HideZeroOne
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Incident Handling & Response Professional

Intrusion Detection By Analyzing Traffic (Part 2)

Section 02 | Module 02

OUTLINE

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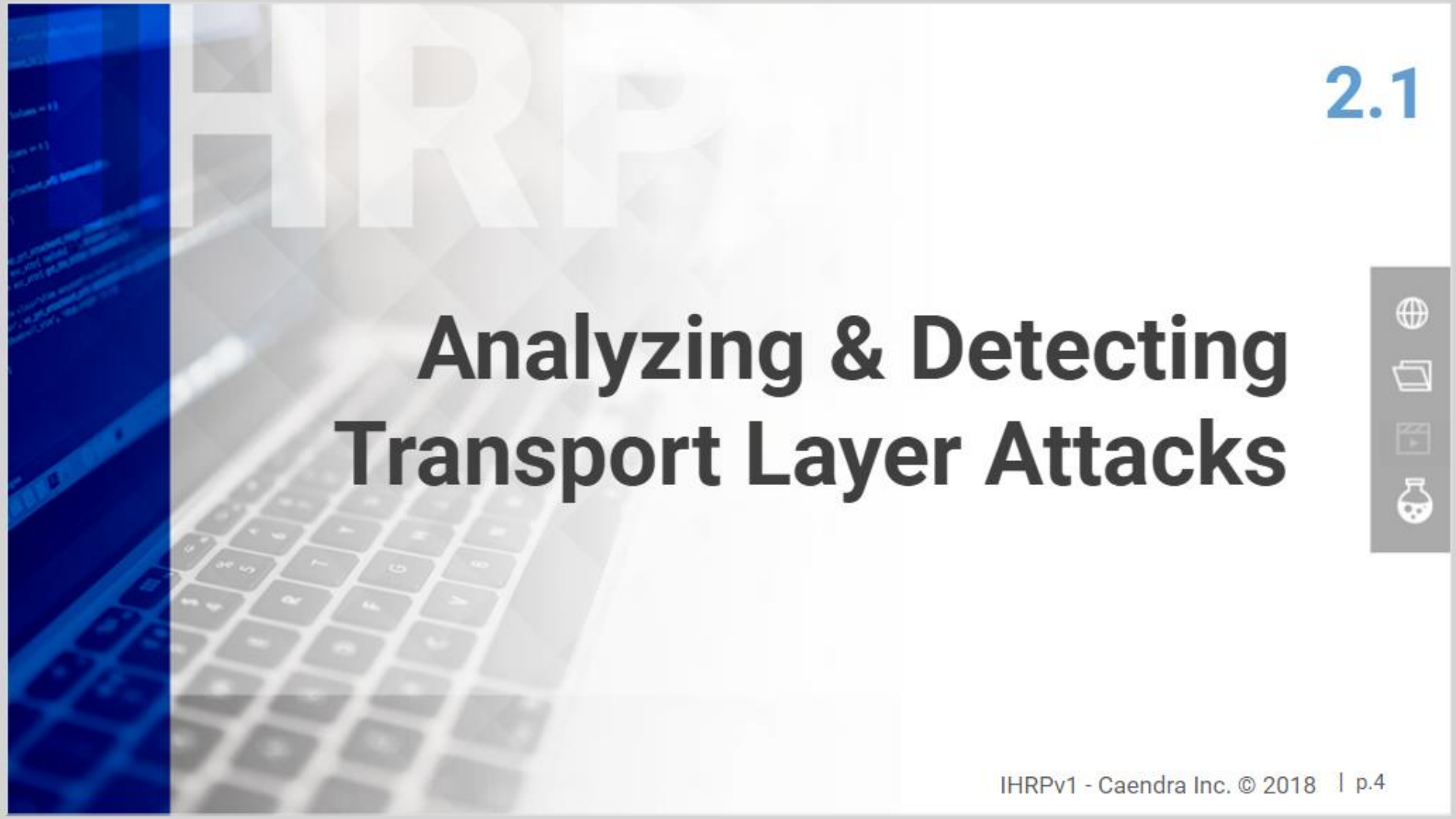
Learning Objectives

By the end of this module, you should have a better understanding of:

- ✓ How the attacks at the Transport and Application layers work
- ✓ How to detect attacks at the Transport and Application layers
- ✓ The detection capabilities of open-source IDS



2.1

Analyzing & Detecting Transport Layer Attacks

OUTLINE

2.1 Analyzing & Detecting Transport Layer Attacks

Up to this point, we have seen how to analyze and detect attacks at the IEEE 802.x Link layer.

Let's now cover how to analyze and detect attacks at the Transport layer. We'll focus on the TCP, UDP and ICMP protocols.

2.1.1 TCP

Let's start our journey to understanding the Transport layer, by analyzing the most important aspects of the TCP protocol.

TCP is a reliable and connection-oriented protocol, leveraged by many application-layer protocols to deliver packets.

https://tools.ietf.org/html/rfc793

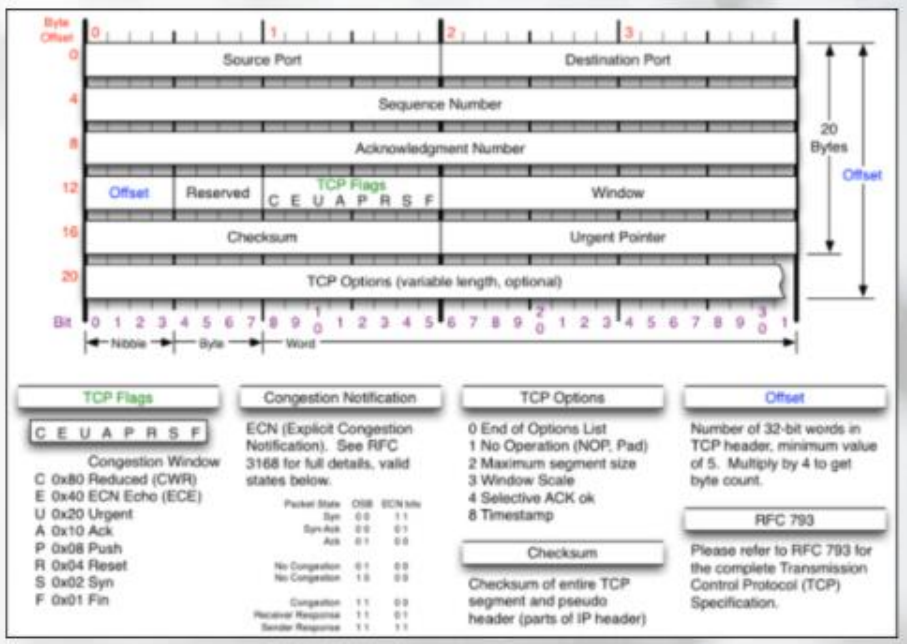
2.1.1 TCP

TCP is quite complex, due to its rich functionality. This is apparent when studying the TCP header.

2.1.1 TCP

The TCP header contains information such as:

- **Source Port**: The port from where the packet is transmitted
- **Destination Port**: The port where the packet will arrive
- **Sequence Number**: Field value that ensures the integrity of a data stream. It identifies a TCP segment.
- **Acknowledgement Number**: Field value containing the expected sequence number of the next packet to arrive from the connection peer.
- **Flags**: Note that, the URG, ACK, PSH, RST, SYN and FIN flags are used to identify the type of the packet in transit
- **Window Size**: Indicates the TCP receiver buffer size
- **Checksum**: Field value that ensures the integrity of the TCP header and data upon arrival
- **Urgent Pointer:** In case the URG flag is set, this field indicates the position within the packet from where reading data should start
- **Options**: Optional fields that may be specified

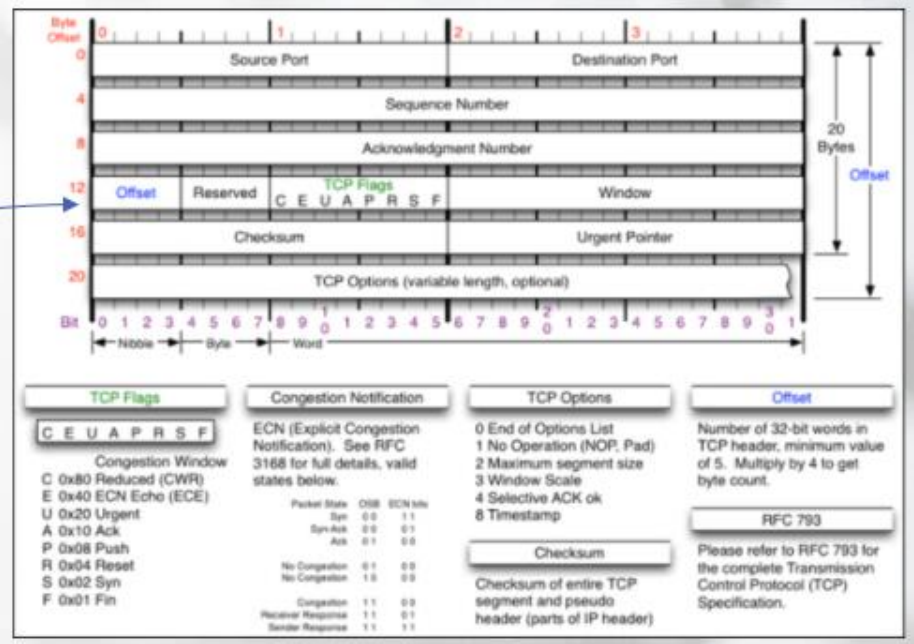


Source: https://skminhaj.wordpress.com/2016/02/15/tcp-segment-vs-udp-datagram-header-format/

2.1.1 TCP

Notes:

1. The TCP header's size is 20 bytes, when no options are specified
2. Offset = TCP header length
3. When the SYN flag is set on a TCP segment, you'll most probably come across the TCP maximum segment size option
4. When the SYN flag is set, there are no data following the header



Source: https://skminhaj.wordpress.com/2016/02/15/tcp-segment-vs-udp-datagram-header-format/

2.1.1 TCP

As already mentioned, TCP is a connection-oriented protocol. For a connection to be established between two hosts, a procedure known as *3-way handshake* is required. Then, the actual data transmission can commence.

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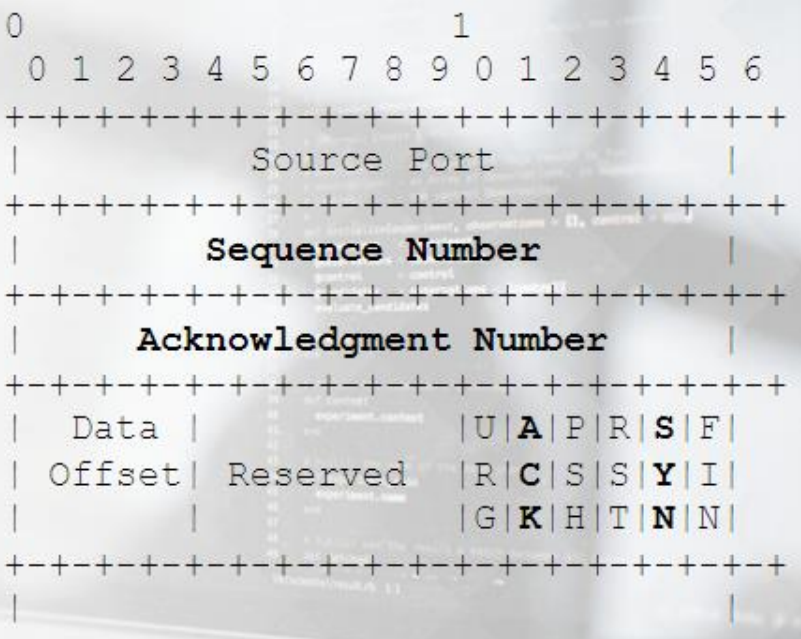
2.1.1 TCP

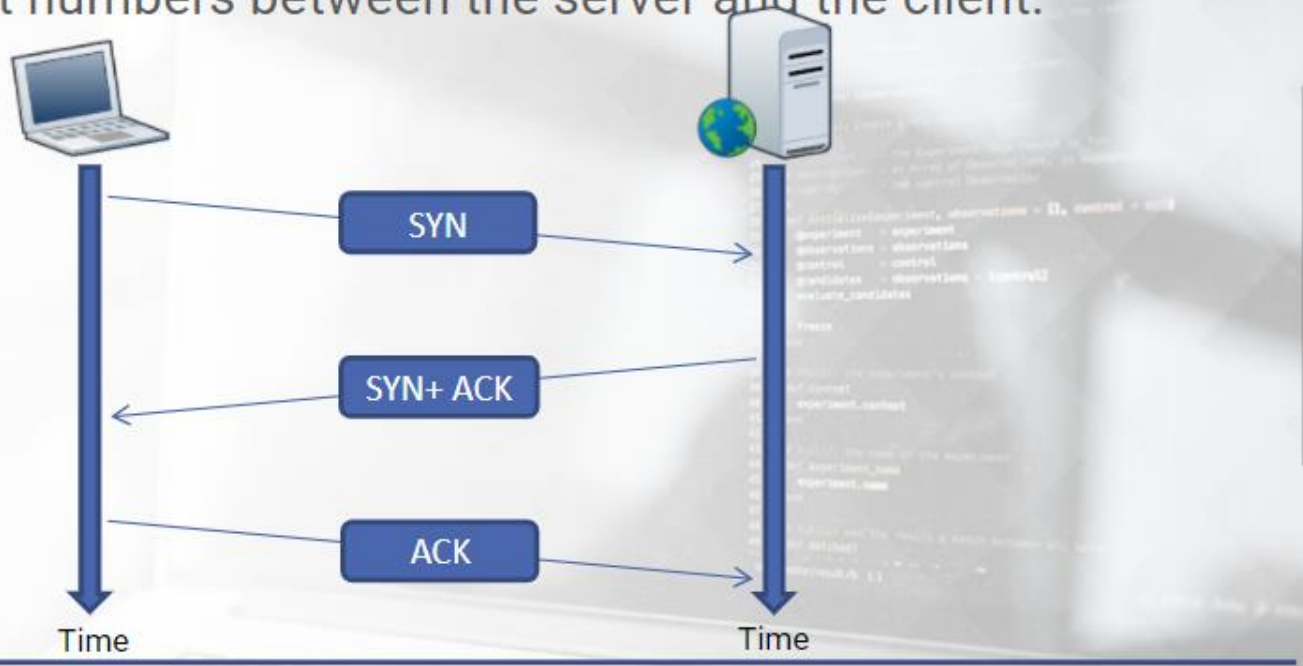
The header fields involved in the handshake are:

- Sequence number
- Acknowledgement numbers
- SYN and ACK flags



2.1.1 TCP

The steps in the handshake are used to synchronize the sequence and acknowledgement numbers between the server and the client.



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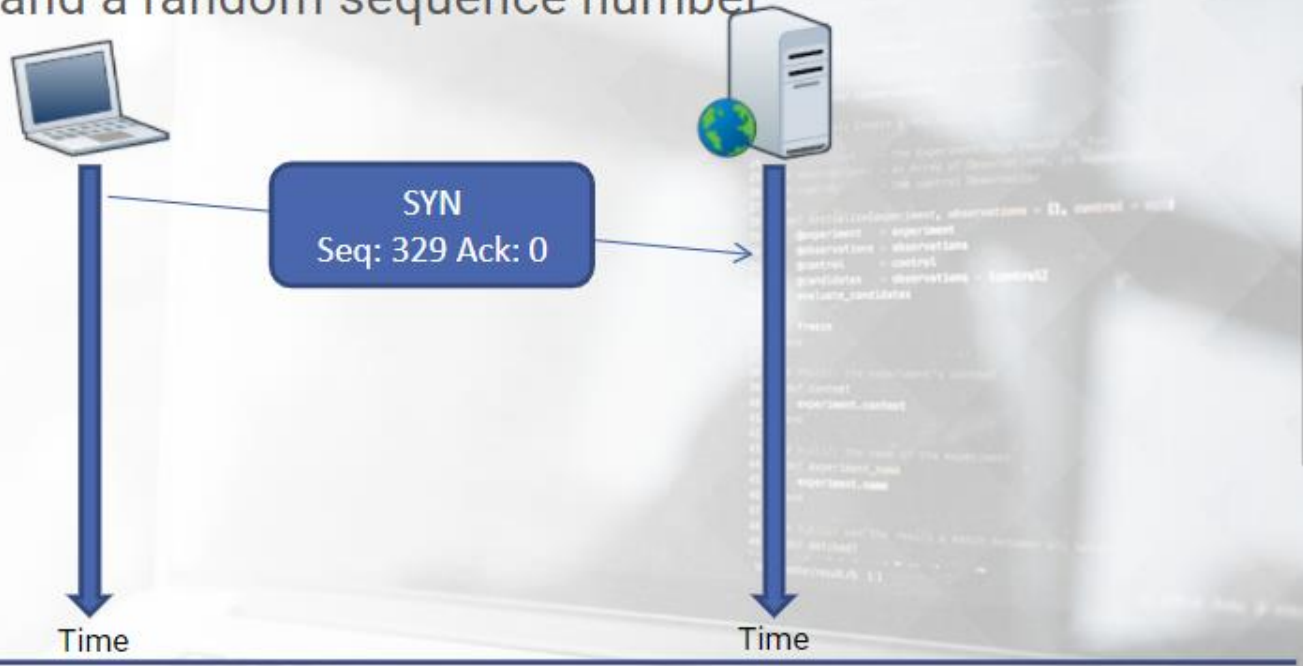
2.1.1 TCP

During the first step, the client sends a TCP packet to the server with the SYN flag enabled and a random sequence number



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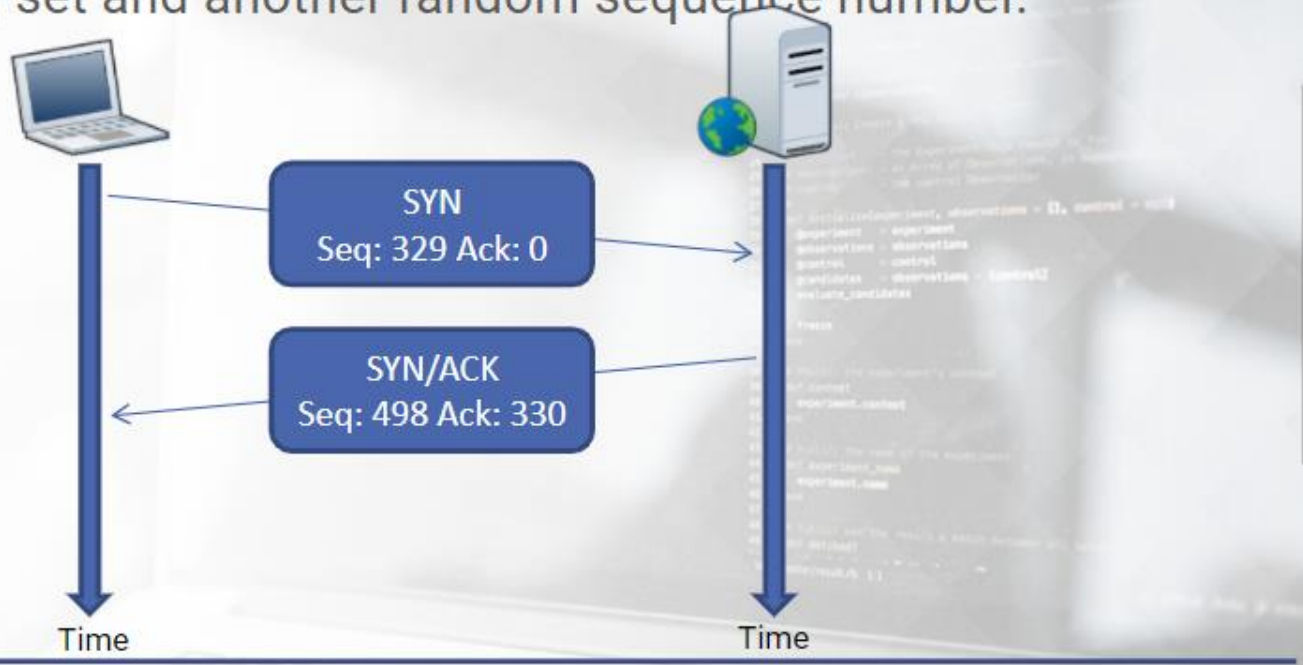
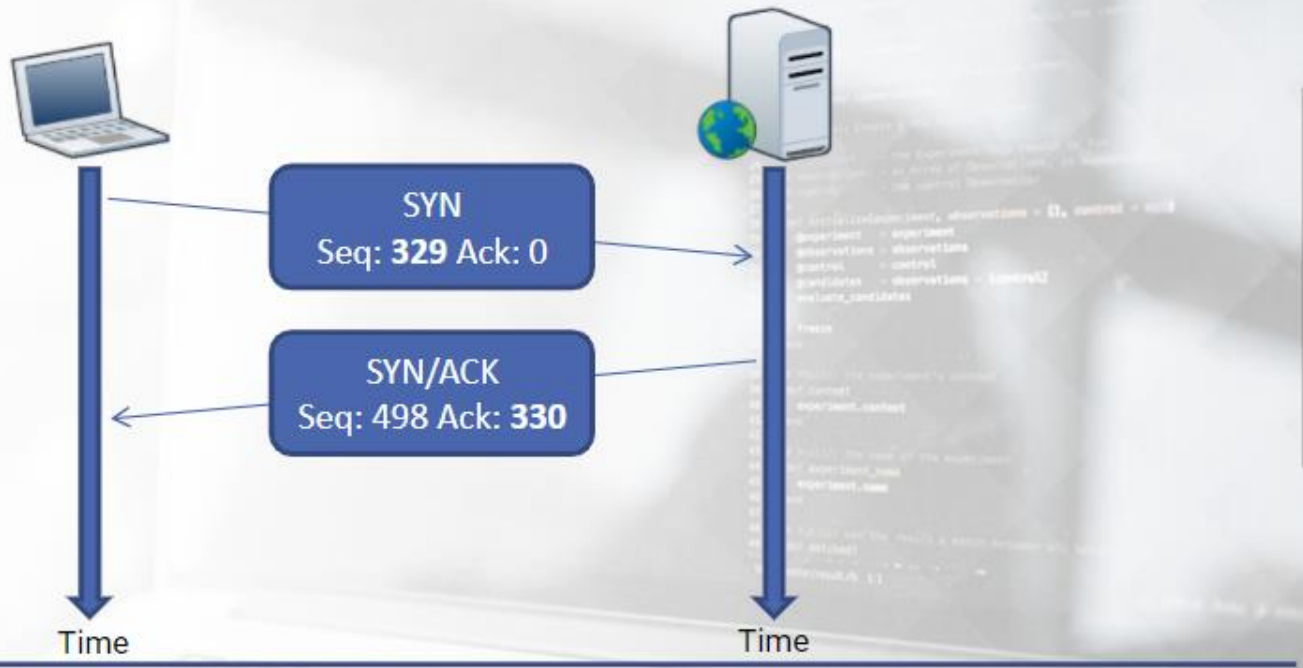
2.1.1 TCP

In the second step, the server replies by sending a packet with both the SYN and ACK flag set and another random sequence number.



