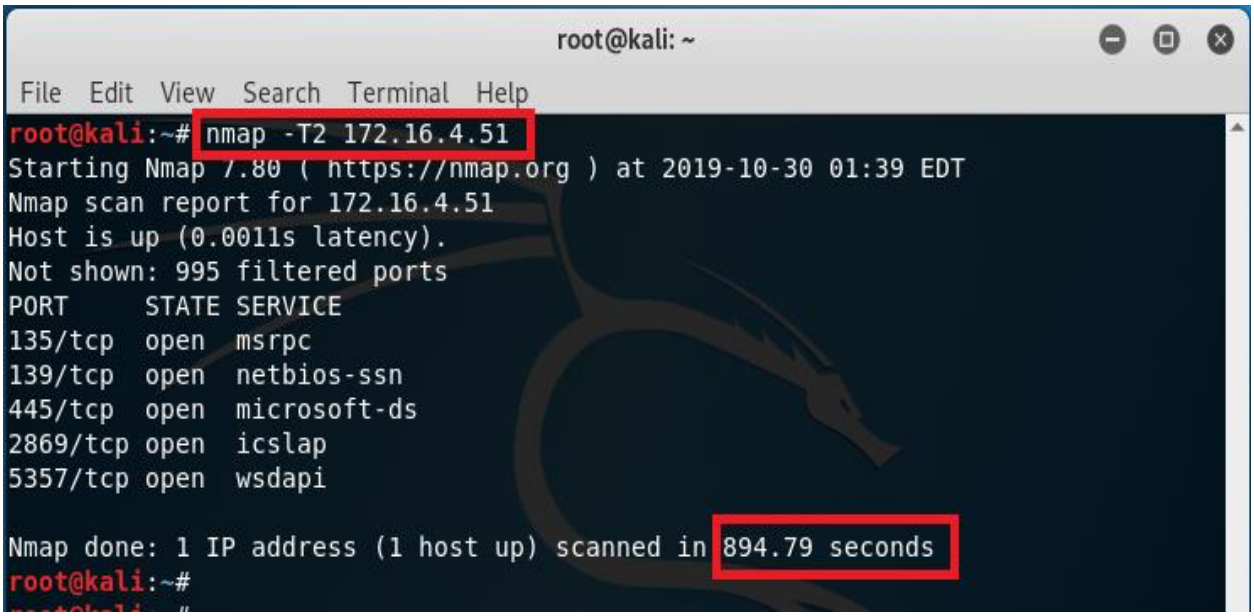
nmap –T1 172.16.4.51

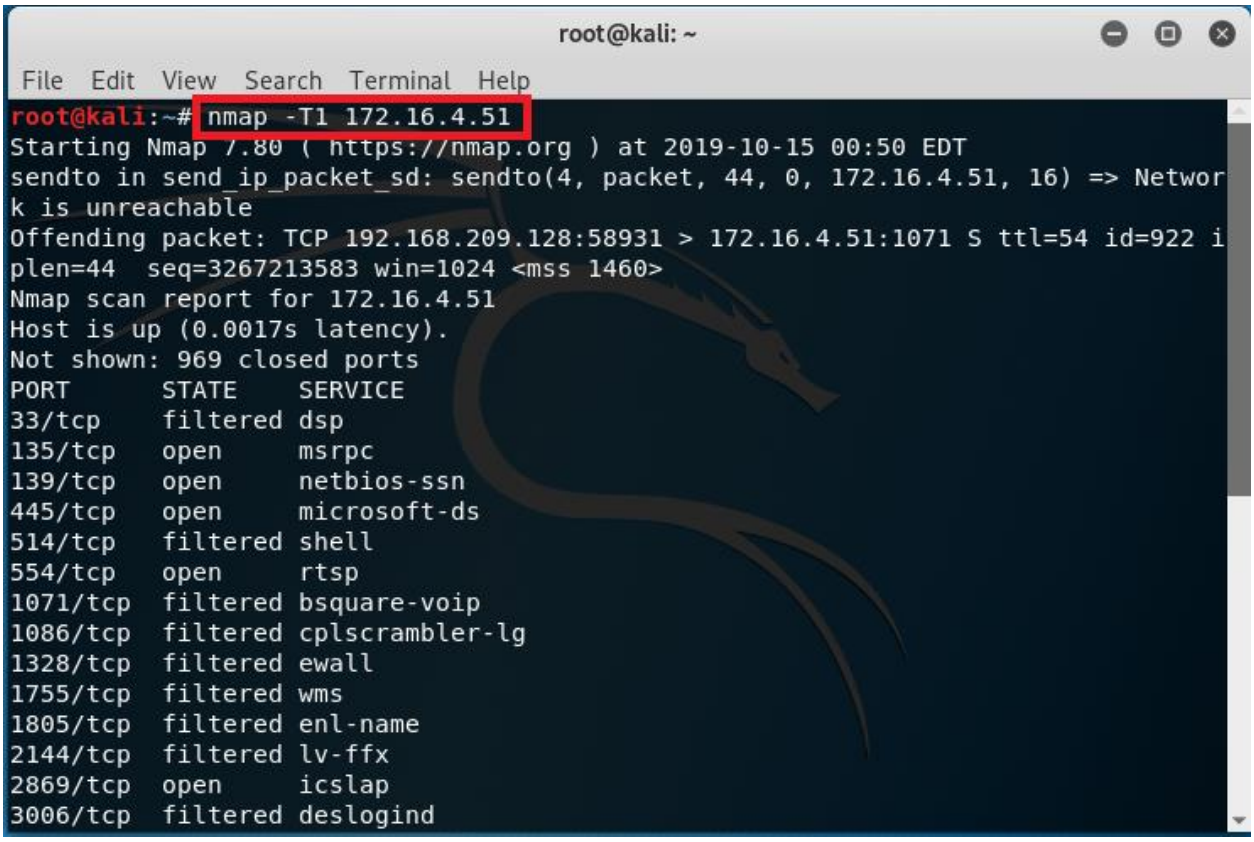
nmap –T0 172.16.4.51

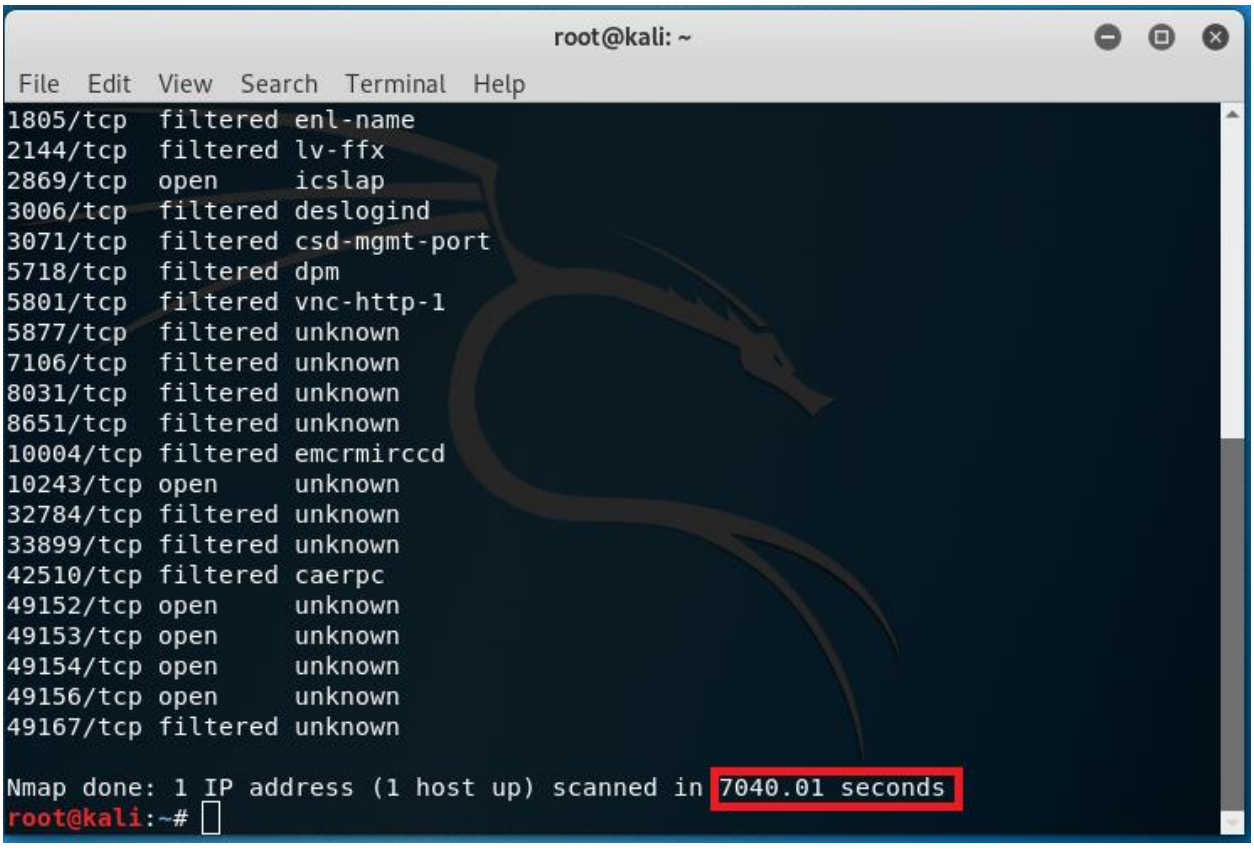





root@kali: ~
File Edit View Search Terminal Help
root@kali:~# nmap -T3 172.16.4.51
Starting Nmap 7.80 (https://nmap.org) at 2019-11-03 23:00 EST
Nmap scan report for 172.16.4.51
Host is up (0.019s latency).
Not shown: 996 filtered ports
PORT STATE SERVICE
135/tcp open msrpc
139/tcp open netbios-ssn
445/tcp open microsoft-ds
5357/tcp open wsdapi
Nmap done: 1 IP address (1 host up) scanned in 49.59 seconds
root@kali:~#


root@kali: ~
File Edit View Search Terminal Help
root@kali:~# nmap -T2 172.16.4.51
Starting Nmap 7.80 (https://nmap.org) at 2019-10-30 01:39 EDT
Nmap scan report for 172.16.4.51
Host is up (0.0011s latency).
Not shown: 995 filtered ports
PORT STATE SERVICE
