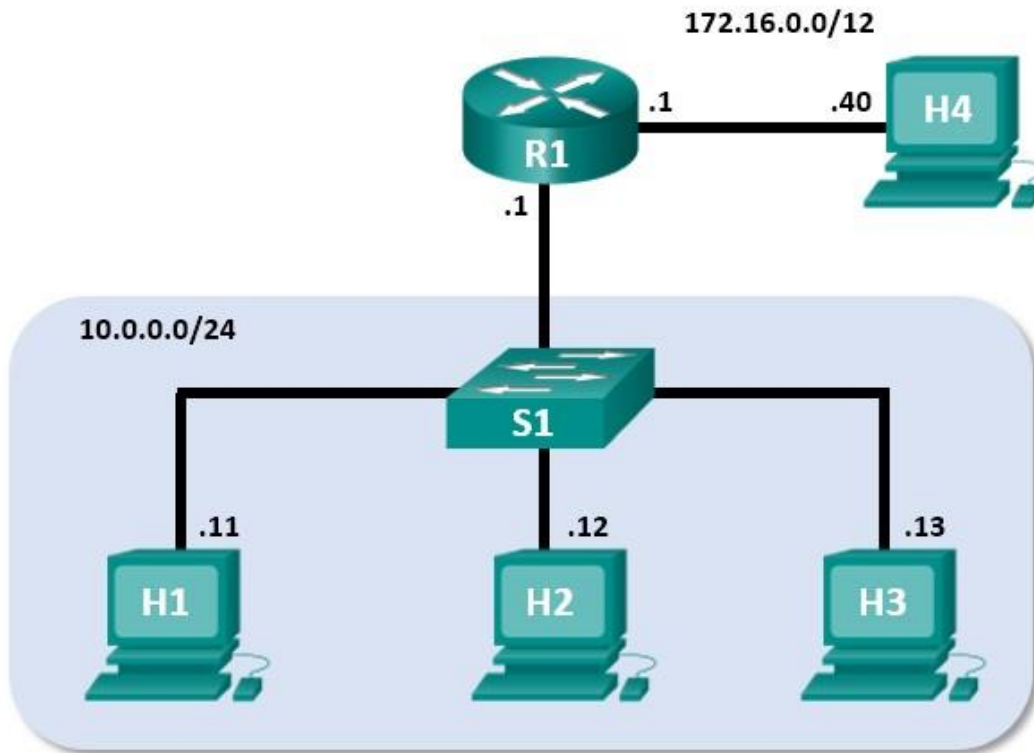


CS 6353. Network and System Security

Lab - Using Wireshark to Observe the TCP 3-Way Handshake

Mininet Topology



Objectives

Part 1: Prepare the Hosts to Capture the Traffic

Part 2: Analyze the Packets using Wireshark

Part 3: View the Packets using tcpdump

Background / Scenario

In this lab, you will use Wireshark to capture and examine packets generated between the PC browser using the HyperText Transfer Protocol (HTTP) and a web server, such as www.google.com. When an application, such as HTTP or File Transfer Protocol (FTP) first starts on a host, TCP uses the three-way handshake to establish a reliable TCP session between the two hosts. For example, when a PC uses a web browser to surf the internet, a three-way handshake is initiated, and a session is established between the PC host and web server. A PC can have multiple, simultaneous, active TCP sessions with various web sites.

Required Resources

- CyberOps Workstation virtual machine

Instructions

- ## Start Mininet.

c. Start host H1 and H4 in Mininet.

d. Start the web server on H4.

- e. For security purposes, you are not able to run Firefox from the root user account. On host H1, use the switch user command to switch from the root user to the analyst user account:

f. Start the web browser on H1. This will take a few moments.

g. After the Firefox window opens, start a tcpdump session in the terminal **Node: H1** and send the output to a file called **capture.pcap**. With the -v option, you can watch the progress. This capture will stop after capturing 50 packets, as it is configured with the option -c 50.

h. After the tcpdump starts, quickly navigate to 172.16.0.40 in the Firefox web browser.



Part 2: Analyze the Packets using Wireshark

Step 1: Apply a filter to the saved capture.

- Press ENTER to see the prompt. Start Wireshark on **Node: H1**. Click **OK** when prompted by the warning regarding running Wireshark as superuser.

```
[analyst@secOps ~]$ wireshark &
```

- In Wireshark, click **File > Open**. Select the saved pcap file located at /home/analyst/capture.pcap.
- Apply a **tcp** filter to the capture. In this example, the first 3 frames are the interested traffic.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	10.0.0.11	172.16.0.40	TCP	74	58716 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERFECT
2	0.000081	172.16.0.40	10.0.0.11	TCP	74	80 → 58716 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK_PERFECT
3	0.000082	10.0.0.11	172.16.0.40	TCP	66	58716 → 80 [ACK] Seq=1 Ack=1 Win=29696 Len=0 TSval=386454
4	0.000194	10.0.0.11	172.16.0.40	HTTP	356	GET /favicon.ico HTTP/1.1

Step 2: Examine the information within packets including IP addresses, TCP port numbers, and TCP control flags.