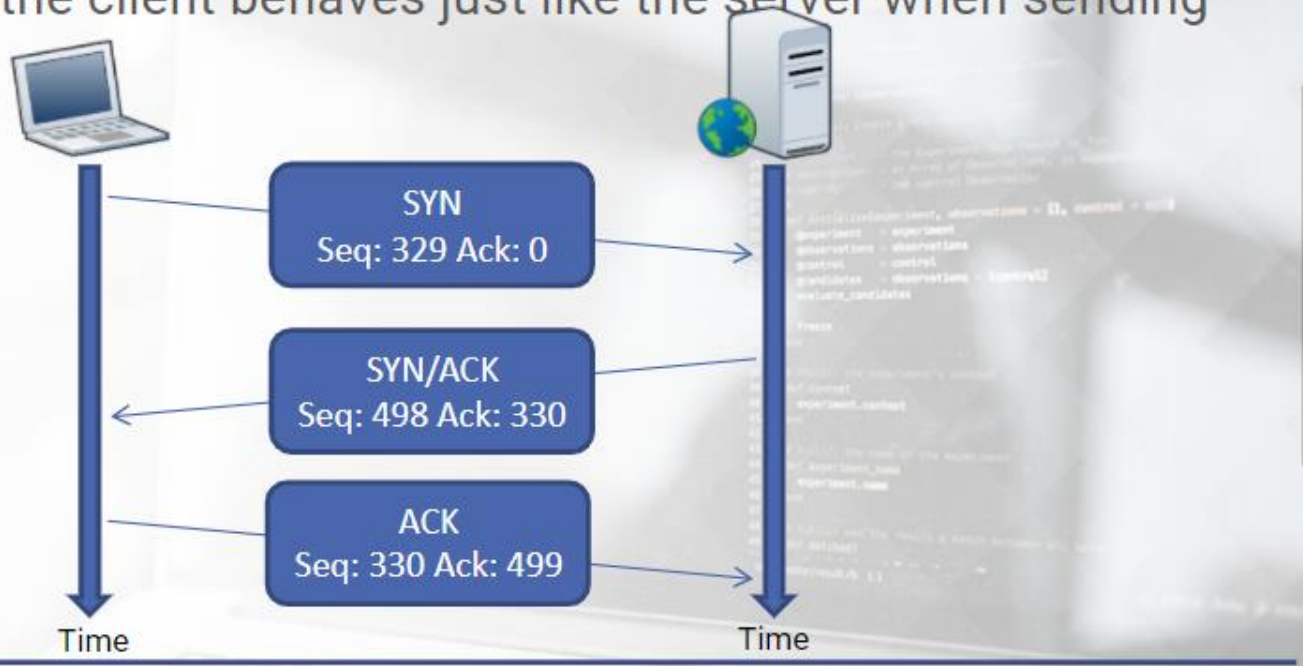
2.1.1 TCP

The ACK number is always a simple increment of the SYN number sent by the client.



2.1.1 TCP

Finally the client completes the synchronization by sending an ACK packet. Note that the client behaves just like the server when sending ACK packets.



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2.1.1 TCP

Consider the *3-way_handshake.pcap file* found in this module's resources.

Let's now see, how the 3-way handshake looks like on the wire (Wireshark).

```
  1 0.000000  192.168.1.2      174.143.213.184  TCP      74 54841 → 80 [SYN] Seq=4129057982 Win=5840 Len=0 MSS=1460 SACK_PERM=1 TS
  2 0.046770  174.143.213.184  192.168.1.2      TCP      74 80 → 54841 [SYN, ACK] Seq=4200111240 Ack=4129057983 Win=5792 Len=0 MSS
  3 0.046803  192.168.1.2      174.143.213.184  TCP      66 54841 → 80 [ACK] Seq=4129057983 Ack=4200111241 Win=5888 Len=0 TSval=80
  4 0.046841  192.168.1.2      174.143.213.184  HTTP    791 GET /images/layout/logo.png HTTP/1.1
```

```
▸ Frame 1: 74 bytes on wire (592 bits), 74 bytes captured (592 bits)
▸ Ethernet II, Src: AsustekC_b3:01:84 (00:1d:60:b3:01:84), Dst: Actionte_2f:47:87 (00:26:62:2f:47:87)
▸ Internet Protocol Version 4, Src: 192.168.1.2, Dst: 174.143.213.184
▾ Transmission Control Protocol, Src Port: 54841, Dst Port: 80, Seq: 4129057982, Len: 0
    Source Port: 54841
    Destination Port: 80
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence number: 4129057982
    Acknowledgment number: 0
    Header Length: 40 bytes
  ▸ Flags: 0x002 (SYN)
    Window size value: 5840
    [Calculated window size: 5840]
    Checksum: 0x85f0 [unverified]
    [Checksum Status: Unverified]
    Urgent pointer: 0
  ▸ Options: (20 bytes), Maximum segment size, SACK permitted, Time
```

```
▸ Frame 2: 74 bytes on wire (592 bits), 74 bytes captured (592 bits)
▸ Ethernet II, Src: Actionte_2f:47:87 (00:26:62:2f:47:87), Dst: AsustekC_b3:01:84 (00:1d:60:b3:01:84)
▸ Internet Protocol Version 4, Src: 174.143.213.184, Dst: 192.168.1.2
▾ Transmission Control Protocol, Src Port: 80, Dst Port: 54841, Seq: 4200111240, Ack: 4129057983, Len: 0
    Source Port: 80
    Destination Port: 54841
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence number: 4200111240
    Acknowledgment number: 4129057983
    Header Length: 40 bytes
  ▸ Flags: 0x012 (SYN, ACK)
    Window size value: 5792
    [Calculated window size: 5792]
    Checksum: 0x4ff1 [unverified]
    [Checksum Status: Unverified]
    Urgent pointer: 0
  ▸ Options: (20 bytes), Maximum segment size, SACK permitted, Timestamps, No-Operation (NOP), Window scale
  ▸ [SEQ/ACK analysis]
```


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2.1.1 TCP

Consider the *3-way_handshake.pcap file* found in this module's resources.

Let's now see, how the 3-way handshake looks like on the wire (Wireshark).

```
   1 0.000000  192.168.1.2      174.143.213.184  TCP      74 54841 → 80 [SYN] Seq=4129057982 Win=5840 Len=0 MSS=1460 SACK_PERM=1 TS
   2 0.046770  174.143.213.184  192.168.1.2      TCP      74 80 → 54841 [SYN, ACK] Seq=4200111240 Ack=4129057983 Win=5792 Len=0 MSS
   3 0.046803  192.168.1.2      174.143.213.184  TCP      66 54841 → 80 [ACK] Seq=4129057983 Ack=4200111241 Win=5888 Len=0 TSval=86
   4 0.046841  192.168.1.2      174.143.213.184  HTTP     791 GET /images/layout/logo.png HTTP/1.1
```

```
▸ Frame 2: 74 bytes on wire (592 bits), 74 bytes captured (592 bits)
▸ Ethernet II, Src: Actionte_2f:47:87 (00:26:62:2f:47:87), Dst: AsustekC_b3:01:84 (00:1d:60:b3:01:84)
▸ Internet Protocol Version 4, Src: 174.143.213.184, Dst: 192.168.1.2
▾ Transmission Control Protocol, Src Port: 80, Dst Port: 54841, Seq: 4200111240, Ack: 4129057983, Len: 0
    Source Port: 80
    Destination Port: 54841
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence number: 4200111240
    Acknowledgment number: 4129057983
    Header Length: 40 bytes
  ▸ Flags: 0x012 (SYN, ACK)
    Window size value: 5792
    [Calculated window size: 5792]
    Checksum: 0x4ff1 [unverified]
    [Checksum Status: Unverified]
    Urgent pointer: 0
  ▾ Options: (20 bytes), Maximum segment size, SACK permitted, Timestamps, No-Operation (NOP), Win
    ▸ Maximum segment size: 1460 bytes
    ▸ TCP SACK Permitted Option: True
    ▸ Timestamps: TSval 315395185, TSecr 863195
    ▸ No-Operation (NOP)
    ▸ Window scale: 6 (multiply by 64)
  ▾ [SEQ/ACK analysis]
      [This is an ACK to the segment in frame: 1]
      [The RTT to ACK the segment was: 0.046770000 seconds]
      [iRTT: 0.046803000 seconds]
```

```
▸ Frame 3: 66 bytes on wire (528 bits), 66 bytes captured (528 bits)
▸ Ethernet II, Src: AsustekC_b3:01:84 (00:1d:60:b3:01:84), Dst: Actionte_2f:47:87 (00:26:62:2f:47:87)
▸ Internet Protocol Version 4, Src: 192.168.1.2, Dst: 174.143.213.184
▾ Transmission Control Protocol, Src Port: 54841, Dst Port: 80, Seq: 4129057983, Ack: 4200111241, Len: 0
    Source Port: 54841
    Destination Port: 80
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence number: 4129057983
    Acknowledgment number: 4200111241
    Header Length: 32 bytes
  ▸ Flags: 0x010 (ACK)
    Window size value: 46
    [Calculated window size: 5888]
    [Window size scaling factor: 128]
    Checksum: 0x9529 [unverified]
    [Checksum Status: Unverified]
    Urgent pointer: 0
  ▾ Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps
    ▸ No-Operation (NOP)
    ▸ No-Operation (NOP)
    ▸ Timestamps: TSval 863200, TSecr 315395185
  ▾ [SEQ/ACK analysis]
      [This is an ACK to the segment in frame: 2]
      [The RTT to ACK the segment was: 0.000033000 seconds]
      [iRTT: 0.046803000 seconds]
```


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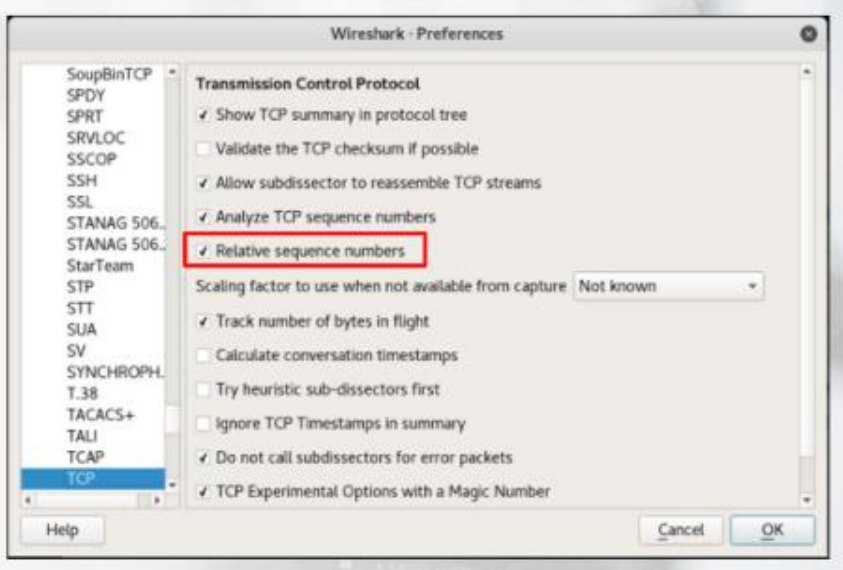
2.1.1 TCP

2.1.1 TCP

Note: Wireshark has an option called *Relative sequence numbers* on, by default. According to the official definition from the online Wireshark Wiki,

"By default Wireshark and TShark will keep track of all TCP sessions and convert all Sequence Numbers (SEQ numbers) and Acknowledge Numbers (ACK Numbers) into relative numbers.

This means that instead of displaying the real/absolute SEQ and ACK numbers in the display, Wireshark will display a SEQ and ACK number relative to the first seen segment for that conversation."



https://wiki.wireshark.org/TCP_Relative_Sequence_Numbers

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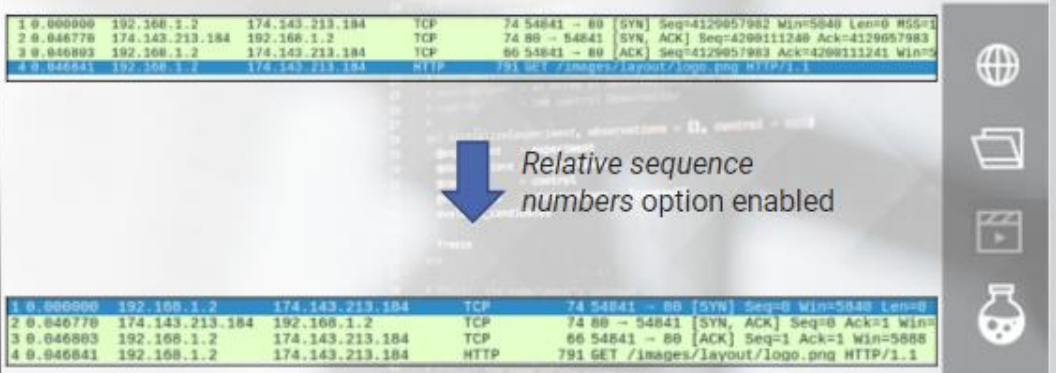
2.1.1 TCP

For example, the initial relative sequence number shown in packet #1 (of the *3-way_handshake.pcap* file) is 0. If you look at the ASCII decode though, you'll notice that the actual sequence number is 0xf61c6cbe, or 4129057982 decimal.



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2.1.1.1 Suspicious TCP Traffic

Let's now go through some suspicious TCP traffic cases, but before doing so, find below some tips on what kind of TCP traffic should alarm you.

Normal TCP Traffic	Suspicious TCP Traffic
3 way handshake (SYN, SYN/ACK, ACK)	Excessive SYN packets (scanning)
	Usage of different flags
	Single host to multiple ports or single host to multiple nodes (scanning)

2.1.1.2 Sequence Number Prediction & SYN Scanning

One of the ways using which the venerable Nmap tool tries to perform OS fingerprinting, is by examining the Initial Sequence Numbers (ISNs) generated by the target host (after connections are being attempted to a listening port).

Each TCP/IP stack (and subsequently each OS) features its own way of generating Initial Sequence Numbers.

https://nmap.org/book/osdetect-methods.html#osdetect-gcd

2.1.1.2 Sequence Number Prediction & SYN Scanning

More specifically, Nmap sends a series of SYN packets to an open port and tries to perform OS fingerprinting, by attempting to identify the ISN generation formula in the returned SYN/ACK and comparing the returned values to a file that contains expected returned values for a series of checks.

2.1.1.2 Sequence Number Prediction & SYN Scanning

Open the *nmap_sequence_number_prediction.pcap* file found in this module's resources, to see what could be a Nmap OS fingerprinting attempt.

2.1.1.2 Sequence Number Prediction & SYN Scanning

Detection

The first thing you should notice, is the big amount of SYN packets being sent to the 192.168.1.2 host (in a short amount of time and without the corresponding SYN/ACK packets).

If you also carefully analyze the series of SYN packets that Nmap sent, you will notice something weird. Nmap repeatedly used the ISN from the scanning host, while scanning the different ports of the remote host. Unique ISNs should be used, while attempting to connect to different ports of a remote host.

1	0.000000	192.168.1.6	192.168.1.2	TCP	58 36901 → 3389 [SYN] Seq=3917476875 Win=1024 Len=0 MSS=1460
2	0.000349	192.168.1.2	192.168.1.6	TCP	60 3389 → 36901 [SYN, ACK] Seq=2694453486 Ack=3917476876 Win=64000 Len=…
3	0.000366	192.168.1.6	192.168.1.2	TCP	58 36901 → 25 [SYN] Seq=3917476875 Win=1024 Len=0 MSS=1460
4	0.000432	192.168.1.6	192.168.1.2	TCP	54 36901 → 3389 [RST] Seq=3917476876 Win=0 Len=0
5	0.000671	192.168.1.6	192.168.1.2	TCP	58 36901 → 135 [SYN] Seq=3917476875 Win=1024 Len=0 MSS=1460
6	0.000906	192.168.1.6	192.168.1.2	TCP	58 36901 → 3306 [SYN] Seq=3917476875 Win=1024 Len=0 MSS=1460
7	0.000973	192.168.1.6	192.168.1.2	TCP	58 36901 → 139 [SYN] Seq=3917476875 Win=1024 Len=0 MSS=1460
8	0.001115	192.168.1.6	192.168.1.2	TCP	58 36901 → 111 [SYN] Seq=3917476875 Win=1024 Len=0 MSS=1460
9	0.001821	192.168.1.6	192.168.1.2	TCP	58 36901 → 143 [SYN] Seq=3917476875 Win=1024 Len=0 MSS=1460
10	0.001825	192.168.1.2	192.168.1.6	TCP	60 135 → 36901 [SYN, ACK] Seq=1710440461 Ack=3917476876 Win=8192 Len=0 …

2.1.1.2 Sequence Number Prediction & SYN Scanning

Detection

Once you identify a scanning host, you can determine if you are dealing with Nmap, by noting the scanning host's ISN and executing the below.

```
>> tcpdump -S -r nmap_sequence_number_prediction.pcap tcp[4:4] = 3917476875
```

```
03:23:10.142073 IP kali.36901 > desktop-agckn5j.3389: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:10.142439 IP kali.36901 > desktop-agckn5j.smtp: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:10.142744 IP kali.36901 > desktop-agckn5j.loc-srv: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:10.142979 IP kali.36901 > desktop-agckn5j.mysql: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:10.143046 IP kali.36901 > desktop-agckn5j.netbios-ssn: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:10.143188 IP kali.36901 > desktop-agckn5j.sunrpc: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:10.143894 IP kali.36901 > desktop-agckn5j.imap2: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:10.144370 IP kali.36901 > desktop-agckn5j.1723: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:10.144477 IP kali.36901 > desktop-agckn5j.https: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:10.144540 IP kali.36901 > desktop-agckn5j.imaps: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:10.147462 IP kali.36901 > desktop-agckn5j.rtsp: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:10.147575 IP kali.36901 > desktop-agckn5j.1720: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:10.147638 IP kali.36901 > desktop-agckn5j.http-alt: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:10.147736 IP kali.36901 > desktop-agckn5j.ftp: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:10.147803 IP kali.36901 > desktop-agckn5j.5900: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:10.147903 IP kali.36901 > desktop-agckn5j.smux: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:11.347428 IP kali.36901 > desktop-agckn5j.microsoft-ds: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:11.347752 IP kali.36901 > desktop-agckn5j.domain: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:11.347864 IP kali.36901 > desktop-agckn5j.ssh: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:11.348057 IP kali.36901 > desktop-agckn5j.pop3s: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:11.348149 IP kali.36901 > desktop-agckn5j.telnet: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:11.348299 IP kali.36901 > desktop-agckn5j.pop3: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
03:23:11.348404 IP kali.36901 > desktop-agckn5j.1025: Flags [S], seq 3917476875, win 1024, options [mss 1460], length 0
```

The scanning host's ISN reuse, indicates that the scanning/fingerprinting attempt most probably originates from a Nmap instance

2.1.1.3 Source Port Abnormalities

When it comes to ports, what you should know is that a distinction exists between Privileged (server) ports and Unprivileged (client)/ephemeral ports. Specifically,

- Privileged (server) ports [1-1023] ← Should remain unchanged during the entire connection
- Unprivileged (client)/ephemeral ports [> 1023] ← Chosen only for one connection. Can be chosen again after the connection closes.

2.1.1.3 Source Port Abnormalities

Consider the *nmap_sequence_number_prediction.pcap* file found in this module's resources once again.

Can you spot anything irregular?

2.1.1.3 Source Port Abnormalities

Detection

ip.src==192.168.1.6

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.6	192.168.1.2	TCP		58 36901 → 3389 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
3	0.000366	192.168.1.6	192.168.1.2	TCP		58 36901 → 25 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
4	0.000432	192.168.1.6	192.168.1.2	TCP		54 36901 → 3389 [RST] Seq=1 Win=0 Len=0
5	0.000671	192.168.1.6	192.168.1.2	TCP		58 36901 → 135 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
6	0.000906	192.168.1.6	192.168.1.2	TCP		58 36901 → 3306 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
7	0.000973	192.168.1.6	192.168.1.2	TCP		58 36901 → 139 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
8	0.001115	192.168.1.6	192.168.1.2	TCP		58 36901 → 111 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
9	0.001821	192.168.1.6	192.168.1.2	TCP		58 36901 → 143 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
12	0.002144	192.168.1.6	192.168.1.2	TCP		54 36901 → 135 [RST] Seq=1 Win=0 Len=0
13	0.002149	192.168.1.6	192.168.1.2	TCP		54 36901 → 139 [RST] Seq=1 Win=0 Len=0

2.1.1.3 Source Port Abnormalities

Detection

ip.src==192.168.1.6

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.6	192.168.1.2	TCP	58	36901 → 3389 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
3	0.000366	192.168.1.6	192.168.1.2	TCP	58	36901 → 25 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
4	0.000432	192.168.1.6	192.168.1.2	TCP	54	36901 → 3389 [RST] Seq=1 Win=0 Len=0
5	0.000671	192.168.1.6	192.168.1.2	TCP	58	36901 → 135 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
6	0.000906	192.168.1.6	192.168.1.2	TCP	58	36901 → 3306 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
7	0.000973	192.168.1.6	192.168.1.2	TCP	58	36901 → 139 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
8	0.001115	192.168.1.6	192.168.1.2	TCP	58	36901 → 111 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
9	0.001821	192.168.1.6	192.168.1.2	TCP	58	36901 → 143 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
12	0.002144	192.168.1.6	192.168.1.2	TCP	54	36901 → 135 [RST] Seq=1 Win=0 Len=0
13	0.002149	192.168.1.6	192.168.1.2	TCP	54	36901 → 139 [RST] Seq=1 Win=0 Len=0

If you carefully look at packets #1, #3-#9 and #12-#13, you will notice that the host 192.168.1.6 uses the same source port (36901) for multiple connection attempts to different ports of the remote host. This is abnormal. The normal behavior would be incrementing the source port numbers inside the ephemeral port range.

2.1.1.4 Destination Port Abnormalities

Consider the *strange_scanning.pcap* file found in this module's resources.

Can you spot anything suspicious?