135/tcp open msrpc
139/tcp open netbios-ssn
445/tcp open microsoft-ds
2869/tcp open icslap
5357/tcp open wsdapi
Nmap done: 1 IP address (1 host up) scanned in 894.79 seconds
root@kali:~#


root@kali: ~
File Edit View Search Terminal Help
root@kali:~# nmap -T1 172.16.4.51
Starting Nmap 7.80 (https://nmap.org) at 2019-10-15 00:50 EDT
sendto in send_ip_packet_sd: sendto(4, packet, 44, 0, 172.16.4.51, 16) => Networ
k is unreachable
Offending packet: TCP 192.168.209.128:58931 > 172.16.4.51:1071 S ttl=54 id=922 i
plen=44 seq=3267213583 win=1024 <mss 1460>
Nmap scan report for 172.16.4.51
Host is up (0.0017s latency).
Not shown: 969 closed ports
PORT STATE SERVICE
33/tcp filtered dsp
135/tcp open msrpc
139/tcp open netbios-ssn
445/tcp open microsoft-ds
514/tcp filtered shell
554/tcp open rtsp
1071/tcp filtered bsquare-voip
1086/tcp filtered cplscrambler-lg
1328/tcp filtered ewall
1755/tcp filtered wms
1805/tcp filtered enl-name
2144/tcp filtered lv-ffx
2869/tcp open icslap
3006/tcp filtered deslogind


root@kali: ~
File Edit View Search Terminal Help
1805/tcp filtered enl-name
2144/tcp filtered lv-ffx
2869/tcp open icslap
3006/tcp filtered deslogind
3071/tcp filtered csd-mgmt-port
5718/tcp filtered dpm
5801/tcp filtered vnc-http-1
5877/tcp filtered unknown
7106/tcp filtered unknown
8031/tcp filtered unknown
8651/tcp filtered unknown
10004/tcp filtered emcrmirccd
10243/tcp open unknown
32784/tcp filtered unknown
33899/tcp filtered unknown
42510/tcp filtered caerpc
49152/tcp open unknown
49153/tcp open unknown
49154/tcp open unknown
49156/tcp open unknown
49167/tcp filtered unknown
Nmap done: 1 IP address (1 host up) scanned in 7040.01 seconds
root@kali:~#