- In this example, frame 1 is the start of the three-way handshake between the PC and the server on H4. In the packet list pane (top section of the main window), select the first packet, if necessary.
- Click the **arrow** to the left of the Transmission Control Protocol in the packet details pane to expand it and examine the TCP information. Locate the source and destination port information.
- Click the **arrow** to the left of the Flags. A value of 1 means that flag is set. Locate the flag that is set in this packet.

Note: You may have to adjust the top and middle windows sizes within Wireshark to display the necessary information.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	10.0.0.11	172.16.0.40	TCP	74	58716 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERFECT
2	0.000081	172.16.0.40	10.0.0.11	TCP	74	80 → 58716 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK_PERFECT
3	0.000082	10.0.0.11	172.16.0.40	TCP	66	58716 → 80 [ACK] Seq=1 Ack=1 Win=29696 Len=0 TSval=386454
4	0.000194	10.0.0.11	172.16.0.40	HTTP	356	GET /favicon.ico HTTP/1.1

<p>▶ Frame 1: 74 bytes on wire (592 bits), 74 bytes captured (592 bits)</p> <p>▶ Ethernet II, Src: a6:a1:15:2c:d8:de (a6:a1:15:2c:d8:de), Dst: a2:86:17:7c:c3:65 (a2:86:17:7c:c3:65)</p> <p>▶ Internet Protocol Version 4, Src: 10.0.0.11, Dst: 172.16.0.40</p> <p>Transmission Control Protocol, Src Port: 58716, Dst Port: 80, Seq: 0, Len: 0</p> <p>Source Port: 58716</p> <p>Destination Port: 80</p> <p>[Stream index: 0]</p> <p>[TCP Segment Len: 0]</p> <p>Sequence number: 0 (relative sequence number)</p> <p>Acknowledgment number: 0</p> <p>Header Length: 40 bytes</p> <p>Flags: 0x002 (SYN)</p> <p>Window size value: 29200</p> <p>[Calculated window size: 29200]</p> <p>Checksum: 0xb671 [unverified]</p> <p>[Checksum Status: Unverified]</p> <p>Urgent pointer: 0</p> <p>Options: (20 bytes), Maximum segment size, SACK permitted, Timestamps, No-Operation (NOP), Window scale</p>

What is the TCP source port number? **34468**

How would you classify the source port? **Dynamic or Private**

What is the TCP destination port number? **80**

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How would you classify the destination port?

Well-known, registered.

Which flag (or flags) is set?

SYN Flag

What is the relative sequence number set to?

0

- d. Select the next packet in the three-way handshake. In this example, this is frame 2. This is the web server replying to the initial request to start a session.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	10.0.0.11	172.16.0.40	TCP	74	58716 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERFECT
2	0.000081	172.16.0.40	10.0.0.11	TCP	74	80 → 58716 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460
3	0.000082	10.0.0.11	172.16.0.40	TCP	66	58716 → 80 [ACK] Seq=1 Ack=1 Win=29696 Len=0 TSval=38645
4	0.000194	10.0.0.11	172.16.0.40	HTTP	356	GET /favicon.ico HTTP/1.1

Frame 2: 74 bytes on wire (592 bits), 74 bytes captured (592 bits)	
Ethernet II, Src: a2:86:17:7c:c3:65 (a2:86:17:7c:c3:65), Dst: a6:a1:15:2c:d8:de (a6:a1:15:2c:d8:de)	
Internet Protocol Version 4, Src: 172.16.0.40, Dst: 10.0.0.11	
Transmission Control Protocol, Src Port: 80, Dst Port: 58716, Seq: 0, Ack: 1, Len: 0	
Source Port: 80	
Destination Port: 58716	
[Stream index: 0]	
[TCP Segment Len: 0]	
Sequence number: 0 (relative sequence number)	
Acknowledgment number: 1 (relative ack number)	
Header Length: 40 bytes	
Flags: 0x012 (SYN, ACK)	
Window size value: 28960	
[Calculated window size: 28960]	
Checksum: 0xc85a [unverified]	
[Checksum Status: Unverified]	
Urgent pointer: 0	
Options: (20 bytes), Maximum segment size, SACK permitted, Timestamps, No-Operation (NOP), Window scale	

What are the values of the source and destination ports?

Source port: 80 and Destination port: 34468.

Which flags are set?

The SYN and Acknowledgement flag are set.

What are the relative sequence and acknowledgment numbers set to?

The relative sequence number is 0 and the acknowledgement number is 1.

- e. Finally, select the third packet in the three-way handshake.