2.1.1.4 Destination Port Abnormalities

Detection

1	0.000000	192.168.1.6	192.168.1.4	TCP	60 2704 → 0 [SYN] Seq=0 Win=512 Len=0
2	0.000036	192.168.1.4	192.168.1.6	TCP	54 0 → 2704 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
3	1.000539	192.168.1.6	192.168.1.4	TCP	60 2705 → 0 [SYN] Seq=0 Win=512 Len=0
4	1.000578	192.168.1.4	192.168.1.6	TCP	54 0 → 2705 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
5	2.000999	192.168.1.6	192.168.1.4	TCP	60 2706 → 0 [SYN] Seq=0 Win=512 Len=0
6	2.001037	192.168.1.4	192.168.1.6	TCP	54 0 → 2706 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
7	3.002394	192.168.1.6	192.168.1.4	TCP	60 2707 → 0 [SYN] Seq=0 Win=512 Len=0
8	3.002428	192.168.1.4	192.168.1.6	TCP	54 0 → 2707 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
9	4.003780	192.168.1.6	192.168.1.4	TCP	60 2708 → 0 [SYN] Seq=0 Win=512 Len=0
10	4.003819	192.168.1.4	192.168.1.6	TCP	54 0 → 2708 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
11	5.004594	192.168.1.6	192.168.1.4	TCP	60 2709 → 0 [SYN] Seq=0 Win=512 Len=0
12	5.004632	192.168.1.4	192.168.1.6	TCP	54 0 → 2709 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
13	6.005871	192.168.1.6	192.168.1.4	TCP	60 2710 → 0 [SYN] Seq=0 Win=512 Len=0
14	6.005912	192.168.1.4	192.168.1.6	TCP	54 0 → 2710 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
15	7.006765	192.168.1.6	192.168.1.4	TCP	60 2711 → 0 [SYN] Seq=0 Win=512 Len=0
16	7.006798	192.168.1.4	192.168.1.6	TCP	54 0 → 2711 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
17	8.007188	192.168.1.6	192.168.1.4	TCP	60 2712 → 0 [SYN] Seq=0 Win=512 Len=0
18	8.007222	192.168.1.4	192.168.1.6	TCP	54 0 → 2712 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0

2.1.1.4 Destination Port Abnormalities

Detection

1	0.000000	192.168.1.6	192.168.1.4	TCP	60 2704 → 0 [SYN] Seq=0 Win=512 Len=0
2	0.000036	192.168.1.4	192.168.1.6	TCP	54 0 → 2704 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
3	1.000539	192.168.1.6	192.168.1.4	TCP	60 2705 → 0 [SYN] Seq=0 Win=512 Len=0
4	1.000578	192.168.1.4	192.168.1.6	TCP	54 0 → 2705 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
5	2.000999	192.168.1.6	192.168.1.4	TCP	60 2706 → 0 [SYN] Seq=0 Win=512 Len=0
6	2.001037	192.168.1.4	192.168.1.6	TCP	54 0 → 2706 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
7	3.002394	192.168.1.6	192.168.1.4	TCP	60 2707 → 0 [SYN] Seq=0 Win=512 Len=0
8	3.002428	192.168.1.4	192.168.1.6	TCP	54 0 → 2707 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
9	4.003780	192.168.1.6	192.168.1.4	TCP	60 2708 → 0 [SYN] Seq=0 Win=512 Len=0
10	4.003819	192.168.1.4	192.168.1.6	TCP	54 0 → 2708 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
11	5.004594	192.168.1.6	192.168.1.4	TCP	60 2709 → 0 [SYN] Seq=0 Win=512 Len=0
12	5.004632	192.168.1.4	192.168.1.6	TCP	54 0 → 2709 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
13	6.005871	192.168.1.6	192.168.1.4	TCP	60 2710 → 0 [SYN] Seq=0 Win=512 Len=0
14	6.005912	192.168.1.4	192.168.1.6	TCP	54 0 → 2710 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
15	7.006765	192.168.1.6	192.168.1.4	TCP	60 2711 → 0 [SYN] Seq=0 Win=512 Len=0
16	7.006798	192.168.1.4	192.168.1.6	TCP	54 0 → 2711 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
17	8.007188	192.168.1.6	192.168.1.4	TCP	60 2712 → 0 [SYN] Seq=0 Win=512 Len=0
18	8.007222	192.168.1.4	192.168.1.6	TCP	54 0 → 2712 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0

Obviously, we are dealing with a scanning attempt, but what is that destination port 0 (TCP) all about?
A host is not supposed to be listening on port 0. A scanning tool sending packets to port 0 (TCP) of the remote host, is trying identify if the remote host is alive. If the remote host is alive, then, a **RST** response should be sent to all those packets.

2.1.1.5 TCP RST Attack

It has been known for years that an existing TCP connection can be cut apart through a crafted TCP RST (and other) packet sent either to the client or the server. For a successful RST attack to be executed, an attacker should have prior knowledge of the below.

- **Source Port**
- **Destination Port**
- **Source IP**
- **Destination IP**
- **“correct” Sequence Number**

2.1.1.5 TCP RST Attack

It has been known for years that an existing TCP connection can be cut apart through a crafted TCP RST (and other) packet sent either to the client or the server. For a successful RST attack to be executed, an attacker should have prior knowledge of the below.

- **Source Port**
- **Destination Port**
- **Source IP**
- **Destination IP**
- **"correct" Sequence Number**

Those can be easily identified by an attacker in the same network, who is sniffing the network traffic.

TCP RST attacks can also be executed remotely though, as described in the following paper https://packetstormsecurity.com/files/download/33170/SlippingInTheWindow_v1.0.doc

2.1.1.5 TCP RST Attack

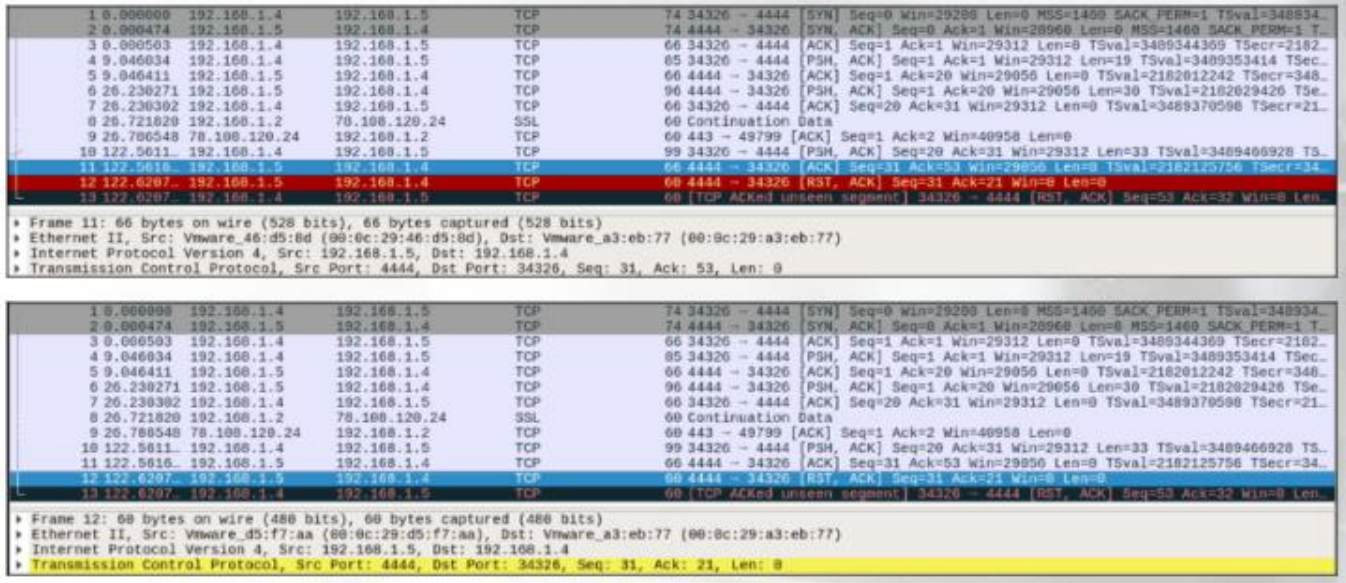
Consider the *TCP_RST_Attack.pcap file* found in this module's resources.

Try to identify any abnormalities.

OUTLINE

2.1.1.5 TCP RST Attack

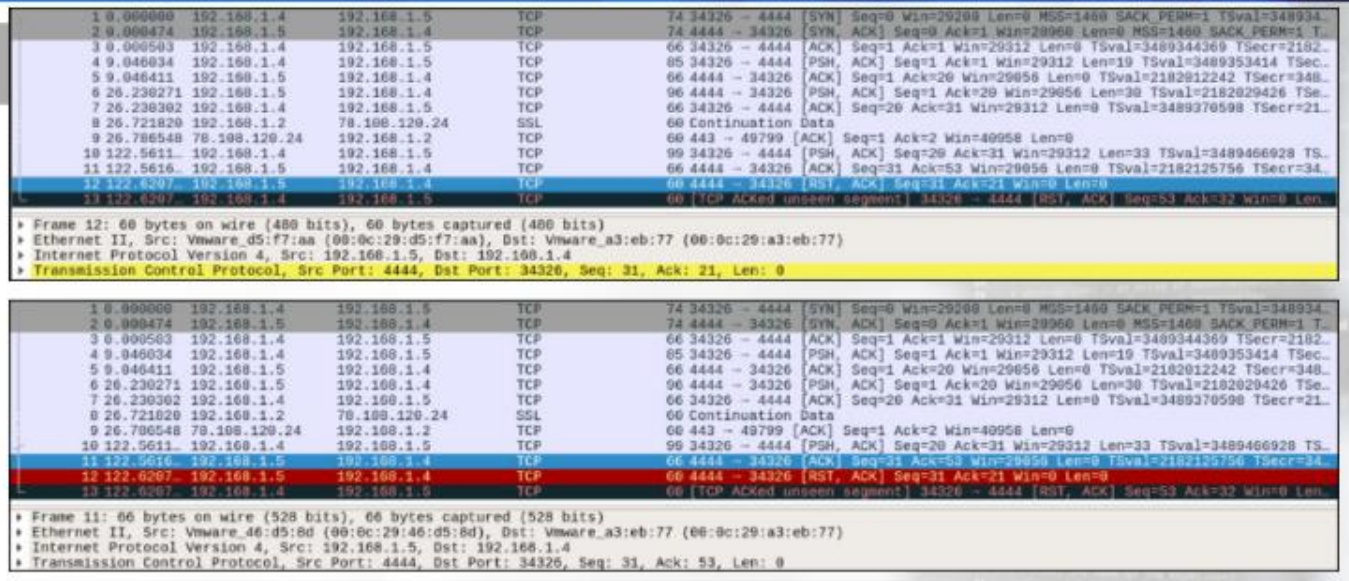
Detection



OUTLINE

2.1.1.5 TCP RST Attack

Detection



- If you carefully look at packet #12, you will notice that the 192.168.1.5 host sent a TCP RST packet and subsequently terminated the connection. So far, everything seems normal. Now, if you carefully look at packet #11, you will notice normal data transmission originating from the 192.168.1.5 host, but its MAC address is different than the one included in packet #12.
- It looks like an attacker executed a TCP RST attack to terminate the connection, spoofing the 192.168.1.5 host.
- The next sequence number was first identified through sniffing traffic and then used inside the spoofed RST packet.

OUTLINE

2.1.1.6 TCP Session Hijacking

As you might have figured out by now, TCP is defenseless against “packet injection” attacks. An attacker could choose to hijack a whole TCP session, instead of executing a simple TCP RST attack.

TCP session hijacking requires the same prior knowledge as the TCP RST attack.

2.1.1.6 TCP Session Hijacking

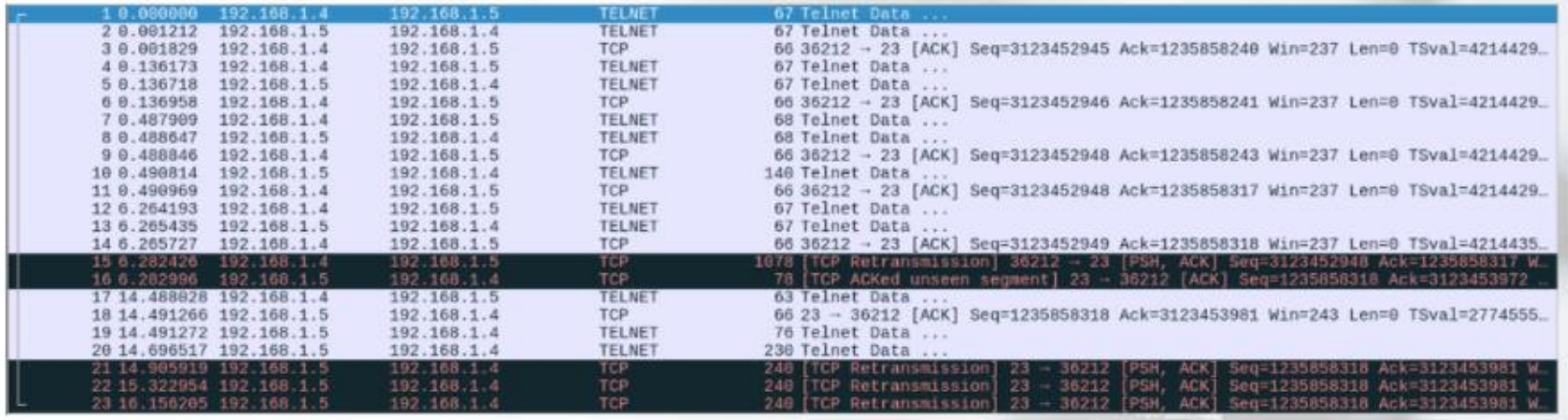
Consider the *TCP-hijacking.pcap file* found in this module's resources.

Try to identify any abnormalities.

OUTLINE

2.1.1.6 TCP Session Hijacking

Detection



1	0.000000	192.168.1.4	192.168.1.5	TELNET	67 Telnet Data ...
2	0.001212	192.168.1.5	192.168.1.4	TELNET	67 Telnet Data ...
3	0.001829	192.168.1.4	192.168.1.5	TCP	66 36212 → 23 [ACK] Seq=3123452945 Ack=1235858240 Win=237 Len=0 TSval=4214429…
4	0.136173	192.168.1.4	192.168.1.5	TELNET	67 Telnet Data ...
5	0.136718	192.168.1.5	192.168.1.4	TELNET	67 Telnet Data ...
6	0.136958	192.168.1.4	192.168.1.5	TCP	66 36212 → 23 [ACK] Seq=3123452946 Ack=1235858241 Win=237 Len=0 TSval=4214429…
7	0.487909	192.168.1.4	192.168.1.5	TELNET	68 Telnet Data ...
8	0.488647	192.168.1.5	192.168.1.4	TELNET	68 Telnet Data ...
9	0.488846	192.168.1.4	192.168.1.5	TCP	66 36212 → 23 [ACK] Seq=3123452948 Ack=1235858243 Win=237 Len=0 TSval=4214429…
10	0.490814	192.168.1.5	192.168.1.4	TELNET	140 Telnet Data ...
11	0.490969	192.168.1.4	192.168.1.5	TCP	66 36212 → 23 [ACK] Seq=3123452948 Ack=1235858317 Win=237 Len=0 TSval=4214429…
12	6.264193	192.168.1.4	192.168.1.5	TELNET	67 Telnet Data ...
13	6.265435	192.168.1.5	192.168.1.4	TELNET	67 Telnet Data ...
14	6.265727	192.168.1.4	192.168.1.5	TCP	66 36212 → 23 [ACK] Seq=3123452949 Ack=1235858318 Win=237 Len=0 TSval=4214435…
15	6.282426	192.168.1.4	192.168.1.5	TCP	1078 [TCP Retransmission] 36212 → 23 [PSH, ACK] Seq=3123452948 Ack=1235858317 W…
16	6.282996	192.168.1.5	192.168.1.4	TCP	78 [TCP ACKed unseen segment] 23 → 36212 [ACK] Seq=1235858318 Ack=3123453972 …
17	14.488028	192.168.1.4	192.168.1.5	TELNET	63 Telnet Data ...
18	14.491266	192.168.1.5	192.168.1.4	TCP	66 23 → 36212 [ACK] Seq=1235858318 Ack=3123453981 Win=243 Len=0 TSval=2774555…
19	14.491272	192.168.1.5	192.168.1.4	TELNET	76 Telnet Data ...
20	14.696517	192.168.1.5	192.168.1.4	TELNET	230 Telnet Data ...
21	14.905919	192.168.1.5	192.168.1.4	TCP	240 [TCP Retransmission] 23 → 36212 [PSH, ACK] Seq=1235858318 Ack=3123453981 W…
22	15.322954	192.168.1.5	192.168.1.4	TCP	240 [TCP Retransmission] 23 → 36212 [PSH, ACK] Seq=1235858318 Ack=3123453981 W…
23	16.156205	192.168.1.5	192.168.1.4	TCP	240 [TCP Retransmission] 23 → 36212 [PSH, ACK] Seq=1235858318 Ack=3123453981 W…

OUTLINE

2.1.1.6 TCP Session Hijacking

Detection

1	0.000000	192.168.1.4	192.168.1.5	TELNET	67 Telnet Data ...
2	0.001212	192.168.1.5	192.168.1.4	TELNET	67 Telnet Data ...
3	0.001829	192.168.1.4	192.168.1.5	TCP	66 36212 → 23 [ACK] Seq=3123452945 Ack=1235858240 Win=237 Len=0 TSval=4214429…
4	0.136173	192.168.1.4	192.168.1.5	TELNET	67 Telnet Data ...
5	0.136718	192.168.1.5	192.168.1.4	TELNET	67 Telnet Data ...
6	0.136958	192.168.1.4	192.168.1.5	TCP	66 36212 → 23 [ACK] Seq=3123452946 Ack=1235858241 Win=237 Len=0 TSval=4214429…
7	0.487909	192.168.1.4	192.168.1.5	TELNET	68 Telnet Data ...
8	0.488647	192.168.1.5	192.168.1.4	TELNET	68 Telnet Data ...
9	0.488846	192.168.1.4	192.168.1.5	TCP	66 36212 → 23 [ACK] Seq=3123452948 Ack=1235858243 Win=237 Len=0 TSval=4214429…
10	0.490814	192.168.1.5	192.168.1.4	TELNET	140 Telnet Data ...
11	0.490969	192.168.1.4	192.168.1.5	TCP	66 36212 → 23 [ACK] Seq=3123452948 Ack=1235858317 Win=237 Len=0 TSval=4214429…
12	6.264193	192.168.1.4	192.168.1.5	TELNET	67 Telnet Data ...
13	6.265435	192.168.1.5	192.168.1.4	TELNET	67 Telnet Data ...
14	6.265727	192.168.1.4	192.168.1.5	TCP	66 36212 → 23 [ACK] Seq=3123452949 Ack=1235858318 Win=237 Len=0 TSval=4214435…
15	6.282426	192.168.1.4	192.168.1.5	TCP	1078 [TCP Retransmission] 36212 → 23 [PSH, ACK] Seq=3123452946 Ack=1235858317 W…
16	6.282906	192.168.1.5	192.168.1.4	TCP	78 [TCP ACKed unseen segment] 23 → 36212 [ACK] Seq=1235858318 Ack=3123453972 …
17	14.488028	192.168.1.4	192.168.1.5	TELNET	63 Telnet Data ...
18	14.491266	192.168.1.5	192.168.1.4	TCP	66 23 → 36212 [ACK] Seq=1235858318 Ack=3123453981 Win=243 Len=0 TSval=2774555…
19	14.491272	192.168.1.5	192.168.1.4	TELNET	76 Telnet Data ...
20	14.696517	192.168.1.5	192.168.1.4	TELNET	230 Telnet Data ...
21	14.905919	192.168.1.5	192.168.1.4	TCP	240 [TCP Retransmission] 23 → 36212 [PSH, ACK] Seq=1235858318 Ack=3123453981 W…
22	15.322954	192.168.1.5	192.168.1.4	TCP	240 [TCP Retransmission] 23 → 36212 [PSH, ACK] Seq=1235858318 Ack=3123453981 W…
23	16.156205	192.168.1.5	192.168.1.4	TCP	240 [TCP Retransmission] 23 → 36212 [PSH, ACK] Seq=1235858318 Ack=3123453981 W…

- This is obviously a capture file of a Telnet session. Telnet offers no encryption and thus, we can see every command the client issued and every result returned by the server in clear text.
- Let's analyze packet #15.
  - *TCP Retransmission* is displayed because the sequence number and the acknowledgement number of this packet are the same as the ones in packet #11.
  - The MAC address of the client (192.168.1.4) in this packet is different than the MAC address that is included in all previous packets related to this host.
- It looks like an attacker has taken over (hijacked) the whole Telnet session. This is also apparent in packet #17, that includes the MAC address of the attacker and the command the attacker issued (*uname –a*)
- The server has no defense mechanism to detect that the Telnet session is hijacked and sends the output of the *uname –a* command back to the 192.168.1.4 client.

2.1.1.7 TCP Options Abuse

At the end of the TCP header, one may find TCP options being specified.

Historically, TCP options have been abused for evasion and information gathering purposes.

OUTLINE

2.1.1.7.1 TCP Timestamps Option

One example of a TCP option that can be abused, is the TCP Timestamps option.

According to RFC 1323, the Timestamps option carries two four-byte timestamp fields. The Timestamp Value field (TSval) contains the current value of the timestamp clock of the TCP sending the option. The Timestamp Echo Reply field (TSecr) is only valid if the ACK bit is set in the TCP header; if it is valid, it “echos” a timestamp value that was sent by the remote TCP in the TSval field of a Timestamps option.

https://tools.ietf.org/html/rfc1323

OUTLINE

2.1.1.7.1 TCP Timestamps Option

Specifically, the TCP Timestamps options can be abused in order to:

1. Determine the patch level of a system, through uptime analysis
2. Perform host identification using clock skew
3. Identify how a target DMZ is structured

http://www.caida.org/publications/papers/2005/fingerprinting/KohnoBroidoClaffy05-devicefingerprinting.pdf

2.1.1.7.1 TCP Timestamps Option

Technical details on how attackers are abusing the TCP Timestamps option can be found in the following link.

https://www.scip.ch/en/?labs.20150305

2.1.1.7.2 Leveraging TCP Option Support & Ordering

Oftentimes, TCP/IP stacks, support a subset of the available TCP options and also, perform TCP option storing in their own unique order. Nmap leverages the above (and other things), in order to perform OS fingerprinting.

2.1.1.7.2 Leveraging TCP Option Support & Ordering

The following article offers technical details (as well as an example) on how OS fingerprinting can be achieved by analyzing TCP options (refer to the *TCP Options* section).

https://nmap.org/nmap-fingerprinting-article.txt

2.1.2 UDP

UDP Overview

- ✓ UDP is a less complicated (than TCP) and lightweight protocol, due to the lack of fields that ensure reliable delivery
- ✓ Unlike TCP, UDP can deliver traffic to multiple hosts.
- ✓ Privileged (server) and ephemeral (client) ports exist, just like in TCP (For each new connection, a different ephemeral port should be utilized)
- ✓ IPv6 dictated some changes such as:
  - UDP length 0 that designates a jumbogram packet
  - The requirement for UDP checksums

2.1.2 UDP

UDP-based attacking techniques, such as DNS Command & Control, DNS exfiltration etc. will be covered as the course progresses. Hang on…

OUTLINE

2.1.3 ICMP

ICMP Overview

- ✓ The Internet Control Message Protocol (ICMP) is another less complicated (than TCP) and lightweight protocol
- ✓ It is commonly used for network troubleshooting and delivering error messages
- ✓ It is an unreliable protocol
- ✓ It can send and respond to broadcast messages
- ✓ There are no ports and client-server communications involved

2.1.3.1 ICMP Abuse

Historically, ICMP has been abused for all kinds of nefarious purposes, from mapping and reconnaissance all the way to DDoS and Man-In-The-Middle attacks.