STEP 4: IDENTIFY VULNERABILITIES

Introduction: After finding the open ports and services running on it, this step identifies the vulnerabilities associated with the open ports. For example, vulnerabilities associated with the open ports of Simple Network Management Protocol (SNMP) and Server Message Block (SMB) protocols.

Simple Network Management Protocol (SNMP) is built in to virtually every network device. Network management programs (such as HP OpenView and LANDesk) use SNMP for remote network host management. Unfortunately, SNMP also presents security vulnerabilities.

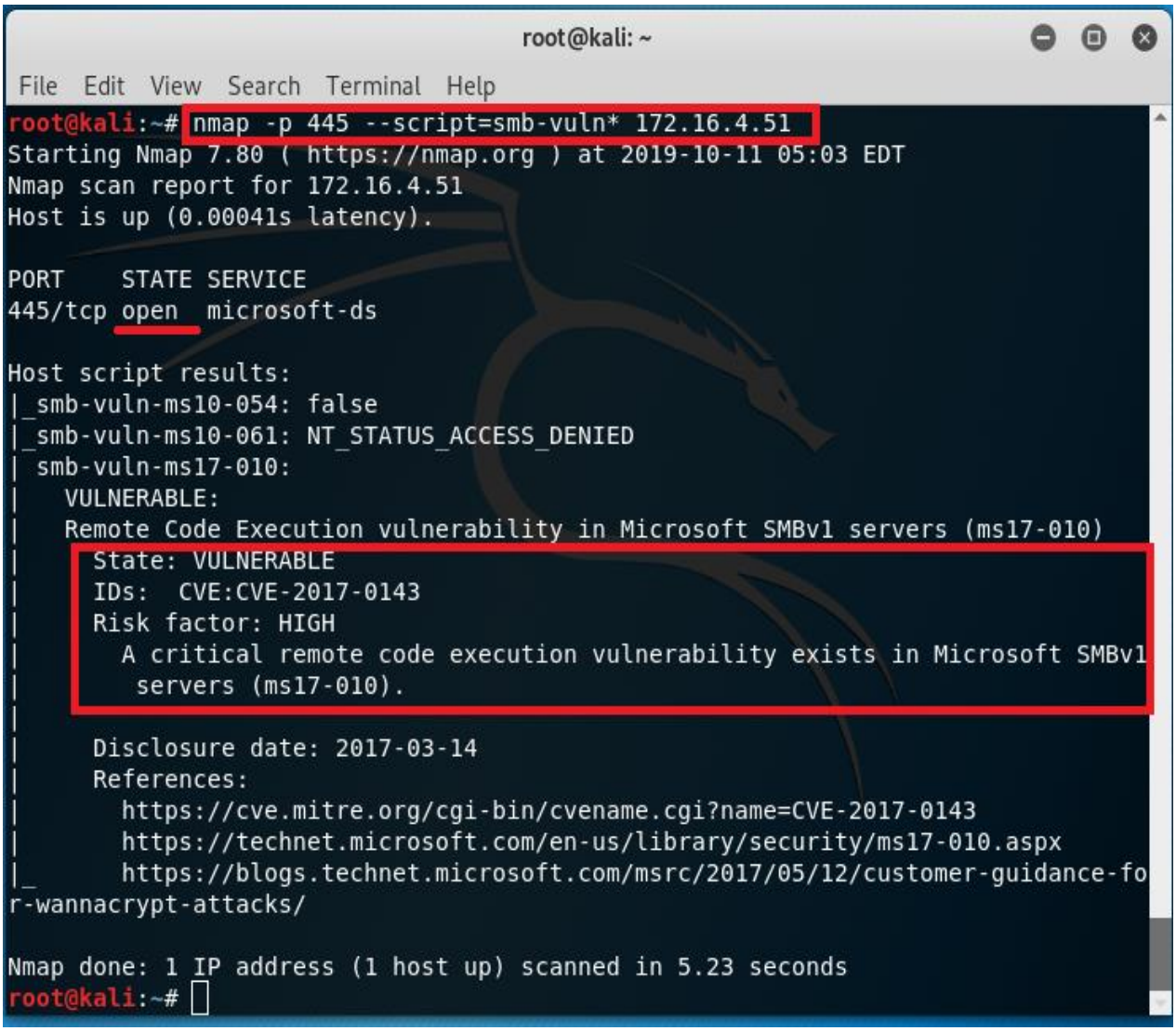
If SNMP is compromised, an attacker can collect information of network such as ARP tables, usernames, and TCP connections to perform various attacks. If SNMP shows up in port scans, then a hacker will try to hack the system.