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Filter:	tcp	▼	Expression...	Clear	Apply	Save
No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	10.0.0.11	172.16.0.40	TCP	74	58716 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERFECT
2	0.000081	172.16.0.40	10.0.0.11	TCP	74	80 → 58716 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460
3	0.000082	10.0.0.11	172.16.0.40	TCP	66	58716 → 80 [ACK] Seq=1 Ack=1 Win=29696 Len=0 TSval=38645
4	0.000194	10.0.0.11	172.16.0.40	HTTP	356	GET /favicon.ico HTTP/1.1

▶ Frame 3: 66 bytes on wire (528 bits), 66 bytes captured (528 bits)

▶ Ethernet II, Src: a6:a1:15:2c:d8:de (a6:a1:15:2c:d8:de), Dst: a2:86:17:7c:c3:65 (a2:86:17:7c:c3:65)

▶ Internet Protocol Version 4, Src: 10.0.0.11, Dst: 172.16.0.40

▼ Transmission Control Protocol, Src Port: 58716, Dst Port: 80, Seq: 1, Ack: 1, Len: 0

Source Port: 58716

Destination Port: 80

[Stream index: 0]

[TCP Segment Len: 0]

Sequence number: 1 (relative sequence number)

Acknowledgment number: 1 (relative ack number)

Header Length: 32 bytes

▶ Flags: 0x010 (ACK)

Window size value: 58

[Calculated window size: 29696]

[Window size scaling factor: 512]

Checksum: 0xb669 [unverified]

[Checksum Status: Unverified]

Urgent pointer: 0

Examine the third and final packet of the handshake.

Which flag (or flags) is set?

The acknowledgment flag is set.

The relative sequence and acknowledgment numbers are set to 1 as a starting point. The TCP connection is established and communication between the source computer and the web server can begin.

Part 3: View the packets using tcpdump

You can also view the pcap file and filter for the desired information.

- a. Open a new terminal window, enter **man tcpdump**. **Note:** You may need to press ENTER to see the prompt.

Using the manual pages available with the Linux operating system, you read or search through the manual pages for options for selecting the desired information from the pcap file.

```
[analyst@secOps ~]$ man tcpdump
TCPDUMP(1)                                General Commands Manual                                TCPDUMP(1)
NAME                                     tcpdump - dump traffic on a network SYNOPSIS
tcpdump [ -AbdDefhHIJKlLnNOpqStuUvX# ] [ -B buffer_size ]
[ -c count ]
[ -C file_size ] [ -G rotate_seconds ] [ -F file ]
[ -i interface ] [ -j tstamp_type ] [ -m module ] [ -M secret ]
[ --number ] [ -Q in|out|inout ]
[ -r file ] [ -V file ] [ -s snaplen ] [ -T type ] [ -w file ]
[ -W filecount ]
[ -E spi@ipaddr algo:secret,... ]
[ -y datalinktype ] [ -z postrotate-command ] [ -Z user ]
[ --time-stamp-precision=tstamp_precision ]
```

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```
[ --immediate-mode ] [ --version ]  
[ expression ] <some  
output omitted>
```

To search through the man pages, you can use / (searching forward) or ? (searching backward) to find specific terms, and **n** to forward to the next match and **q** to quit. For example, search for the information on the switch **-r**, type **/-r**. Type **n** to move to the next match.

What does the switch **-r** do?

The **-r** switch reads packets from a file which was created with the **-w** option or by other tools that write pcap or pcap-ng files.) Standard input is used if file is.

- b. In the same terminal, open the capture file using the following command to view the first 3 TCP packets captured:

```
[analyst@secOps ~]$ tcpdump -r /home/analyst/capture.pcap tcp -c 3 reading  
from file capture.pcap, link-type EN10MB (Ethernet)  
13:58:30.647462 IP 10.0.0.11.58716 > 172.16.0.40.http: Flags [S], seq 2432755549, win  
29200, options [mss 1460,sackOK,TS val 3864513189 ecr 0,nop,wscale 9], length 0  
13:58:30.647543 IP 172.16.0.40.http > 10.0.0.11.58716: Flags [S.], seq 1766419191, ack  
2432755550, win 28960, options [mss 1460,sackOK,TS val 50557410 ecr  
3864513189,nop,wscale 9], length 0  
13:58:30.647544 IP 10.0.0.11.58716 > 172.16.0.40.http: Flags [.] , ack 1, win 58,  
options [nop,nop,TS val 3864513189 ecr 50557410], length 0
```

To view the 3-way handshake, you may need to increase the number of lines after the **-c** option.

- c. Navigate to the terminal used to start Mininet. Terminate the Mininet by entering quit in the main CyberOps VM terminal window. mininet> **quit**

```
*** Stopping 0 controllers  
  
*** Stopping 2 terms  
*** Stopping 5 links  
..... *** Stopping 1  
switches s1 ***  
Stopping 5 hosts  
H1 H2 H3 H4 R1  
*** Done [analyst@secOps  
~]$
```

- d. After quitting Mininet, enter **sudo mn -c** to clean up the processes started by Mininet. Enter the password **cyberops** when prompted.

```
[analyst@secOps ~]$ sudo mn -c [sudo]  
password for analyst:
```

Reflection Questions

1. There are hundreds of filters available in Wireshark. A large network could have numerous filters and many different types of traffic. List three filters that might be useful to a network administrator.

HTTPS/HTTP to monitor web traffic, IP specific addresses such as if we are filtering for a particular machine or individual, and TCP.

2. What other ways could Wireshark be used in a production network?

Wireshark can be used to measure ARP messages sent locally across the network. Wireshark can be used by attackers passively to view traffic across the network.