OUTLINE

2.1.3.1 ICMP Abuse

We all know that we can map live hosts via ICMP echo requests to a single, broadcast or subnet address. This mapping technique though has been abused in the past to such a degree that most sites nowadays disallow inbound and/or outbound ICMP echo requests.

This fact triggered the creation of a new wave of ICMP-based mapping techniques by attackers.

2.1.3.1.1 ICMP Address Mask Request/Reply

ICMP can be used to identify a target host's subnet mask. Such information can be useful in distinguishing subnets within an IP address range.

This can be achieved, by sending an ICMP address mask request to a given target.Such a request may elicit responses from gateway hosts or other network devices **only**.

2.1.3.1.1 ICMP Address Mask Request/Reply

Detection

An ICMP Address Mask Request looks as follows on the wire.

```
Internet Control Message Protocol
    Type: 17 (Address mask request)
    Code: 0
    Checksum: 0x17a8 [correct]
    Identifier (BE): 54615 (0xd557)
    Identifier (LE): 22485 (0x57d5)
    Sequence number (BE): 512 (0x0200)
    Sequence number (LE): 2 (0x0002)
    Address mask: 0.0.0.0 (0x00000000)

0000  08 00 27 16 0f 55 08 00  27 0a c9 f5 08 00 45 00   ..'..U.. '.....E.
0010  00 20 3f 0b 00 00 40 01  23 c0 0a 00 02 0f 0a 00   . ?...@. #.......
0020  02 04 11 00 17 a8 d5 57  02 00 00 00 00 00        .......W ......
```


OUTLINE

2.1.3.1.2 ICMP Timestamp Request/Reply

ICMP can also be used to obtain timestamps from remote systems. We previously covered how valuable a timestamp can be. That being said, as the years progressed many Operating Systems have implemented less accurate timestamps, making this approach unreliable.

An attacker can still use this approach though, as an alternative to ping when things are filtered.

2.1.3.1.2 ICMP Timestamp Request/Reply

Detection

An ICMP Timestamp Request looks as follows on the wire.

```
Internet Control Message Protocol
    Type: 13 (Timestamp request)
    Code: 0
    Checksum: 0x7b83 [correct]
    Identifier (BE): 15455 (0x3c5f)
    Identifier (LE): 24380 (0x5f3c)
    Sequence number (BE): 0 (0x0000)
    Sequence number (LE): 0 (0x0000)
    Originate timestamp: 18 hours, 46 minutes, 21.718 seconds after midnight UTC
    Receive timestamp: 0 seconds after midnight UTC
    Transmit timestamp: 0 seconds after midnight UTC
```

2.1.3.1.2 ICMP Timestamp Request/Reply

Detection

An ICMP Timestamp Reply looks as follows on the wire.

```
Internet Control Message Protocol
    Type: 14 (Timestamp reply)
    Code: 0
    Checksum: 0xce3e [correct]
    Identifier (BE): 15455 (0x3c5f)
    Identifier (LE): 24380 (0x5f3c)
    Sequence number (BE): 0 (0x0000)
    Sequence number (LE): 0 (0x0000)
    Originate timestamp: 18 hours, 46 minutes, 21.718 seconds after midnight UTC
    Receive timestamp: 13 hours, 19 minutes, 53.670 seconds after midnight UTC
    Transmit timestamp: 13 hours, 19 minutes, 53.670 seconds after midnight UTC
```

2.1.3.1 ICMP Timestamp Request/Reply

Detection

A great paper showcasing ICMP usage during scanning activities can be found below.

https://www.cs.dartmouth.edu/~sergey/me/netreads/ICMP_Scanning_v3.0.pdf

2.1.3.1.3 Smurf Attack

ICMP has been used in the past to execute devastating Distributed Denial of Service (DDoS) attacks. Such an attack, was the notorious Smurf attack.

OUTLINE

2.1.3.1.3 Smurf Attack

A Smurf attack is executed as follows:

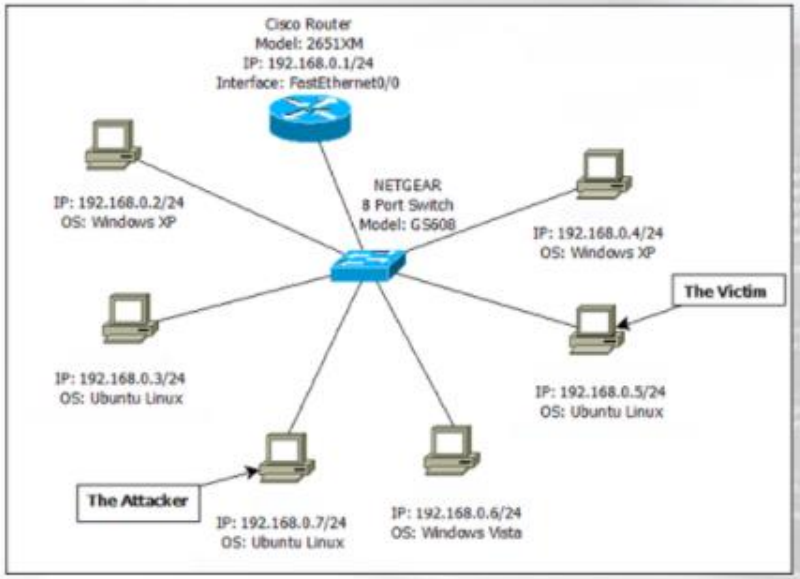
1. A fake Echo request is generated containing a spoofed source IP, which is actually the target server address
2. The request is sent to an intermediate IP broadcast network (The intermediate site/router has to allow ICMP echo requests to broadcast address)
3. The request is transmitted to all of the network hosts on the network
4. All hosts on the network that respond, will send an ICMP echo reply to the target server
5. If the number of ICMP responses is big enough, denial of service or performance degradation is caused to the target server.

Source: https://www.incapsula.com

OUTLINE

2.1.3.1.3 Smurf Attack

Suppose, an environment is set up as follows and the attacker (192.168.0.7) performs a Smurf attack against the victim (192.168.0.5)



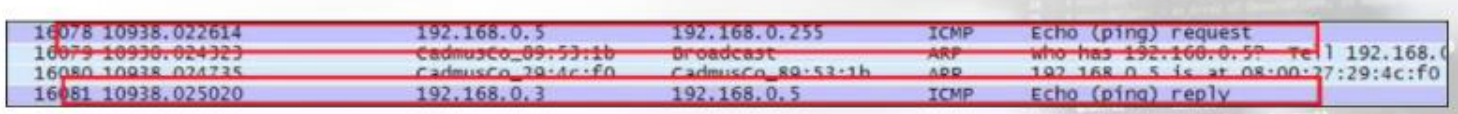
Source: http://www.uwindsor.ca/

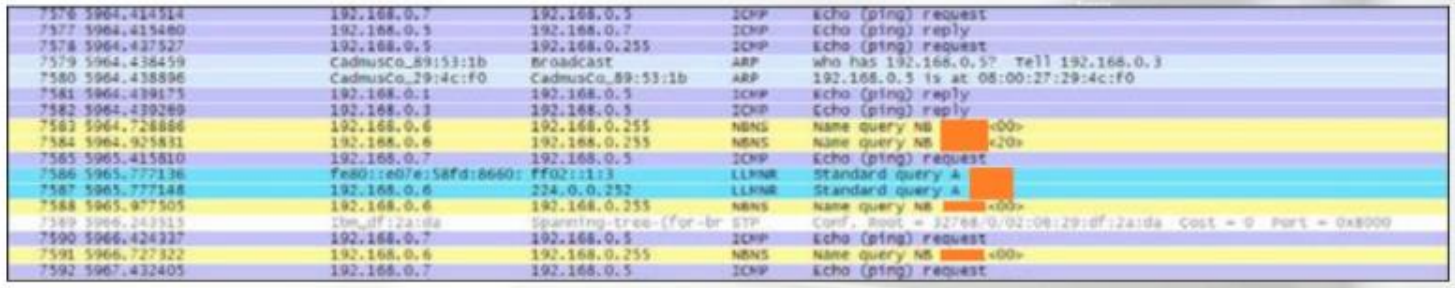
OUTLINE

2.1.3.1.3 Smurf Attack

Detection

The Smurf attack on the wire looks as follows.





Source: http://www.uwindsor.ca/

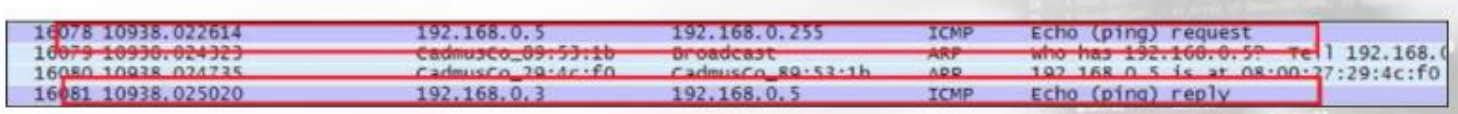
OUTLINE

2.1.3.1.3 Smurf Attack

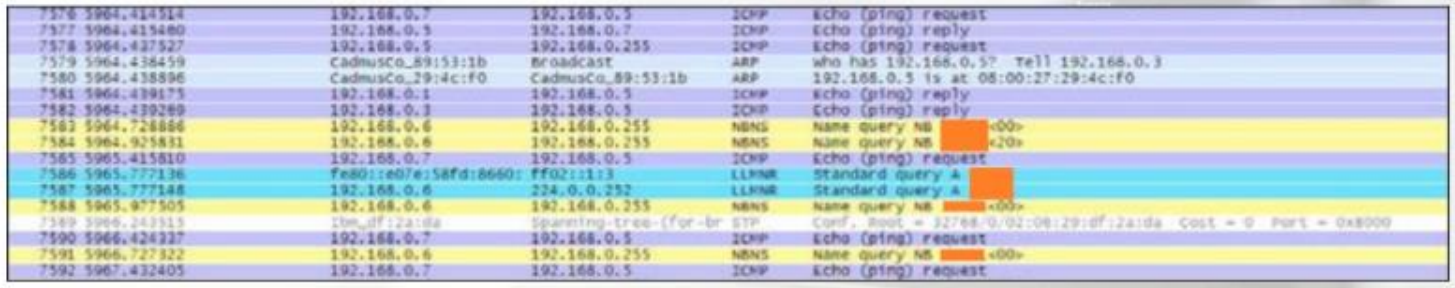
Detection

The Smurf attack on the wire looks as follows.

The spoofed packet was injected and broadcasted successfully



The victim no longer replies to Echo Requests



Source: http://www.uwindsor.ca/

2.1.3.1.3 Smurf Attack

Detection

The IPv6 variant of the Smurf attack on the wire looks as follows.

```
245409 163.369213000  2001:abc:1:1:a00:27ff:fed0:c21a  ff02::1                  ICMPv6  78 Echo (ping) request id=0xface, seq=47806
245410 163.369225000  2001:abc:1:1:dd90:9266:fcdf:d760 2001:abc:1:1:a00:27ff:fed0:c21a ICMPv6  78 Echo (ping) reply id=0xface, seq=47806
245411 163.369267000  2001:abc:1:1:a00:27ff:fed0:c21a  ff02::1                  ICMPv6  78 Echo (ping) request id=0xface, seq=47806
245412 163.369278000  2001:abc:1:1:dd90:9266:fcdf:d760 2001:abc:1:1:a00:27ff:fed0:c21a ICMPv6  78 Echo (ping) reply id=0xface, seq=47806
245413 163.369679000  2001:abc:1:1:a00:27ff:fed0:c21a  ff02::1                  ICMPv6  78 Echo (ping) request id=0xface, seq=47806
245414 163.369695000  2001:abc:1:1:dd90:9266:fcdf:d760 2001:abc:1:1:a00:27ff:fed0:c21a ICMPv6  78 Echo (ping) reply id=0xface, seq=47806
245415 163.369952000  2001:abc:1:1:a00:27ff:fed0:c21a  ff02::1                  ICMPv6  78 Echo (ping) request id=0xface, seq=47806
245416 163.369966000  2001:abc:1:1:dd90:9266:fcdf:d760 2001:abc:1:1:a00:27ff:fed0:c21a ICMPv6  78 Echo (ping) reply id=0xface, seq=47806
```

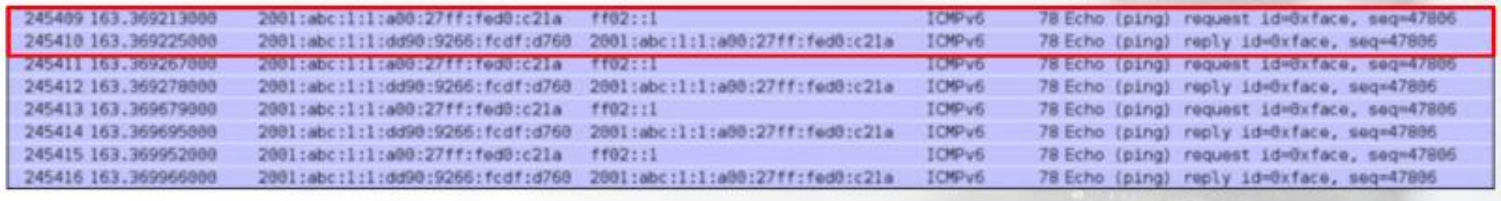

OUTLINE

2.1.3.1.3 Smurf Attack

Detection

The IPv6 variant of the Smurf attack on the wire looks as follows.

The spoofed packet was injected and broadcasted successfully



245409 163.369213000	2001:abc:1:1:a00:27ff:fed0:c21a	ff02::1	ICMPv6	78	Echo (ping) request id=0xface, seq=47806
245410 163.369225000	2001:abc:1:1:dd90:9266:fcdf:d760	2001:abc:1:1:a00:27ff:fed0:c21a	ICMPv6	78	Echo (ping) reply id=0xface, seq=47806
245411 163.369267000	2001:abc:1:1:a00:27ff:fed0:c21a	ff02::1	ICMPv6	78	Echo (ping) request id=0xface, seq=47806
245412 163.369278000	2001:abc:1:1:dd90:9266:fcdf:d760	2001:abc:1:1:a00:27ff:fed0:c21a	ICMPv6	78	Echo (ping) reply id=0xface, seq=47806
245413 163.369679000	2001:abc:1:1:a00:27ff:fed0:c21a	ff02::1	ICMPv6	78	Echo (ping) request id=0xface, seq=47806
245414 163.369695000	2001:abc:1:1:dd90:9266:fcdf:d760	2001:abc:1:1:a00:27ff:fed0:c21a	ICMPv6	78	Echo (ping) reply id=0xface, seq=47806
245415 163.369952000	2001:abc:1:1:a00:27ff:fed0:c21a	ff02::1	ICMPv6	78	Echo (ping) request id=0xface, seq=47806
245416 163.369966000	2001:abc:1:1:dd90:9266:fcdf:d760	2001:abc:1:1:a00:27ff:fed0:c21a	ICMPv6	78	Echo (ping) reply id=0xface, seq=47806

2.1.3.1.4 ICMP Tunneling

It should be noted, that ICMP can be misused to create a covert channel of communication. This can be achieved through ill-intended ICMP tunneling.

Numerous ICMP tunneling solutions exists, but attackers seem to prefer the ptunnel one.

http://freshmeat.sourceforge.net/projects/ptunnel/

2.1.3.1.4 ICMP Tunneling

Consider the *ptunnel.pcap file* found in this module's resources. Try to identify any abnormalities.

OUTLINE

2.1.3.1.4 ICMP Tunneling

Detection

1	0.000000	192.168.1.100	192.168.1.4	ICMP	70	Echo (ping) request id=0x9a32, seq=0/0, ttl=64 (reply in 2)
2	0.000046	192.168.1.4	192.168.1.100	ICMP	70	Echo (ping) reply id=0x9a32, seq=0/0, ttl=64 (request in 1)
3	0.014989	192.168.1.4	192.168.1.100	ICMP	82	Echo (ping) reply id=0x9a32, seq=0/0, ttl=64
4	0.015246	192.168.1.100	192.168.1.4	ICMP	82	Echo (ping) request id=0x9a32, seq=1/256, ttl=64 (reply in 5)
5	0.015262	192.168.1.4	192.168.1.100	ICMP	82	Echo (ping) reply id=0x9a32, seq=1/256, ttl=64 (request in 4)
6	0.015319	192.168.1.4	192.168.1.100	ICMP	70	Echo (ping) reply id=0x9a32, seq=1/256, ttl=64
7	0.015439	192.168.1.4	192.168.1.100	ICMP	94	Echo (ping) reply id=0x9a32, seq=2/512, ttl=64
→ 8	0.015612	192.168.1.100	192.168.1.4	ICMP	170	Echo (ping) request id=0x9a32, seq=2/512, ttl=64 (reply in 9)
← 9	0.015622	192.168.1.4	192.168.1.100	ICMP	170	Echo (ping) reply id=0x9a32, seq=2/512, ttl=64 (request in 8)
10	0.017822	192.168.1.4	192.168.1.100	ICMP	86	Echo (ping) reply id=0x9a32, seq=3/768, ttl=64
11	0.017958	192.168.1.100	192.168.1.4	ICMP	94	Echo (ping) request id=0x9a32, seq=3/768, ttl=64 (reply in 12)
12	0.017977	192.168.1.4	192.168.1.100	ICMP	94	Echo (ping) reply id=0x9a32, seq=3/768, ttl=64 (request in 11)
13	0.018171	192.168.1.4	192.168.1.100	ICMP	74	Echo (ping) reply id=0x9a32, seq=4/1024, ttl=64
14	0.018282	192.168.1.100	192.168.1.4	ICMP	74	Echo (ping) request id=0x9a32, seq=4/1024, ttl=64 (reply in 15)
15	0.018295	192.168.1.4	192.168.1.100	ICMP	74	Echo (ping) reply id=0x9a32, seq=4/1024, ttl=64 (request in 14
16	0.018440	192.168.1.4	192.168.1.100	ICMP	690	Echo (ping) reply id=0x9a32, seq=5/1280, ttl=64

2.1.3.1.4 ICMP Tunneling

Detection

1	0.000000	192.168.1.100	192.168.1.4	ICMP	70	Echo (ping) request id=0x9a32, seq=0/0, ttl=64 (reply in 2)
2	0.000046	192.168.1.4	192.168.1.100	ICMP	70	Echo (ping) reply id=0x9a32, seq=0/0, ttl=64 (request in 1)
3	0.014989	192.168.1.4	192.168.1.100	ICMP	82	Echo (ping) reply id=0x9a32, seq=0/0, ttl=64
4	0.015246	192.168.1.100	192.168.1.4	ICMP	82	Echo (ping) request id=0x9a32, seq=1/256, ttl=64 (reply in 5)
5	0.015262	192.168.1.4	192.168.1.100	ICMP	82	Echo (ping) reply id=0x9a32, seq=1/256, ttl=64 (request in 4)
6	0.015319	192.168.1.4	192.168.1.100	ICMP	70	Echo (ping) reply id=0x9a32, seq=1/256, ttl=64
7	0.015439	192.168.1.4	192.168.1.100	ICMP	94	Echo (ping) reply id=0x9a32, seq=2/512, ttl=64
→ 8	0.015612	192.168.1.100	192.168.1.4	ICMP	170	Echo (ping) request id=0x9a32, seq=2/512, ttl=64 (reply in 9)
← 9	0.015622	192.168.1.4	192.168.1.100	ICMP	170	Echo (ping) reply id=0x9a32, seq=2/512, ttl=64 (request in 8)
10	0.017822	192.168.1.4	192.168.1.100	ICMP	86	Echo (ping) reply id=0x9a32, seq=3/768, ttl=64
11	0.017958	192.168.1.100	192.168.1.4	ICMP	94	Echo (ping) request id=0x9a32, seq=3/768, ttl=64 (reply in 12)
12	0.017977	192.168.1.4	192.168.1.100	ICMP	94	Echo (ping) reply id=0x9a32, seq=3/768, ttl=64 (request in 11)
13	0.018171	192.168.1.4	192.168.1.100	ICMP	74	Echo (ping) reply id=0x9a32, seq=4/1024, ttl=64
14	0.018282	192.168.1.100	192.168.1.4	ICMP	74	Echo (ping) request id=0x9a32, seq=4/1024, ttl=64 (reply in 15)
15	0.018295	192.168.1.4	192.168.1.100	ICMP	74	Echo (ping) reply id=0x9a32, seq=4/1024, ttl=64 (request in 14
16	0.018440	192.168.1.4	192.168.1.100	ICMP	690	Echo (ping) reply id=0x9a32, seq=5/1280, ttl=64

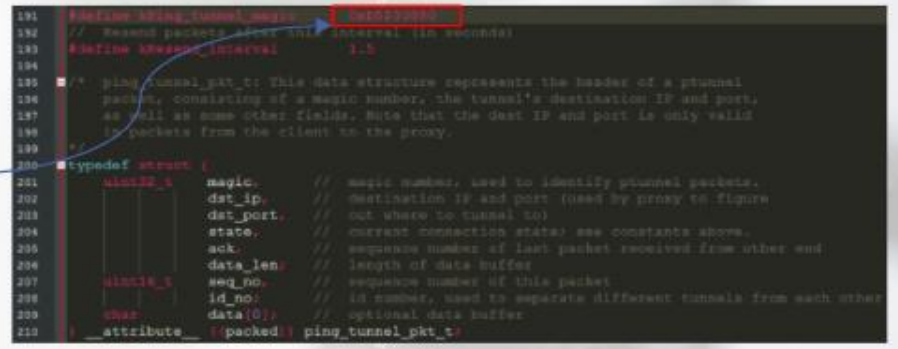
- The capture file seems imbalanced as far as the amount of Echo requests and Echo replies is concerned. You can see two or more replies for each request
- An Echo request and the associated Echo reply should have the same length (have identical payloads). This isn't the case in this capture file.
- The payload size in some ICMP packets is a lot bigger than normal. For example, see packet #16.

2.1.3.1.4 ICMP Tunneling

Detection

Let's dig deeper...

First, download ptunnel and then, open the *ptunnel.h* file using a text editor. Around line #191, you will identify that the ptunnel header begins with a magic number, a short unique sequence of bytes that lets the recipient know that the ICMP payload should be treated as ptunnel traffic. This magic number is 0xD5200880, by default.