Command:

nmap -p 445 --script=smb-vuln* <target>

For example:

nmap -p 445 --script=smb-vuln* 172.16.4.51

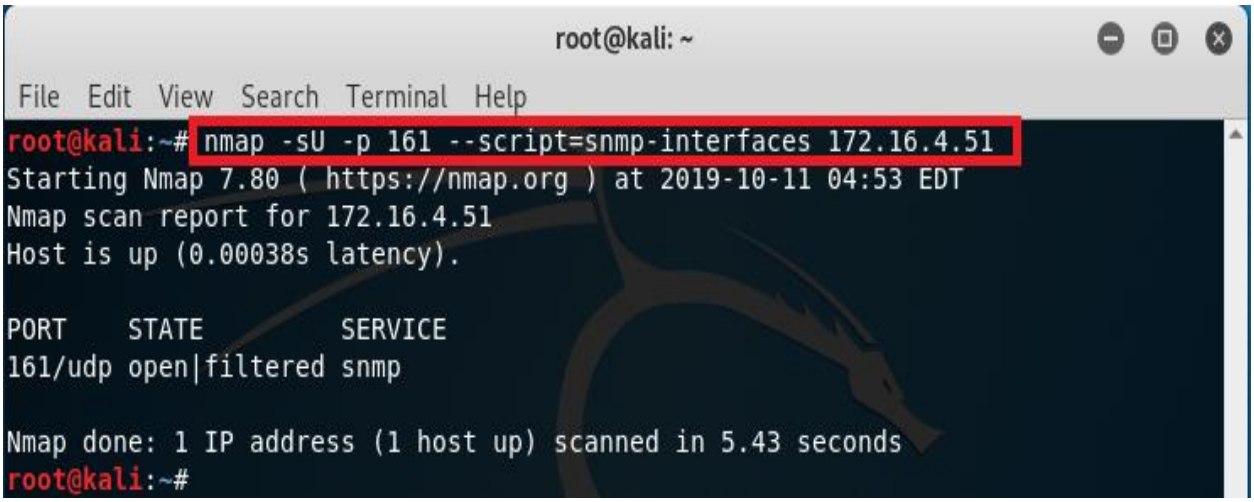


Command:

nmap -sU -p 161 --script=snmp-interfaces <target>

For example:

nmap -sU -p 161 --script=snmp-interfaces 172.16.4.51



COUNTERMEASURES

The following countermeasures must be followed:

- Always disable SNMP and SMB on hosts if not using it for a particular period of time.
- Block the SNMP ports (UDP ports 161 and 162) and SMB ports (TCP port 139 and 445) at the network perimeter.
- Change the default SNMP community read string from public and the default community write string from private to another long and complex value that's virtually impossible to guess.
- There's technically a "U" that's part of the solution: upgrade. Upgrading systems (at least the ones you can) to SNMP version 3 and SMB version 2 can resolve many of the well-known SNMP and SMB security weaknesses.

REFERENCES

[1] O. S. Limited, "Nmap Package Description," 2020. https://tools.kali.org/information-gathering/nmap (accessed Jan. 20, 2020).