2.1.3.1.4 ICMP Tunneling

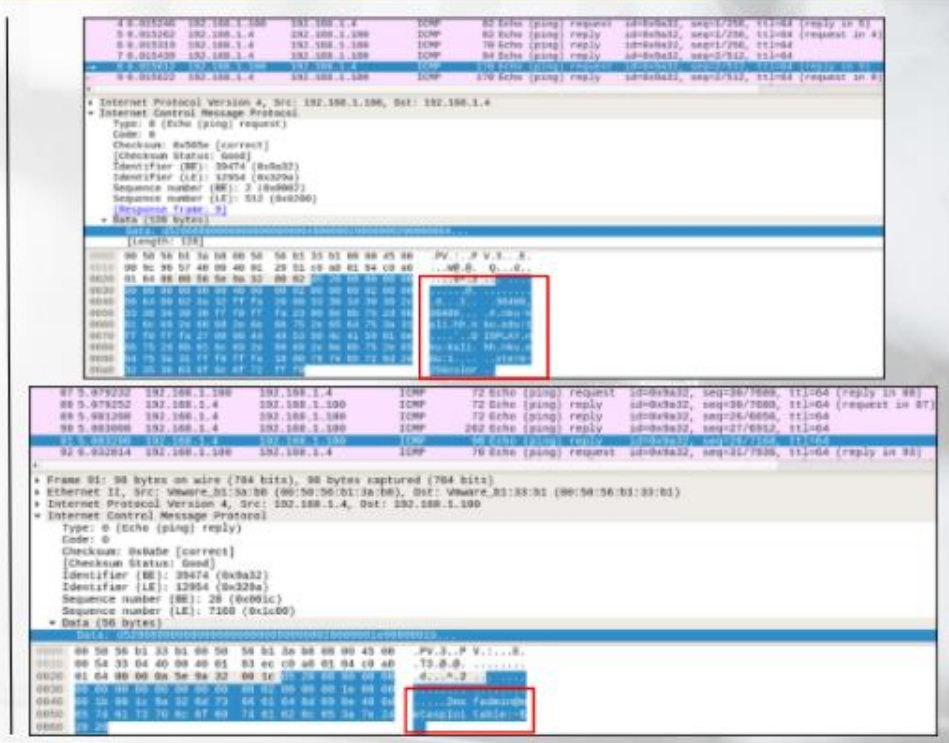
Detection

It looks like all ICMP packets of this capture file include the previously mentioned ptunnel magic value (0xD5200880), inside the ICMP payload. The yellow rectangles designate the ICMP header session identifier.

2.1.3.1.4 ICMP Tunneling

Detection

In addition, there are indications that a whole session, between an attacker and a compromised machine, is being concealed through ICMP traffic (ICMP tunneling).



OUTLINE

2.1.3.1.4 ICMP Tunneling

Detection

The fact that a whole session, between an attacker and a compromised machine, is being concealed through ICMP traffic (ICMP tunneling) can be also identified by using the *strings* Linux command against the capture file as follows.

```
>> strings ptunnel.pcap
```

```
root@kali:~/Desktop/IHRP_PCAPs/Part 2# strings ptunnel.pcap
D06@
808@
P09@
38400,38400
nku-kali.hh.nku.edu:1
DISPLAY
nku-kali.hh.nku.edu:1
xterm-256color
38400,38400
nku-kali.hh.nku.edu:1
DISPLAY
nku-kali.hh.nku.edu:1
xterm-256color
H0;@
<0=@
2
 _                                  _       _ _        _     _
| |                                | |     (_) |      | |   | |
| |  _ __ ___   ___ _ __ __ _ ___| |_ __ _ _| | ___  | |__ | | ___
| | | '_ ` _ \ / _ \ '__/ _` / __| __/ _` | | |/ _ \ | '_ \| |/ _ \
| | | | | | | |  __/ | | (_| \__ \ || (_| | | |  __/ | |_) | |  __/
|_| |_| |_| |_|\___|_|  \__,_|___/\__\__,_|_|_|\___| |_.__/|_|\___|
                                  _|
Warning: Never expose this VM to an untrusted network!
Contact: msfdev[at]metasploit.com
Login with msfadmin/msfadmin to get started
metasploitable login: 7L
:13@
:1E@
:1W@
81e@
:1l@
:1w@
:1y@
2Password: 9L
```

2.1.3.1.5 Abusing ICMP Redirect

When two machines want to communicate with each other the router has to find the shortest path between them.

If there is an alternate path between the two machines and if it is shorter than the previous path, then, the router will send an ICMP redirect packet to the sender machine.

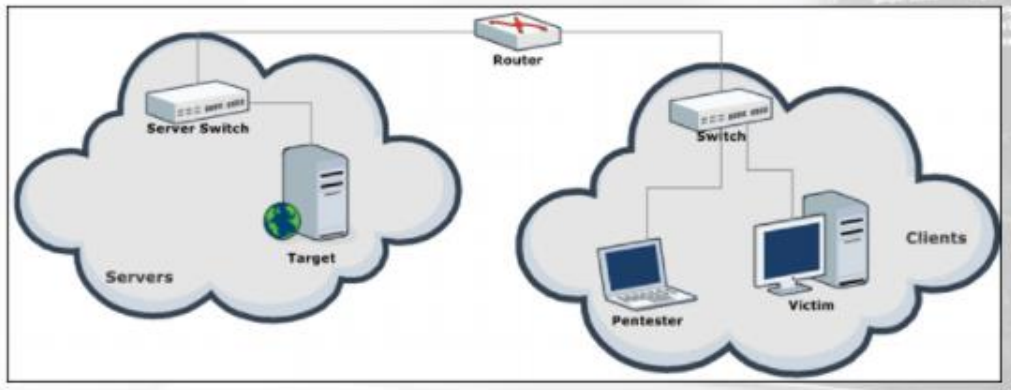
2.1.3.1.5 Abusing ICMP Redirect

This ICMP redirect packet will instruct the sender to change its routing table so that it uses the shortest path.

However, such ICMP redirect packets can be forged by a attacker and make the sender host redirect its packet to an attacker-controlled or non-existing destination.

2.1.3.1.5 Abusing ICMP Redirect

Suppose, an environment is set up as follows. The network has been hardened to prevent successful execution of ARP- spoofing-based attacks. Somehow, the pentester residing in the client network, managed to sniff client traffic and capture clear-text credentials.



OUTLINE

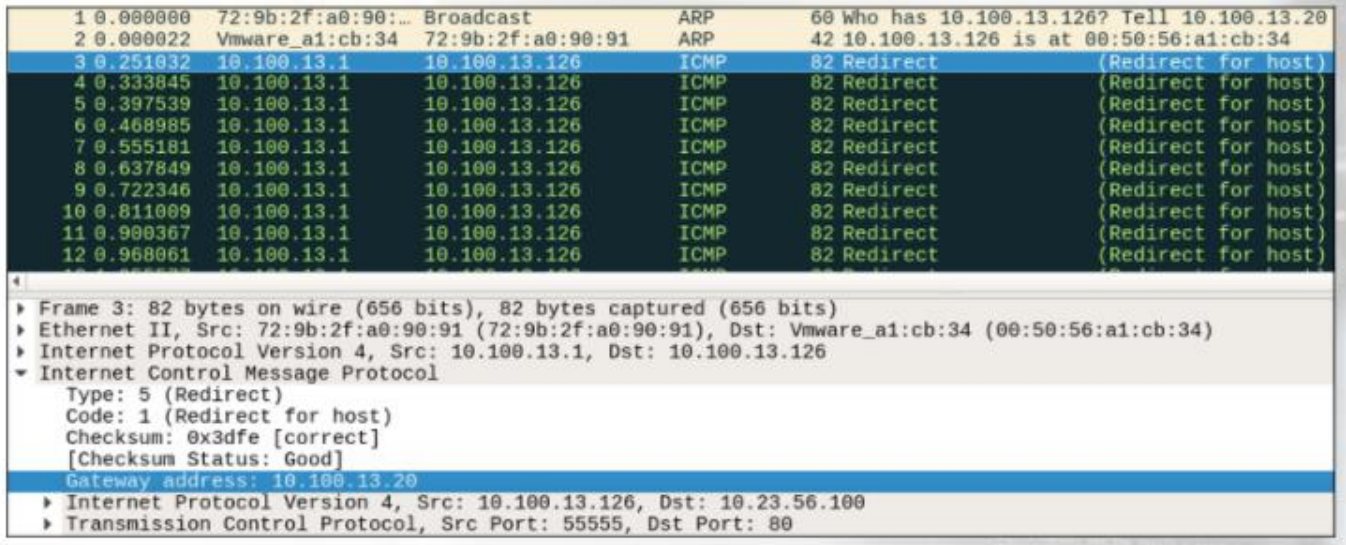
2.1.3.1.5 Abusing ICMP Redirect

Consider the *client_network.pcap file* found in this module's resources. Try to identify how the pentester managed to sniff client traffic, in spite of the anti-ARP-poisoning measures.

Note: The majority of TCP traffic has been removed.

2.1.3.1.5 Abusing ICMP Redirect

Detection

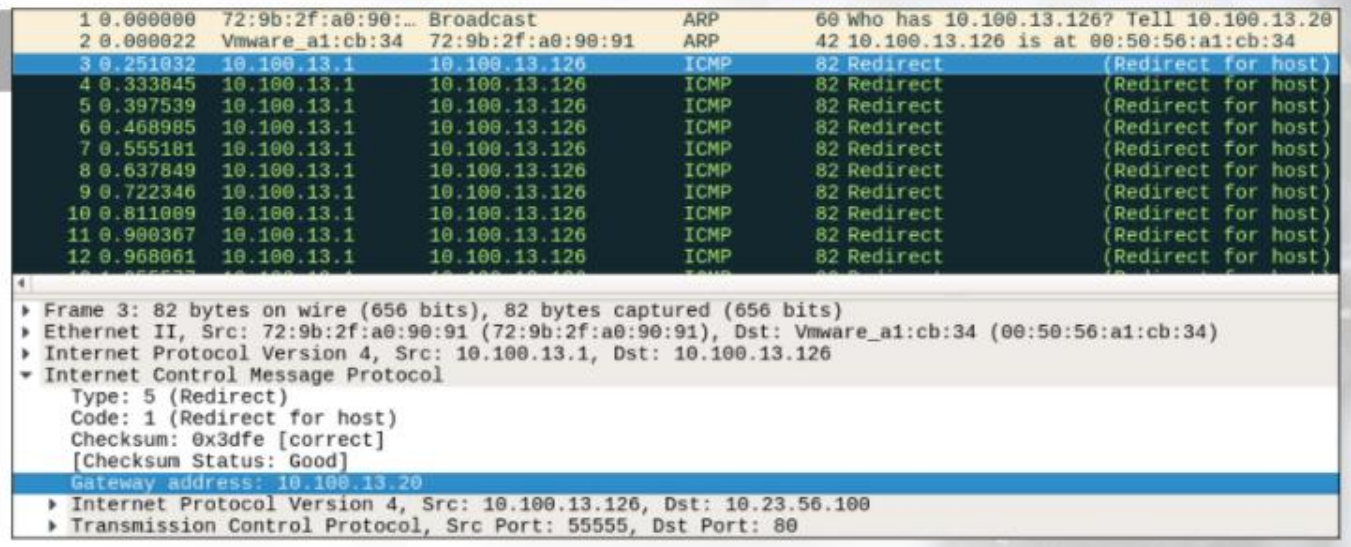


```
    1 0.000000  72:9b:2f:a0:90:… Broadcast           ARP      60 Who has 10.100.13.126? Tell 10.100.13.20
    2 0.000022  Vmware_a1:cb:34  72:9b:2f:a0:90:91   ARP      42 10.100.13.126 is at 00:50:56:a1:cb:34
    3 0.251032  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
    4 0.333845  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
    5 0.397539  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
    6 0.468985  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
    7 0.555181  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
    8 0.637849  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
    9 0.722346  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
   10 0.811009  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
   11 0.900367  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
   12 0.968061  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)

▸ Frame 3: 82 bytes on wire (656 bits), 82 bytes captured (656 bits)
▸ Ethernet II, Src: 72:9b:2f:a0:90:91 (72:9b:2f:a0:90:91), Dst: Vmware_a1:cb:34 (00:50:56:a1:cb:34)
▸ Internet Protocol Version 4, Src: 10.100.13.1, Dst: 10.100.13.126
▾ Internet Control Message Protocol
    Type: 5 (Redirect)
    Code: 1 (Redirect for host)
    Checksum: 0x3dfe [correct]
    [Checksum Status: Good]
    Gateway address: 10.100.13.20
  ▸ Internet Protocol Version 4, Src: 10.100.13.126, Dst: 10.23.56.100
  ▸ Transmission Control Protocol, Src Port: 55555, Dst Port: 80
```

2.1.3.1.5 Abusing ICMP Redirect

Detection



```
    1 0.000000  72:9b:2f:a0:90:…  Broadcast           ARP      60 Who has 10.100.13.126? Tell 10.100.13.20
    2 0.000022  Vmware_a1:cb:34  72:9b:2f:a0:90:91   ARP      42 10.100.13.126 is at 00:50:56:a1:cb:34
    3 0.251032  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
    4 0.333845  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
    5 0.397539  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
    6 0.468985  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
    7 0.555181  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
    8 0.637849  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
    9 0.722346  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
   10 0.811089  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
   11 0.900367  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)
   12 0.968061  10.100.13.1      10.100.13.126       ICMP     82 Redirect              (Redirect for host)

▸ Frame 3: 82 bytes on wire (656 bits), 82 bytes captured (656 bits)
▸ Ethernet II, Src: 72:9b:2f:a0:90:91 (72:9b:2f:a0:90:91), Dst: Vmware_a1:cb:34 (00:50:56:a1:cb:34)
▸ Internet Protocol Version 4, Src: 10.100.13.1, Dst: 10.100.13.126
▾ Internet Control Message Protocol
    Type: 5 (Redirect)
    Code: 1 (Redirect for host)
    Checksum: 0x3dfe [correct]
    [Checksum Status: Good]
    Gateway address: 10.100.13.20
  ▸ Internet Protocol Version 4, Src: 10.100.13.126, Dst: 10.23.56.100
  ▸ Transmission Control Protocol, Src Port: 55555, Dst Port: 80
```

- A large number of ICMP Redirect packets exist. In those packets the router instructs the client 10.100.13.126 to make a change in its routing table to use the gateway 10.100.13.20 for all subsequent packets. At this moment, you should check if the gateway 10.100.13.20 is a legitimate gateway.
- If you filter the whole capture file, based on the MAC address of the router (10.100.13.1) [**eth.src==72:9b:2f:a0:90:91**], you will notice that this MAC address is associated with the 10.100.13.20 machine.
- Even though it is not clearly visible in the capture file, every HTTP request can now be sniffed by the 10.100.13.20 host, as a result of the ICMP Redirect attack.
- So, it looks like the penetration tester crafted malicious ICMP Redirect packets, spoofing the router, and mounted an ICMP Redirect attack.

2.1 Analyzing & Detecting Transport Layer Attacks

This is the end of the *Analyzing & Detecting Transport Layer Attacks* part.

Moving forward, we will show you how to analyze common application protocol traffic and attacks.

OUTLINE

2.2

Analyzing Common Application Protocol Traffic & Attacks

OUTLINE

2.2 Analyzing Common Application Protocol Traffic & Attacks

We eventually reached the Application layer of the TCP/IP model. In this part of the module, we will focus our attention on Microsoft-specific protocols, HTTP(S), SMTP and DNS .

We will analyze them on the wire and also see attacks that either leverage them or misuse them.

2.2.1 Microsoft-specific Protocols

Undoubtedly, Windows is the most widely used Operating System. All those Windows hosts out there, use some universal and Microsoft-specific/Microsoft-implemented protocols. Let's go through them and see how they look in the wire.

2.2.1.1 NetBIOS

Network Basic Input/Output System (NetBIOS) is a set of protocols developed in the early 1980s for LAN communications, in order to provide services for the session layer (fifth layer in the OSI model).

A few years later, it was adopted by Microsoft for their networking over LAN, and then it was migrated for working over TCP/IP (NetBIOS over TCP/IP—NBT), which is discussed in RFC 1001 and 1002.

2.2.1.1 NetBIOS

In today's networks, NetBIOS provides three services:

- Name service (port 137) for name registration and name to IP address resolution. Also referred to as NetBIOS-NS.
- Datagram distribution service (port 138) for service announcements by clients and servers. Also referred to as NetBIOS-DGM.
- Session service (port 139) for session negotiation between hosts. This is used for accessing files, opening directories, and so on. Also referred to as NetBIOS-SSN.

2.2.1.1 NetBIOS

NBNS is the service that registers and translates names to IP addresses. The Microsoft environment was implemented with WINS, and as most networks did not use it, it was later replaced by DNS. It works over UDP port 137.

OUTLINE

2.2.1.1 NetBIOS

NBDS is used for service announcements by clients and servers. With this service, devices on the network announce their names, services that they can provide to other devices on the network, and how to connect to these services. It works over UDP port 138

2.2.1.1 NetBIOS

NBSS is used to establish sessions between hosts, open or save files, and execute remote files and other sessions over the network. It works over TCP port 139.

2.2.1.1 NetBIOS

There are additional protocols, such as **Server Message Block (SMB)**, that run over NBSS for transaction operations and over NBDS for service announcement, spools for printer requests, and several others.

2.2.1.2 SMB

SMB is a protocol that is used for browsing directories, copying files, accessing services such as printers, and several other operations over the network.

Common Internet File System (CIFS) is a form, or flavor, of SMB.

2.2.1.2 SMB

SMB runs on top of the session layer protocols such as NetBIOS as originally designed or can also run directly over TCP port 445.

2.2.1.2 SMB

SMB 2.0 was introduced by Microsoft in 2006 in Windows Vista, with the intention of reducing the commands and subcommands required in the SMB 1.0 protocol.

Even though SMB 2.0 came out as a proprietary protocol, Microsoft published the standard to allow other systems to interoperate with their operating systems

2.2.1.2 SMB

SMB 2.1 was released with Windows 7 and Server 2008 R2 with performance improvements compared to SMB 2.0.

OUTLINE

2.2.1.2 SMB

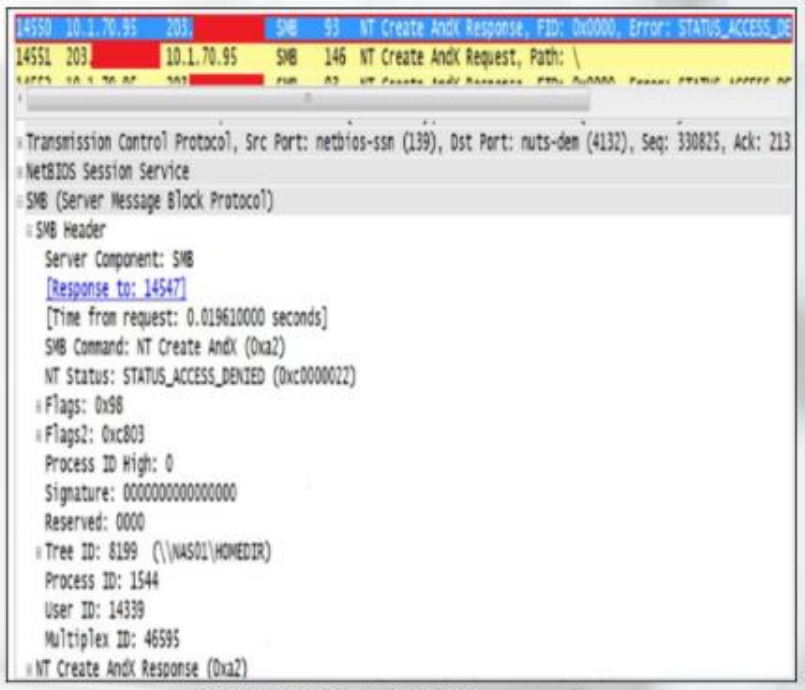
SMB 3.0 (earlier referred to as SMB 2.2) was introduced with Windows 8 and Server 2012. SMM 3.0 has significant performance improvements (compared to earlier releases) in order to support virtualization occurring in the data center computing environment.

2.2.1.2 SMB

Detection

SMB works in a client-server model, where the client makes specific requests to the server, and based on the requests, the server responds accordingly. Most of the requests are related to accessing filesystems, while other forms of requests involve Inter-Process Communication (IPC).

Code 0 means STATUS_OK, which implies that everything works fine and there is no problem. Any other code should be examined.



STATUS_ACCESS_DENIED SMB error example

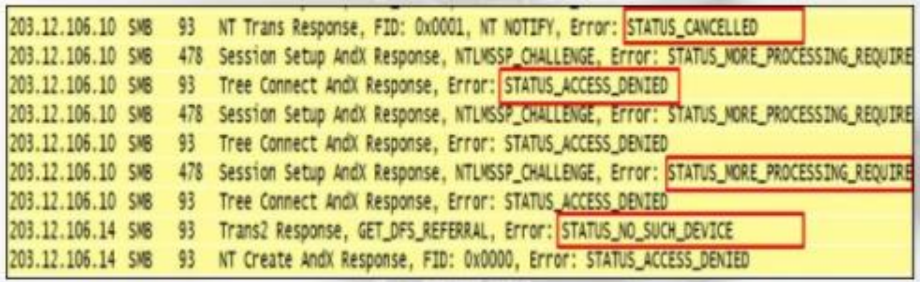
OUTLINE

2.2.1.2 SMB

Detection

SMB works in a client-server model, where the client makes specific requests to the server, and based on the requests, the server responds accordingly. Most of the requests are related to accessing filesystems, while other forms of requests involve Inter-Process Communication (IPC).

Code 0 means STATUS_OK, which implies that everything works fine and there is no problem. Any other code should be examined.



SMB errors you should examine

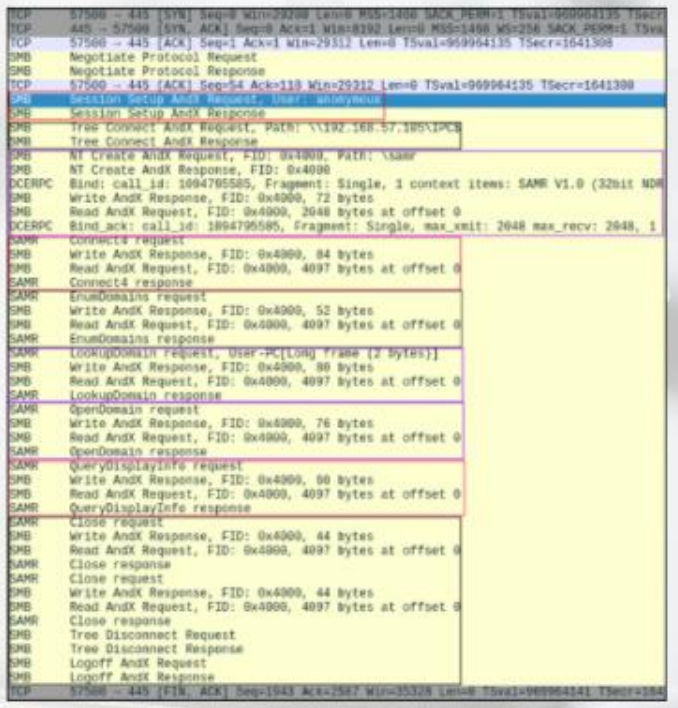
OUTLINE

2.2.1.2 SMB

Detection

Certain versions of Windows allowed for anonymous and passwordless authentication. Such a connection is often referred to as a NULL session. A NULL session may be limited in terms of privileges, but it could be used to execute various RPC calls and subsequently perform information gathering or user enumeration.

On your right, you see traffic generated by Nmap's *smb-enum-users* script. Notice the **successful** attempt to identify if a NULL session is possible. Also notice the RPC calls inside the subsequent rectangles, that were run to provide the attacker with a user list.



OUTLINE

2.2.1.3 MSRPC

The RPC (Remote Procedure Call) mechanism allows an application to seamlessly invoke remote procedures, as if these procedures were executed locally.

There are two main implementations of the RPC mechanism:

- ONC RPC
- DCE RPC

https://www.ietf.org/rfc/rfc1831.txt
http://pubs.opengroup.org/onlinepubs/9629399/

2.2.1.3 MSRPC

MSRPC is the Microsoft implementation of the DCE RPC mechanism. In particular, Microsoft added new transport protocols for DCE RPC, which use named pipes carried into the SMB protocol.

File operations utilize SMB/CIFS, whereas administrative operations, resource management operations etc. utilize MSRPC.

OUTLINE

2.2.1.3 MSRPC

There are multiple MSRPC implementations:

- RCP over SMB (this is an example RPC over SMB traffic)
- DCOM (RPC directly over TCP/UDP) [TCP/UDP port 135]
- RPC over HTTP or HTTPS [TCP/UDP port 593]

The RPC Endpoint Mapper comes into play in those implementations

2.2.1.3.1 MSRPC Over TCP Session

There are multiple MSRPC implementations:

- RCP over SMB (this is an example RPC over SMB traffic)
- **DCOM** **(RPC directly over TCP/UDP) [TCP/UDP port 135]**
- RPC over HTTP or HTTPS [TCP/UDP port 593]

The RPC Endpoint Mapper comes into play in those implementations

2.2.1.3.1 MSRPC Over TCP Session

TCP/IP RPC services listen on dynamic TCP or UDP ports. Thus, to reach a given RPC service, identified by its interface identifier (UUID), a port mapping service is necessary.

The portmapper service is an RPC service listening on different endpoints.

2.2.1.3.1 MSRPC Over TCP Session

Typically, to discover the port on which a given RPC service can be reached, a client will establish a TCP connection to port 135, asking for the port allocated to a given RPC service.

Then, the client closes the connection to port 135 and opens a new connection to the port returned by the portmapper service.

2.2.1.3.1 MSRPC Over TCP Session

Consider the *schannel_win7-member_to_win2k3-dc.pcap file* found in this module's resources, to see how the MSRPC over TCP session implementation looks like on the wire.

Note: Study the pcap file from packet #129 onwards.

2.2.2 HTTP(S)

Everyday, we browse numerous websites. While doing so, we are generating HTTP(S) traffic.

It is time we give the HTTP and HTTPS protocols a better look...

2.2.2.1 HTTP

A few things to remember about HTTP:

- HTTP traffic consists of a series of requests and responses known as **messages**.
  - Client will make a request & server will respond.
  - HTTP responses include a **3 digit status code**.
- HTTP messages include a **message header** and **body**.
- HTTP uses **methods** to perform various operations.
  - 8 HTTP methods defined in RFC 2616.
  - Not all methods will be permitted by web server.

https://www.ietf.org/rfc/rfc2616.txt

2.2.2.1 HTTP

Some facts to help distinguish normal and suspicious HTTP traffic

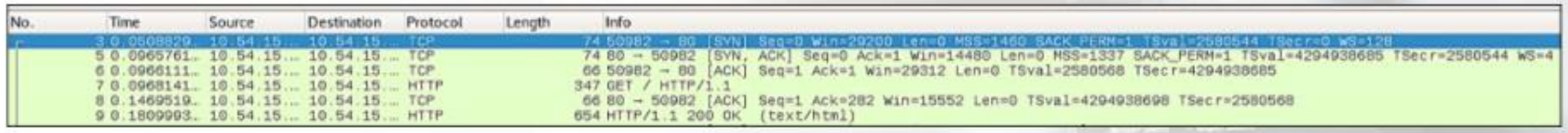
Normal HTTP Traffic	Suspicious HTTP Traffic
Port 80, TCP Port 8080, TCP (used as alternate) Port 8088, TCP (used as alternate)	Malicious binaries (backdoors), scripts, web shells, etc. will use this port because typically in all corporate environments the port is open.
Plaintext traffic	If the traffic is encrypted then most likely it's being used for malicious traffic. Malicious traffic can be in plaintext as well.
Web server typically in FQDN format.	Server will point to an IP address instead of FQDN format.

2.2.2.1 HTTP

Let’s now see how normal HTTP traffic looks like.

OUTLINE

2.2.2.1 HTTP

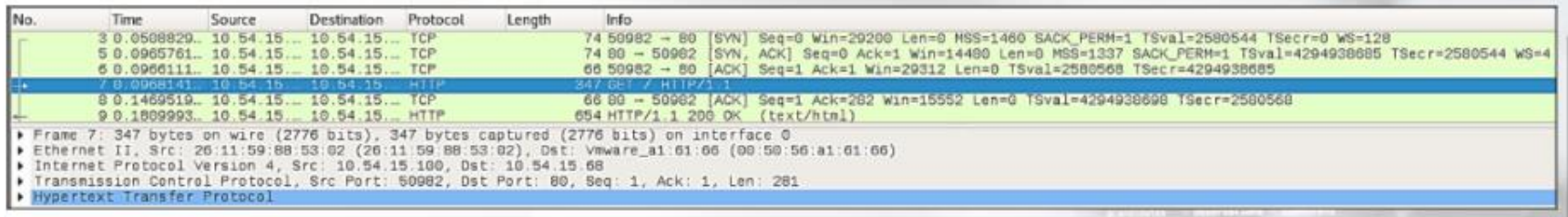


No.	Time	Source	Destination	Protocol	Length	Info
3	0.0508829..	10.54.15....	10.54.15....	TCP	74	50982 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=2580544 TSecr=0 WS=128
5	0.0965761..	10.54.15....	10.54.15....	TCP	74	80 → 50982 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=4294938685 TSecr=2580544 WS=4
6	0.0966111..	10.54.15....	10.54.15....	TCP	66	50982 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=2580568 TSecr=4294938685
7	0.0968141..	10.54.15....	10.54.15....	HTTP	347	GET / HTTP/1.1
8	0.1469519..	10.54.15....	10.54.15....	TCP	66	80 → 50982 [ACK] Seq=1 Ack=282 Win=15552 Len=0 TSval=4294938698 TSecr=2580568
9	0.1809993..	10.54.15....	10.54.15....	HTTP	654	HTTP/1.1 200 OK (text/html)

Here is a brief summary concerning the image above:

- We are seeing 6 packets (4 relating to TCP and 2 relating to HTTP).
- Packets 3-6 is the **TCP Handshake**. HTTP relies on TCP for reliability.
- Packet 7 we notice a **HTTP method** (GET).
- Packet 9 we notice a **HTTP response code** (200 OK).

2.2.2.1 HTTP



No.	Time	Source	Destination	Protocol	Length	Info
3	0.0508829..	10.54.15....	10.54.15....	TCP	74	50982 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=2580544 TSecr=0 WS=128
5	0.0965761..	10.54.15....	10.54.15....	TCP	74	80 → 50982 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=4294938685 TSecr=2580544 WS=4
6	0.0966111..	10.54.15....	10.54.15....	TCP	66	50982 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=2580568 TSecr=4294938685
7	0.0968141..	10.54.15....	10.54.15....	HTTP	347	GET / HTTP/1.1
8	0.1469519..	10.54.15....	10.54.15....	TCP	66	80 → 50982 [ACK] Seq=1 Ack=282 Win=15552 Len=0 TSval=4294938698 TSecr=2580568
9	0.1809993..	10.54.15....	10.54.15....	HTTP	654	HTTP/1.1 200 OK (text/html)

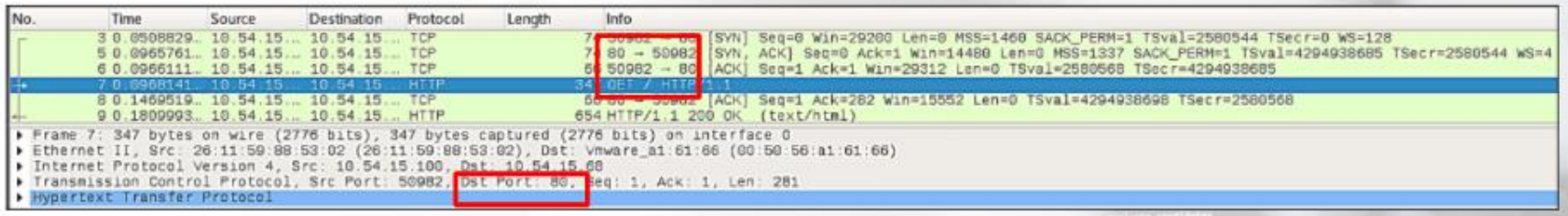
▸ Frame 7: 347 bytes on wire (2776 bits), 347 bytes captured (2776 bits) on interface 0
▸ Ethernet II, Src: 26:11:59:88:53:02 (26:11:59:88:53:02), Dst: vmware_a1:61:66 (00:50:56:a1:61:66)
▸ Internet Protocol Version 4, Src: 10.54.15.100, Dst: 10.54.15.68
▸ Transmission Control Protocol, Src Port: 50982, Dst Port: 80, Seq: 1, Ack: 1, Len: 281
▸ Hypertext Transfer Protocol

In the image above we see the packet information as it pertains the different layers of the OSI model.

- Ethernet II = MAC Addresses (SRC, DST)
- Internet Protocol Version 4 = IP Address (SRC, DST)
- Transmission Control Protocol = TCP (SRC PORT, DST PORT)
- Hypertext Transfer Protocol = HTTP

OUTLINE

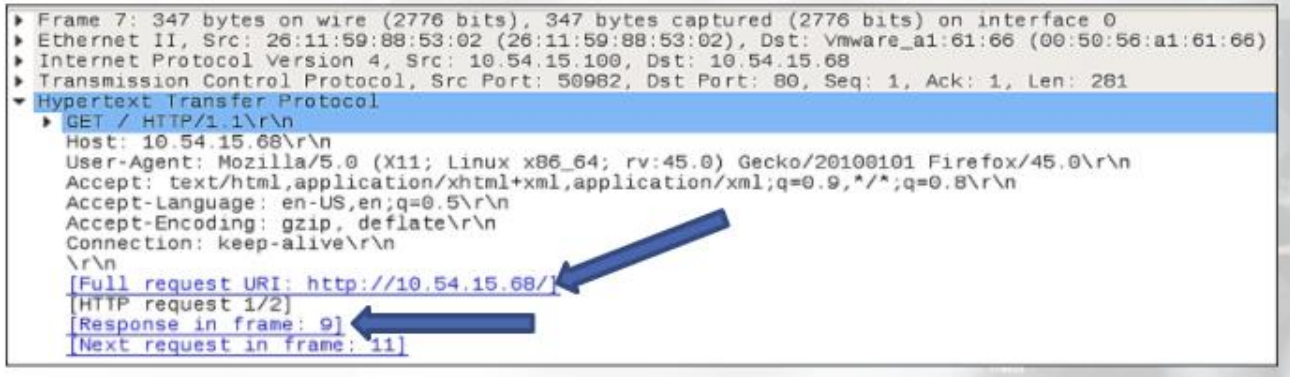
2.2.2.1 HTTP



So far we can tell that the traffic is using an expected port, port 80. Remember that this port doesn't necessarily have to be port 80. An organization can decide to use a different port altogether but we know the standard port is 80 and if it's port 80 then we're expecting web traffic.

OUTLINE

2.2.2.1 HTTP

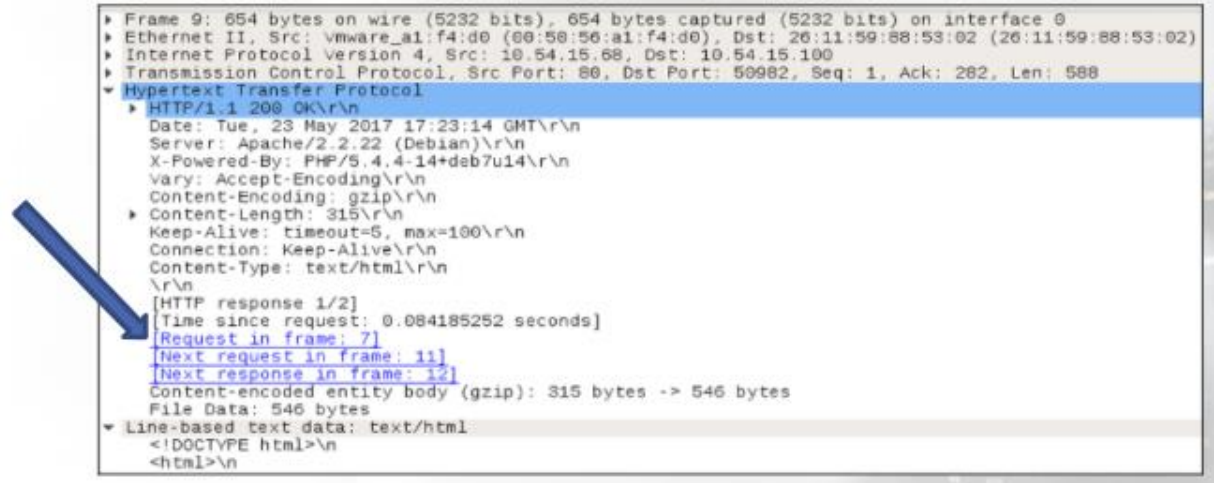


Here, we're looking at the HTTP section of the packet details. The HTTP method is **GET** and the host is **not** in FQDN format. The *http://IP* format should alarm you, but in this case its pointing to an internal server and that is normal behavior in corporate environments. The source host has an IP of 10.54.15.100.

If we double click the link, **[Response in frame: 9]**, in the HTTP section of the packet details of packet 7 we'll jump to packet 9 which contains the packet details of the **HTTP response** to the **HTTP request**.

OUTLINE

2.2.2.1 HTTP



Within this packet we can do the same, jump back to packet 7 using the link **[Request in frame: 7]**.

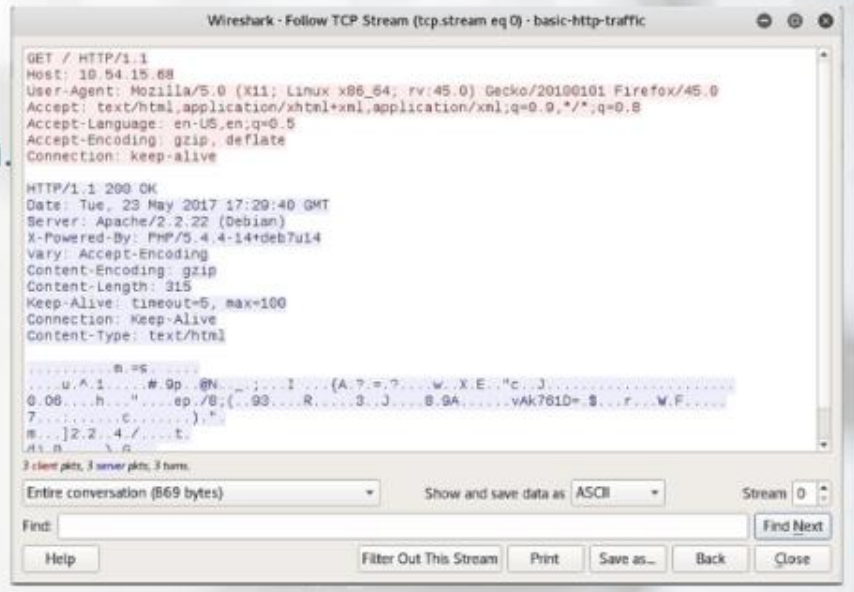
2.2.2.1 HTTP

```
▼ Line-based text data: text/html
    <!DOCTYPE html>\n
    <html>\n
    \n
    <head>\n
    \n
      <meta charset="UTF-8">\n
    \n
      <title>Log-in - login.labs</title>\n
    \n
        <link rel="stylesheet" href="css/style.css" media="screen" type="text/css" />\n
    \n
    </head>\n
    \n
    <body>\n
    \n
      <div class="login-card">\n
        <h1>Log-in</h1><br>\n
      <form method="post" action="login.php">\n
        <input type="text" name="user" autocomplete="off" placeholder="Username">\n
        <input type="password" name="pass" placeholder="Password">\n
        <input type="submit" name="login" class="login login-submit" value="login">\n
      </form>\n
    \n
    </div>\n
    \n
    </body>\n
    \n
    </html>\n
```

Above we notice a section called **Line-based text data: text/html** within the packet details. We can clearly see that the packet is returning a login page for the server.

2.2.2.1 HTTP

The same information can be obtained by right-clicking packet #7 or packet #9 and selecting **Follow -> Follow TCP Stream**.

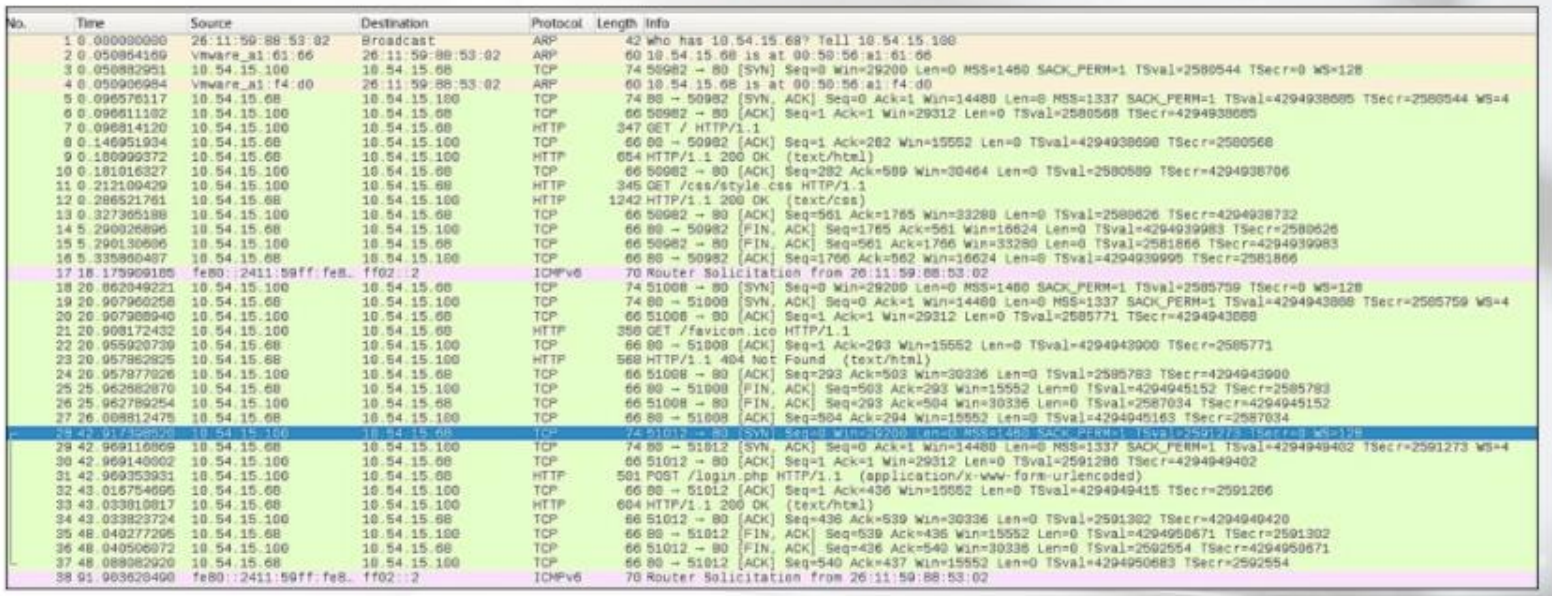


Here we see the same details but only information from the packet that pertains to HTTP.

Now remember that HTTP traffic is supposed to be in cleartext, which we have seen so far. Let's also look at the packet stream after logging into the internal server to see credentials in cleartext.

2.2.2.1 HTTP

Before looking at cleartext credentials let's test our packet analysis skills.
How many TCP streams are there in the packet capture below?



No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	26:11:59:88:53:02	Broadcast	ARP	42	Who has 10.54.15.68? Tell 10.54.15.100
2	0.050864169	Vmware_a1:61:66	26:11:59:88:53:02	ARP	60	10.54.15.68 is at 00:50:56:a1:61:66
3	0.050882951	10.54.15.100	10.54.15.68	TCP	74	50982 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=2580544 TSecr=0 WS=128
4	0.050906984	Vmware_a1:f4:d0	26:11:59:88:53:02	ARP	60	10.54.15.68 is at 00:50:56:a1:f4:d0
5	0.096576117	10.54.15.68	10.54.15.100	TCP	74	80 → 50982 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=4294938685 TSecr=2580544 WS=4
6	0.096611102	10.54.15.100	10.54.15.68	TCP	66	50982 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=2580568 TSecr=4294938685
7	0.096814120	10.54.15.100	10.54.15.68	HTTP	347	GET / HTTP/1.1
8	0.146951934	10.54.15.68	10.54.15.100	TCP	66	80 → 50982 [ACK] Seq=1 Ack=282 Win=15552 Len=0 TSval=4294938690 TSecr=2580568
9	0.180999372	10.54.15.68	10.54.15.100	HTTP	654	HTTP/1.1 200 OK (text/html)
10	0.181016327	10.54.15.100	10.54.15.68	TCP	66	50982 → 80 [ACK] Seq=282 Ack=589 Win=30464 Len=0 TSval=2580589 TSecr=4294938706
11	0.212109429	10.54.15.100	10.54.15.68	HTTP	345	GET /css/style.css HTTP/1.1
12	0.286521761	10.54.15.68	10.54.15.100	HTTP	1242	HTTP/1.1 200 OK (text/css)
13	0.327365188	10.54.15.100	10.54.15.68	TCP	66	50982 → 80 [ACK] Seq=561 Ack=1765 Win=33280 Len=0 TSval=2580626 TSecr=4294938732
14	5.290026896	10.54.15.68	10.54.15.100	TCP	66	80 → 50982 [FIN, ACK] Seq=1765 Ack=561 Win=16624 Len=0 TSval=4294939983 TSecr=2580626
15	5.290130606	10.54.15.100	10.54.15.68	TCP	66	50982 → 80 [FIN, ACK] Seq=561 Ack=1766 Win=33280 Len=0 TSval=2581866 TSecr=4294939983
16	5.335860487	10.54.15.68	10.54.15.100	TCP	66	80 → 50982 [ACK] Seq=1766 Ack=562 Win=16624 Len=0 TSval=4294939995 TSecr=2581866
17	18.175909185	fe80::2411:59ff:fe8..	ff02::2	ICMPv6	70	Router Solicitation from 26:11:59:88:53:02
18	20.862049221	10.54.15.100	10.54.15.68	TCP	74	51008 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=2585759 TSecr=0 WS=128
19	20.907960258	10.54.15.68	10.54.15.100	TCP	74	80 → 51008 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=4294943868 TSecr=2585759 WS=4
20	20.907988940	10.54.15.100	10.54.15.68	TCP	66	51008 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=2585771 TSecr=4294943868
21	20.908172432	10.54.15.100	10.54.15.68	HTTP	358	GET /favicon.ico HTTP/1.1
22	20.955920739	10.54.15.68	10.54.15.100	TCP	66	80 → 51008 [ACK] Seq=1 Ack=293 Win=15552 Len=0 TSval=4294943900 TSecr=2585771
23	20.957862825	10.54.15.68	10.54.15.100	HTTP	568	HTTP/1.1 404 Not Found (text/html)
24	20.957877026	10.54.15.100	10.54.15.68	TCP	66	51008 → 80 [ACK] Seq=293 Ack=503 Win=30336 Len=0 TSval=2585783 TSecr=4294943900
25	25.962882870	10.54.15.68	10.54.15.100	TCP	66	80 → 51008 [FIN, ACK] Seq=503 Ack=293 Win=15552 Len=0 TSval=4294945152 TSecr=2585783
26	25.962789254	10.54.15.100	10.54.15.68	TCP	66	51008 → 80 [FIN, ACK] Seq=293 Ack=504 Win=30336 Len=0 TSval=2587034 TSecr=4294945152
27	26.008812475	10.54.15.68	10.54.15.100	TCP	66	80 → 51008 [ACK] Seq=504 Ack=294 Win=15552 Len=0 TSval=4294945163 TSecr=2587034
28	42.917398800	10.54.15.100	10.54.15.68	TCP	74	51012 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=2591273 TSecr=0 WS=128
29	42.969116869	10.54.15.68	10.54.15.100	TCP	74	80 → 51012 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=4294949402 TSecr=2591273 WS=4
30	42.969140002	10.54.15.100	10.54.15.68	TCP	66	51012 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=2591286 TSecr=4294949402
31	42.969353931	10.54.15.100	10.54.15.68	HTTP	501	POST /login.php HTTP/1.1 (application/x-www-form-urlencoded)
32	43.016754696	10.54.15.68	10.54.15.100	TCP	66	80 → 51012 [ACK] Seq=1 Ack=436 Win=15552 Len=0 TSval=4294949415 TSecr=2591286
33	43.033010817	10.54.15.68	10.54.15.100	HTTP	604	HTTP/1.1 200 OK (text/html)
34	43.033823724	10.54.15.100	10.54.15.68	TCP	66	51012 → 80 [ACK] Seq=436 Ack=539 Win=30336 Len=0 TSval=2591302 TSecr=4294949420
35	48.040277295	10.54.15.68	10.54.15.100	TCP	66	80 → 51012 [FIN, ACK] Seq=539 Ack=436 Win=15552 Len=0 TSval=4294950671 TSecr=2591302
36	48.040506072	10.54.15.100	10.54.15.68	TCP	66	51012 → 80 [FIN, ACK] Seq=436 Ack=540 Win=30336 Len=0 TSval=2592554 TSecr=4294950671
37	48.088082920	10.54.15.68	10.54.15.100	TCP	66	80 → 51012 [ACK] Seq=540 Ack=437 Win=15552 Len=0 TSval=4294950683 TSecr=2592554
38	91.903628490	fe80::2411:59ff:fe8..	ff02::2	ICMPv6	70	Router Solicitation from 26:11:59:88:53:02

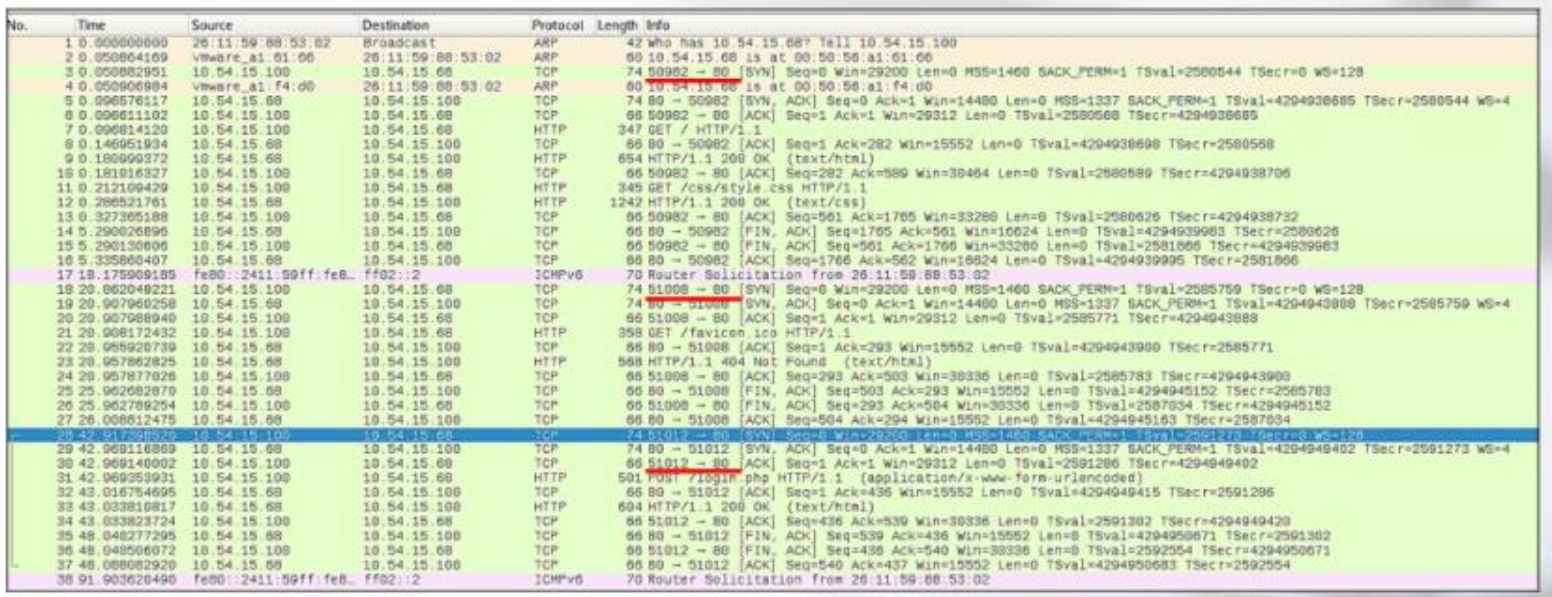
2.2.2.1 HTTP

There are a couple ways to determine this within the Wireshark GUI:

1. Look at the TCP packets then look at source ports and destination ports.
2. Use display filters and increment the numbers to show a particular TCP stream until nothing is displayed.
3. Select **Statistics** -> **Conversations** and then click the **TCP tab**.
4. In the Follow TCP Stream window, at the bottom right, you can navigate through the different streams that Wireshark detected.

2.2.2.1 HTTP

1. From the packet capture we can see different source ports, so, each different source port will have its own TCP Handshake followed by its corresponding traffic.

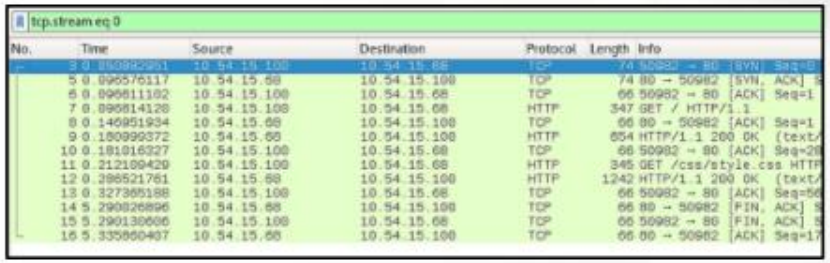


No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	26:11:59:88:53:02	Broadcast	ARP	42	Who has 10.54.15.68? Tell 10.54.15.100
2	0.050864169	vmware_a1:61:66	26:11:59:88:53:02	ARP	60	10.54.15.68 is at 00:50:56:a1:61:66
3	0.050882951	10.54.15.100	10.54.15.68	TCP	74	50982 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=2580544 TSecr=0 WS=128
4	0.050906984	vmware_a1:f4:d0	26:11:59:88:53:02	ARP	60	10.54.15.68 is at 00:50:56:a1:f4:d0
5	0.096576117	10.54.15.68	10.54.15.100	TCP	74	80 → 50982 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=4294938685 TSecr=2580544 WS=4
6	0.096611102	10.54.15.100	10.54.15.68	TCP	66	50982 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=2580568 TSecr=4294938685
7	0.096814120	10.54.15.100	10.54.15.68	HTTP	347	GET / HTTP/1.1
8	0.146951934	10.54.15.68	10.54.15.100	TCP	66	80 → 50982 [ACK] Seq=1 Ack=282 Win=15552 Len=0 TSval=4294938698 TSecr=2580568
9	0.180999372	10.54.15.68	10.54.15.100	HTTP	654	HTTP/1.1 200 OK (text/html)
10	0.181016327	10.54.15.100	10.54.15.68	TCP	66	50982 → 80 [ACK] Seq=282 Ack=589 Win=30464 Len=0 TSval=2580589 TSecr=4294938706
11	0.212109429	10.54.15.100	10.54.15.68	HTTP	345	GET /css/style.css HTTP/1.1
12	0.286521761	10.54.15.68	10.54.15.100	HTTP	1242	HTTP/1.1 200 OK (text/css)
13	0.327365188	10.54.15.100	10.54.15.68	TCP	66	50982 → 80 [ACK] Seq=561 Ack=1765 Win=33280 Len=0 TSval=2580626 TSecr=4294938732
14	5.290026896	10.54.15.68	10.54.15.100	TCP	66	80 → 50982 [FIN, ACK] Seq=1765 Ack=561 Win=16624 Len=0 TSval=4294939983 TSecr=2580626
15	5.290130606	10.54.15.100	10.54.15.68	TCP	66	50982 → 80 [FIN, ACK] Seq=561 Ack=1766 Win=33280 Len=0 TSval=2581866 TSecr=4294939983
16	5.335860407	10.54.15.68	10.54.15.100	TCP	66	80 → 50982 [ACK] Seq=1766 Ack=562 Win=16624 Len=0 TSval=4294939995 TSecr=2581866
17	18.175909185	fe80::2411:59ff:fe8…	ff02::2	ICMPv6	70	Router Solicitation from 26:11:59:88:53:02
18	20.862049221	10.54.15.100	10.54.15.68	TCP	74	51008 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=2585759 TSecr=0 WS=128
19	20.907960258	10.54.15.68	10.54.15.100	TCP	74	80 → 51008 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=4294943888 TSecr=2585759 WS=4
20	20.907988940	10.54.15.100	10.54.15.68	TCP	66	51008 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=2585771 TSecr=4294943888
21	20.908172432	10.54.15.100	10.54.15.68	HTTP	358	GET /favicon.ico HTTP/1.1
22	20.955920739	10.54.15.68	10.54.15.100	TCP	66	80 → 51008 [ACK] Seq=1 Ack=293 Win=15552 Len=0 TSval=4294943900 TSecr=2585771
23	20.957862825	10.54.15.68	10.54.15.100	HTTP	568	HTTP/1.1 404 Not Found (text/html)
24	20.957877026	10.54.15.100	10.54.15.68	TCP	66	51008 → 80 [ACK] Seq=293 Ack=503 Win=30336 Len=0 TSval=2585783 TSecr=4294943900
25	25.962682870	10.54.15.68	10.54.15.100	TCP	66	80 → 51008 [FIN, ACK] Seq=503 Ack=293 Win=15552 Len=0 TSval=4294945152 TSecr=2585783
26	25.962789254	10.54.15.100	10.54.15.68	TCP	66	51008 → 80 [FIN, ACK] Seq=293 Ack=504 Win=30336 Len=0 TSval=2587034 TSecr=4294945152
27	26.008612475	10.54.15.68	10.54.15.100	TCP	66	80 → 51008 [ACK] Seq=504 Ack=294 Win=15552 Len=0 TSval=4294945163 TSecr=2587034
28	42.912598820	10.54.15.100	10.54.15.68	TCP	74	51012 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=2591273 TSecr=0 WS=128
29	42.960116869	10.54.15.68	10.54.15.100	TCP	74	80 → 51012 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=4294949402 TSecr=2591273 WS=4
30	42.960140002	10.54.15.100	10.54.15.68	TCP	66	51012 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=2591286 TSecr=4294949402
31	42.969353931	10.54.15.100	10.54.15.68	HTTP	501	POST /login.php HTTP/1.1 (application/x-www-form-urlencoded)
32	43.016754695	10.54.15.68	10.54.15.100	TCP	66	80 → 51012 [ACK] Seq=1 Ack=436 Win=15552 Len=0 TSval=4294949415 TSecr=2591296
33	43.033810817	10.54.15.68	10.54.15.100	HTTP	604	HTTP/1.1 200 OK (text/html)
34	43.033823724	10.54.15.100	10.54.15.68	TCP	66	51012 → 80 [ACK] Seq=436 Ack=539 Win=30336 Len=0 TSval=2591302 TSecr=4294949420
35	48.048277295	10.54.15.68	10.54.15.100	TCP	66	80 → 51012 [FIN, ACK] Seq=539 Ack=436 Win=15552 Len=0 TSval=4294950671 TSecr=2591302
36	48.048506072	10.54.15.100	10.54.15.68	TCP	66	51012 → 80 [FIN, ACK] Seq=436 Ack=540 Win=30336 Len=0 TSval=2592554 TSecr=4294950671
37	48.088082920	10.54.15.68	10.54.15.100	TCP	66	80 → 51012 [ACK] Seq=540 Ack=437 Win=15552 Len=0 TSval=4294950683 TSecr=2592554
38	91.903620490	fe80::2411:59ff:fe8…	ff02::2	ICMPv6	70	Router Solicitation from 26:11:59:88:53:02

OUTLINE

2.2.2.1 HTTP

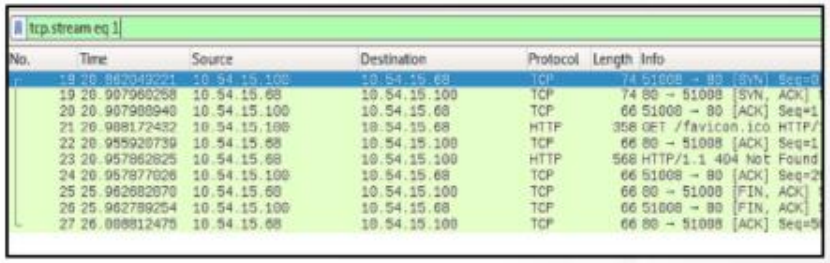
2. Another way this can be done is by using a display filter and increment the number of the TCP Stream. You will identify a non-valid TCP Stream by the non-visible packets.


tcp.stream eq 0

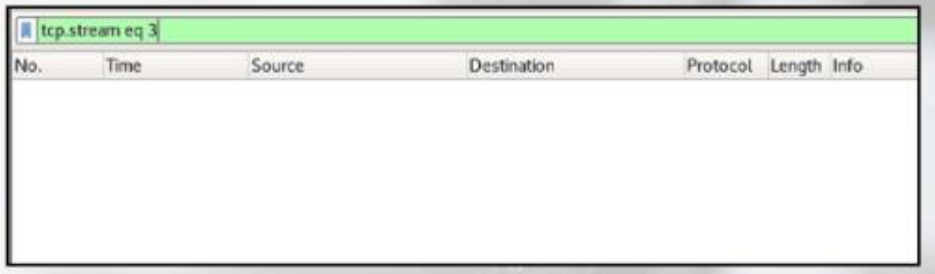
No.	Time	Source	Destination	Protocol	Length	Info
4	0.096576117	10.54.15.68	10.54.15.100	TCP	74	80 → 50982 [SYN, ACK]
5	0.096611102	10.54.15.100	10.54.15.68	TCP	66	50982 → 80 [ACK] Seq=1
7	0.096814128	10.54.15.100	10.54.15.68	HTTP	347	GET / HTTP/1.1
8	0.146951934	10.54.15.68	10.54.15.100	TCP	66	80 → 50982 [ACK] Seq=1
9	0.180999372	10.54.15.68	10.54.15.100	HTTP	854	HTTP/1.1 200 OK (text/
10	0.181016327	10.54.15.100	10.54.15.68	TCP	66	50982 → 80 [ACK] Seq=28
11	0.212109429	10.54.15.100	10.54.15.68	HTTP	345	GET /css/style.css HTTP
12	0.286521761	10.54.15.68	10.54.15.100	HTTP	1242	HTTP/1.1 200 OK (text/
13	0.327365188	10.54.15.100	10.54.15.68	TCP	66	50982 → 80 [ACK] Seq=56
14	5.290826896	10.54.15.68	10.54.15.100	TCP	66	80 → 50982 [FIN, ACK]
15	5.290136606	10.54.15.100	10.54.15.68	TCP	66	50982 → 80 [FIN, ACK]
16	5.335860407	10.54.15.68	10.54.15.100	TCP	66	80 → 50982 [ACK] Seq=17


tcp.stream eq 2

No.	Time	Source	Destination	Protocol	Length	Info
29	42.969116869	10.54.15.68	10.54.15.100	TCP	74	80 → 51012 [SYN, ACK]
30	42.969140002	10.54.15.100	10.54.15.68	TCP	66	51012 → 80 [ACK] Seq=1
31	42.969353931	10.54.15.100	10.54.15.68	HTTP	501	POST /login.php HTTP/1
32	43.016754695	10.54.15.68	10.54.15.100	TCP	66	80 → 51012 [ACK] Seq=1
33	43.033810017	10.54.15.68	10.54.15.100	HTTP	604	HTTP/1.1 200 OK (text
34	43.033823724	10.54.15.100	10.54.15.68	TCP	66	51012 → 80 [ACK] Seq=43
35	48.040277295	10.54.15.68	10.54.15.100	TCP	66	80 → 51012 [FIN, ACK]
36	48.040506072	10.54.15.100	10.54.15.68	TCP	66	51012 → 80 [FIN, ACK]
37	48.088082920	10.54.15.68	10.54.15.100	TCP	66	80 → 51012 [ACK] Seq=5


tcp.stream eq 1

No.	Time	Source	Destination	Protocol	Length	Info
19	20.907960268	10.54.15.68	10.54.15.100	TCP	74	80 → 51008 [SYN, ACK]
20	20.907988940	10.54.15.100	10.54.15.68	TCP	66	51008 → 80 [ACK] Seq=1
21	20.908172432	10.54.15.100	10.54.15.68	HTTP	358	GET /favicon.ico HTTP/
22	20.955920739	10.54.15.68	10.54.15.100	TCP	66	80 → 51008 [ACK] Seq=1
23	20.957862825	10.54.15.68	10.54.15.100	HTTP	568	HTTP/1.1 404 Not Found
24	20.957877026	10.54.15.100	10.54.15.68	TCP	66	51008 → 80 [ACK] Seq=2
25	25.962682070	10.54.15.68	10.54.15.100	TCP	66	80 → 51008 [FIN, ACK]
26	25.962789254	10.54.15.100	10.54.15.68	TCP	66	51008 → 80 [FIN, ACK]
27	26.008812475	10.54.15.68	10.54.15.100	TCP	66	80 → 51008 [ACK] Seq=5


tcp.stream eq 3

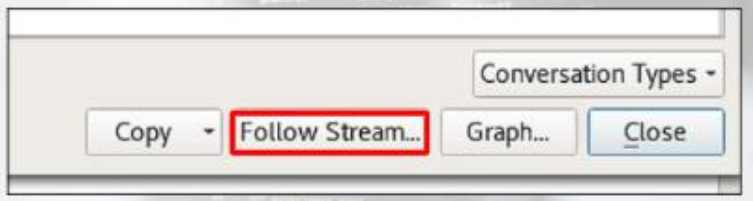
No.	Time	Source	Destination	Protocol	Length	Info

2.2.2.1 HTTP

3. Under the TCP tab in Conversations we can see there are 3 TCP Streams. From here we can select a stream and choose Follow Stream from bottom right corner.

Ethernet · 4 | IPv4 · 1 | IPv6 · 1 | TCP · 3 | UDP

Address A	Port A	Address B	Port B	Packets	Bytes	Packets A → B	Bytes A → B	Packets B → A	Bytes B → A	Rel Start	Duration	Bits/s A → B	Bits/s B → A
10.54.15.100	50982	10.54.15.68	80	13	3198	7	1030	6	2168	0.050883	5.2850	1559	
10.54.15.100	51008	10.54.15.68	80	10	1470	5	630	5	840	20.862049	5.1468	979	
10.54.15.100	51012	10.54.15.68	80	10	1649	5	773	5	876	42.917399	5.1707	1195	

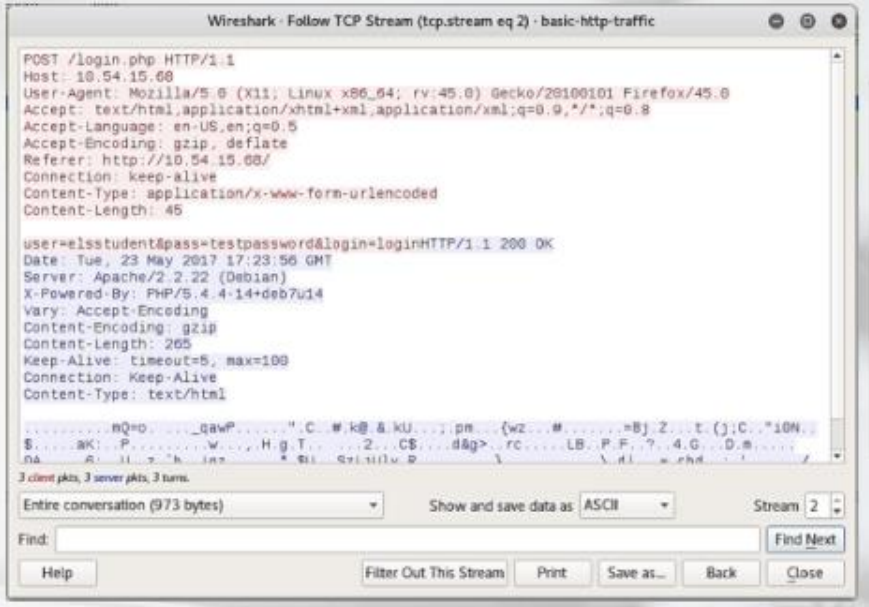


OUTLINE

2.2.2.1 HTTP

4. At the bottom right we can see a box, there we can select the TCP stream we would like to view.

By inspecting each of the TCP Streams we can see from the image that the 3rd
TCP Stream (zero indexed) will contain the cleartext credentials. This is indeed valid HTTP traffic and typical HTTP behavior.



OUTLINE

2.2.2.1.1 Malicious HTTP Traffic Example

Now we'll look at an example of suspicious traffic via port 80 using Wireshark and the techniques already demonstrated.

Remember the tips regarding normal HTTP traffic:

- Typically port 80.
- Cleartext web-based traffic.
- Hosts are accessed using FQDNs instead of IP addresses.

Shared example with the THP course

2.2.2.1.1 Malicious HTTP Traffic Example

Detection

Before we dive deeper, let's take a moment to give the traffic capture below a look and see if we can spot anything that might look odd.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	10.124.211.200	10.124.211.96	TCP	74	33020 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=125613 TSecr=0 WS=128
2	0.056720	10.124.211.96	10.124.211.200	TCP	74	80 → 33020 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=222206 TSecr=125613 WS=4
3	0.056747	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=125627 TSecr=222206
4	0.056824	10.124.211.200	10.124.211.96	HTTP	349	GET / HTTP/1.1
5	0.133531	10.124.211.96	10.124.211.200	TCP	66	80 → 33020 [ACK] Seq=1 Ack=284 Win=15552 Len=0 TSval=222223 TSecr=125627
6	0.133549	10.124.211.96	10.124.211.200	HTTP	101	[TCP Previous segment not captured] Continuation
7	0.133556	10.124.211.200	10.124.211.96	TCP	78	[TCP Window Update] 33020 → 80 [ACK] Seq=284 Ack=1 Win=30336 Len=0 TSval=125647 TSecr=222223 SLE=1326 SRE=1361
8	0.156230	10.124.211.96	10.124.211.200	TCP	1391	[TCP Out-Of-Order] 80 → 33020 [ACK] Seq=1 Ack=284 Win=15552 Len=1325 TSval=222224 TSecr=125627
9	0.156259	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=284 Ack=1361 Win=33280 Len=0 TSval=125652 TSecr=222224
10	3.481485	10.124.211.200	10.124.211.96	HTTP	389	GET /news.php HTTP/1.1
11	3.552272	10.124.211.96	10.124.211.200	TCP	1391	[TCP segment of a reassembled PDU]
12	3.552305	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=607 Ack=2686 Win=36096 Len=0 TSval=126501 TSecr=223083
13	3.552578	10.124.211.96	10.124.211.200	HTTP	1353	HTTP/1.1 200 OK (text/html)
14	3.552589	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=607 Ack=3973 Win=39040 Len=0 TSval=126501 TSecr=223083
15	5.968993	10.124.211.200	10.124.211.96	HTTP	410	GET /newsdetails.php?id=26 HTTP/1.1
16	6.020439	10.124.211.96	10.124.211.200	TCP	1391	[TCP segment of a reassembled PDU]
17	6.020461	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=951 Ack=5298 Win=41856 Len=0 TSval=127118 TSecr=223701
18	6.020470	10.124.211.96	10.124.211.200	HTTP	83	HTTP/1.1 200 OK (text/html)
19	6.020471	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=951 Ack=5315 Win=41856 Len=0 TSval=127118 TSecr=223701
20	9.453656	10.124.211.200	10.124.211.96	HTTP	373	GET /newsdetails.php?id=26%27 HTTP/1.1
21	9.517192	10.124.211.96	10.124.211.200	TCP	1391	[TCP segment of a reassembled PDU]
22	9.517210	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=1258 Ack=6640 Win=44800 Len=0 TSval=127992 TSecr=224575
23	9.517216	10.124.211.96	10.124.211.200	HTTP	68	HTTP/1.1 200 OK (text/html)
24	9.517218	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=1258 Ack=6642 Win=44800 Len=0 TSval=127992 TSecr=224575
25	14.520484	10.124.211.96	10.124.211.200	TCP	66	80 → 33020 [FIN, ACK] Seq=6642 Ack=1258 Win=18768 Len=0 TSval=225826 TSecr=127992
26	14.520662	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [FIN, ACK] Seq=1258 Ack=6643 Win=44800 Len=0 TSval=129243 TSecr=225826
27	14.582082	10.124.211.96	10.124.211.200	TCP	66	80 → 33020 [ACK] Seq=6643 Ack=1259 Win=18768 Len=0 TSval=225842 TSecr=129243
28	17.437742	10.124.211.200	10.124.211.96	TCP	74	33022 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=129973 TSecr=0 WS=128
29	17.503661	10.124.211.96	10.124.211.200	TCP	74	80 → 33022 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=226572 TSecr=129973 WS=4

Shared example with the THP course

2.2.2.1.1 Malicious HTTP Traffic Example

Shared example with the THP course

Detection

There is one thing that stands out right away which is highlighted below.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	10.124.211.200	10.124.211.96	TCP	74	33020 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=125613 TSecr=0 WS=128
2	0.056720	10.124.211.96	10.124.211.200	TCP	74	80 → 33020 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=222206 TSecr=125613 WS=4
3	0.056747	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=125627 TSecr=222206
4	0.056824	10.124.211.200	10.124.211.96	HTTP	349	GET / HTTP/1.1
5	0.133531	10.124.211.96	10.124.211.200	TCP	66	80 → 33020 [ACK] Seq=1 Ack=284 Win=15552 Len=0 TSval=222223 TSecr=125627
6	0.133549	10.124.211.96	10.124.211.200	HTTP	105	[TCP Previous segment not captured] Continuation
7	0.133556	10.124.211.200	10.124.211.96	TCP	78	[TCP Window Update] 33020 → 80 [ACK] Seq=284 Ack=1 Win=30336 Len=0 TSval=125647 TSecr=222223 SLE=1326 SRE=1361
8	0.156238	10.124.211.96	10.124.211.200	TCP	1391	[TCP Out-Of-Order] 80 → 33020 [ACK] Seq=1 Ack=284 Win=15552 Len=1325 TSval=222224 TSecr=125627
9	0.156259	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=284 Ack=1361 Win=33280 Len=0 TSval=125652 TSecr=222224
10	3.481485	10.124.211.200	10.124.211.96	HTTP	389	GET /news.php HTTP/1.1
11	3.552272	10.124.211.96	10.124.211.200	TCP	1391	[TCP segment of a reassembled PDU]
12	3.552305	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=607 Ack=2686 Win=36096 Len=0 TSval=126501 TSecr=223083
13	3.552578	10.124.211.96	10.124.211.200	HTTP	1353	HTTP/1.1 200 OK (text/html)
14	3.552589	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=607 Ack=3973 Win=39040 Len=0 TSval=126501 TSecr=223083
15	5.968993	10.124.211.200	10.124.211.96	HTTP	410	GET /newsdetails.php?id=26 HTTP/1.1
16	6.020439	10.124.211.96	10.124.211.200	TCP	1391	[TCP segment of a reassembled PDU]
17	6.020461	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=951 Ack=5298 Win=41856 Len=0 TSval=127118 TSecr=223701
18	6.020470	10.124.211.96	10.124.211.200	HTTP	83	HTTP/1.1 200 OK (text/html)
19	6.020471	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=951 Ack=5315 Win=41856 Len=0 TSval=127118 TSecr=223701
20	9.453656	10.124.211.200	10.124.211.96	HTTP	373	GET /newsdetails.php?id=26%27 HTTP/1.1
21	9.517192	10.124.211.96	10.124.211.200	TCP	1391	[TCP segment of a reassembled PDU]
22	9.517210	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=1258 Ack=6640 Win=44800 Len=0 TSval=127992 TSecr=224575
23	9.517216	10.124.211.96	10.124.211.200	HTTP	68	HTTP/1.1 200 OK (text/html)
24	9.517218	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=1258 Ack=6642 Win=44800 Len=0 TSval=127992 TSecr=224575
25	14.520484	10.124.211.96	10.124.211.200	TCP	66	80 → 33020 [FIN, ACK] Seq=6642 Ack=1258 Win=18768 Len=0 TSval=225826 TSecr=127992
26	14.520662	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [FIN, ACK] Seq=1258 Ack=6643 Win=44800 Len=0 TSval=129243 TSecr=225826
27	14.582082	10.124.211.96	10.124.211.200	TCP	66	80 → 33020 [ACK] Seq=6643 Ack=1259 Win=18768 Len=0 TSval=225842 TSecr=129243
28	17.437742	10.124.211.200	10.124.211.96	TCP	74	33022 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=129973 TSecr=0 WS=128
29	17.503661	10.124.211.96	10.124.211.200	TCP	74	80 → 33022 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=226572 TSecr=129973 WS=4

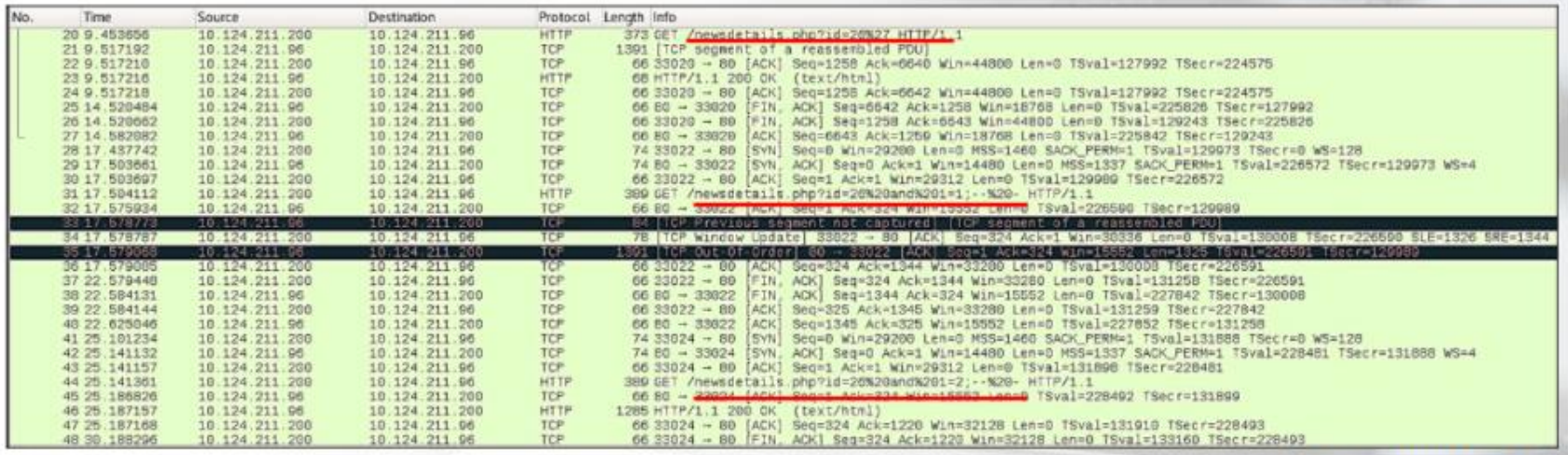
- In the screenshot we can quickly see normal requests to web pages such as news.php and newsdetails.php?id=26 then we see another request to **newsdetails.php?id=26%27**
- If we URL decode **%27** it corresponds to a **single quote** ('). This behavior is typical when looking for a SQL injection. Now was someone looking for a SQLi or did someone make a typo in their web page request? Let's go further down the capture file to find out.

https://www.acunetix.com/websitesecurity/sql-injection/

2.2.2.1.1 Malicious HTTP Traffic Example

Detection

Glancing further at the capture file, a few packets down, we can see more indications of SQL injection attempts. Looking at packets #32 and #44 we can see that the person didn't make a typo request at packet #20. This is indeed an attempt to find SQL injection on the server.



No.	Time	Source	Destination	Protocol	Length	Info
20	9.453656	10.124.211.200	10.124.211.96	HTTP	373	GET /newsdetails.php?id=20%27 HTTP/1.1
21	9.517192	10.124.211.96	10.124.211.200	TCP	1391	[TCP segment of a reassembled PDU]
22	9.517210	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=1258 Ack=6640 Win=44800 Len=0 TSval=127992 TSecr=224575
23	9.517216	10.124.211.96	10.124.211.200	HTTP	68	HTTP/1.1 200 OK (text/html)
24	9.517218	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [ACK] Seq=1258 Ack=6642 Win=44800 Len=0 TSval=127992 TSecr=224575
25	14.520484	10.124.211.96	10.124.211.200	TCP	66	80 → 33020 [FIN, ACK] Seq=6642 Ack=1258 Win=18768 Len=0 TSval=225826 TSecr=127992
26	14.520662	10.124.211.200	10.124.211.96	TCP	66	33020 → 80 [FIN, ACK] Seq=1258 Ack=6643 Win=44800 Len=0 TSval=129243 TSecr=225826
27	14.582082	10.124.211.96	10.124.211.200	TCP	66	80 → 33020 [ACK] Seq=6643 Ack=1259 Win=18768 Len=0 TSval=225842 TSecr=129243
28	17.437742	10.124.211.200	10.124.211.96	TCP	74	33022 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=129973 TSecr=0 WS=128
29	17.503661	10.124.211.96	10.124.211.200	TCP	74	80 → 33022 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=226572 TSecr=129973 WS=4
30	17.503697	10.124.211.200	10.124.211.96	TCP	66	33022 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=129989 TSecr=226572
31	17.504112	10.124.211.200	10.124.211.96	HTTP	389	GET /newsdetails.php?id=20%20and%201=1;--%20- HTTP/1.1
32	17.575934	10.124.211.96	10.124.211.200	TCP	66	80 → 33022 [ACK] Seq=1 Ack=324 Win=15552 Len=0 TSval=226590 TSecr=129989
33	17.578773	10.124.211.96	10.124.211.200	TCP	84	[TCP Previous segment not captured] [TCP segment of a reassembled PDU]
34	17.578787	10.124.211.200	10.124.211.96	TCP	78	[TCP Window Update] 33022 → 80 [ACK] Seq=324 Ack=1 Win=30336 Len=0 TSval=130008 TSecr=226590 SLE=1326 SRE=1344
35	17.579068	10.124.211.96	10.124.211.200	TCP	1391	[TCP Out-Of-Order] 80 → 33022 [ACK] Seq=1 Ack=324 Win=15552 Len=1325 TSval=226591 TSecr=129989
36	17.579085	10.124.211.200	10.124.211.96	TCP	66	33022 → 80 [ACK] Seq=324 Ack=1344 Win=33280 Len=0 TSval=130008 TSecr=226591
37	22.579448	10.124.211.200	10.124.211.96	TCP	66	33022 → 80 [FIN, ACK] Seq=324 Ack=1344 Win=33280 Len=0 TSval=131258 TSecr=226591
38	22.584131	10.124.211.96	10.124.211.200	TCP	66	80 → 33022 [FIN, ACK] Seq=1344 Ack=324 Win=15552 Len=0 TSval=227842 TSecr=130008
39	22.584144	10.124.211.200	10.124.211.96	TCP	66	33022 → 80 [ACK] Seq=325 Ack=1345 Win=33280 Len=0 TSval=131259 TSecr=227842
40	22.625046	10.124.211.96	10.124.211.200	TCP	66	80 → 33022 [ACK] Seq=1345 Ack=325 Win=15552 Len=0 TSval=227852 TSecr=131258
41	25.101234	10.124.211.200	10.124.211.96	TCP	74	33024 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=131888 TSecr=0 WS=128
42	25.141132	10.124.211.96	10.124.211.200	TCP	74	80 → 33024 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=228481 TSecr=131888 WS=4
43	25.141157	10.124.211.200	10.124.211.96	TCP	66	33024 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=131898 TSecr=228481
44	25.141361	10.124.211.200	10.124.211.96	HTTP	389	GET /newsdetails.php?id=20%20and%201=2;--%20- HTTP/1.1
45	25.186826	10.124.211.96	10.124.211.200	TCP	66	80 → 33024 [ACK] Seq=1 Ack=324 Win=15552 Len=0 TSval=228492 TSecr=131899
46	25.187157	10.124.211.96	10.124.211.200	HTTP	1285	HTTP/1.1 200 OK (text/html)
47	25.187168	10.124.211.200	10.124.211.96	TCP	66	33024 → 80 [ACK] Seq=324 Ack=1220 Win=32128 Len=0 TSval=131910 TSecr=228493
48	30.188296	10.124.211.200	10.124.211.96	TCP	66	33024 → 80 [FIN, ACK] Seq=324 Ack=1220 Win=32128 Len=0 TSval=133160 TSecr=228493

Shared example with the THP course

2.2.2.1.1 Malicious HTTP Traffic Example

Detection

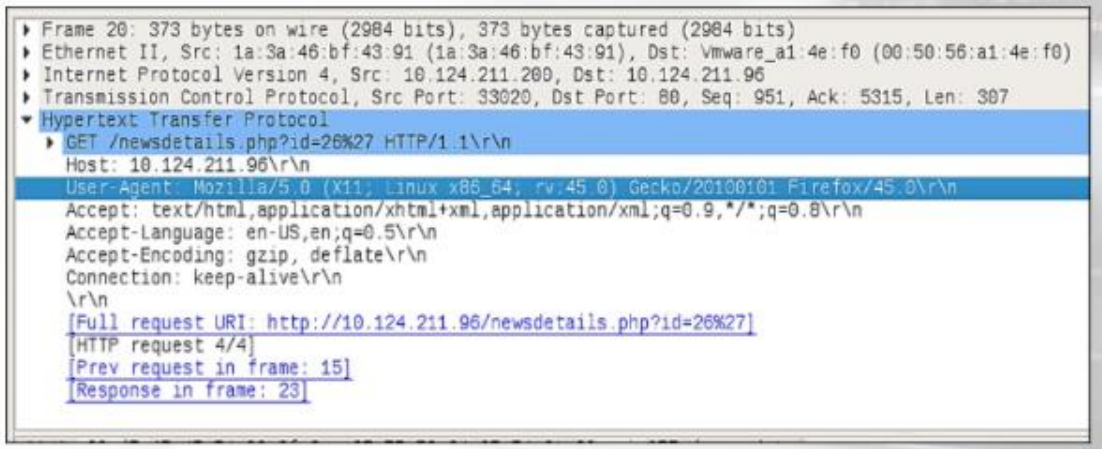
Now knowing that the individual is conducting SQL injection queries against the server, is he/she doing this manually or by using a tool?

Shared example with the THP course

2.2.2.1.1 Malicious HTTP Traffic Example

Detection

We begin at the first packet in question, packet #20. By further inspection, we see that the User-Agent is Firefox and the OS is Linux. User-Agent's can be spoofed, but not always, as we will see shortly.



Shared example with the THP course

2.2.2.1.1 Malicious HTTP Traffic Example

Detection

We see that the User-Agent is the same for packets #31 and #44.

Let's keep looking to see if we can find anything else of interest.

```
▸ Frame 44: 389 bytes on wire (3112 bits), 389 bytes captured (3112 bits)
▸ Ethernet II, Src: 1a:3a:46:bf:43:91 (1a:3a:46:bf:43:91), Dst: Vmware_a1:4e:f0 (00:50:56:a1:4e:f0)
▸ Internet Protocol Version 4, Src: 10.124.211.200, Dst: 10.124.211.96
▸ Transmission Control Protocol, Src Port: 33024, Dst Port: 80, Seq: 1, Ack: 1, Len: 323
▾ Hypertext Transfer Protocol
  ▸ GET /newsdetails.php?id=26%20and%201=2;--%20- HTTP/1.1\r\n
    Host: 10.124.211.96\r\n
    User-Agent: Mozilla/5.0 (X11; Linux x86_64; rv:45.0) Gecko/20100101 Firefox/45.0\r\n
    Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8\r\n
    Accept-Language: en-US,en;q=0.5\r\n
    Accept-Encoding: gzip, deflate\r\n
    Connection: keep-alive\r\n
    \r\n
    [Full request URI: http://10.124.211.96/newsdetails.php?id=26%20and%201=2;--%20-]
    [HTTP request 1/1]
    [Response in frame: 46]
```

```
▸ Frame 31: 389 bytes on wire (3112 bits), 389 bytes captured (3112 bits)
▸ Ethernet II, Src: 1a:3a:46:bf:43:91 (1a:3a:46:bf:43:91), Dst: Vmware_a1:4e:f0 (00:50:56:a1:4e:f0)
▸ Internet Protocol Version 4, Src: 10.124.211.200, Dst: 10.124.211.96
▸ Transmission Control Protocol, Src Port: 33022, Dst Port: 80, Seq: 1, Ack: 1, Len: 323
▾ Hypertext Transfer Protocol
  ▸ GET /newsdetails.php?id=26%20and%201=1;--%20- HTTP/1.1\r\n
    Host: 10.124.211.96\r\n
    User-Agent: Mozilla/5.0 (X11; Linux x86_64; rv:45.0) Gecko/20100101 Firefox/45.0\r\n
    Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8\r\n
    Accept-Language: en-US,en;q=0.5\r\n
    Accept-Encoding: gzip, deflate\r\n
    Connection: keep-alive\r\n
    \r\n
    [Full request URI: http://10.124.211.96/newsdetails.php?id=26%20and%201=1;--%20-]
    [HTTP request 1/1]
```

Shared example with the THP course

2.2.2.1.1 Malicious HTTP Traffic Example

Detection

By looking back to the initial packet of interest, packet #20, we can look at the Line-based **text data: text/html** portion of the packet details and notice that error messages are being displayed to the individual conducting the SQL injection queries.

```
\t<!-- end sidebar -->\n
\t<div id="content">\n
\t\t<div><img src="images/img08.jpg" alt="" width="740" height="220" /></div>\n
\t\t<div class="boxed">\n
\t\t\t<h1 class="title2">\n
\n
<br />\n
<b>Warning</b>:  mysqli_fetch_array() expects parameter 1 to be mysqli_result, boolean given in <b>/var/www/newsdetails.php</b> on line <b>11</b><br />\n
\n
\n
</h1>\n
<p>\n
<br />\n
<b>Warning</b>:  mysqli_fetch_array() expects parameter 1 to be mysqli_result, boolean given in <b>/var/www/newsdetails.php</b> on line <b>29</b><br />\n
</p>\n
\n
        </div>\n
```

Shared example with the THP course

2.2.2.1.1 Malicious HTTP Traffic Example

Detection

Strangely, packet #56, and the packet after that, packet #73, don't seem to contain any SQL injection queries. Maybe the individual decided not to continue the attack?

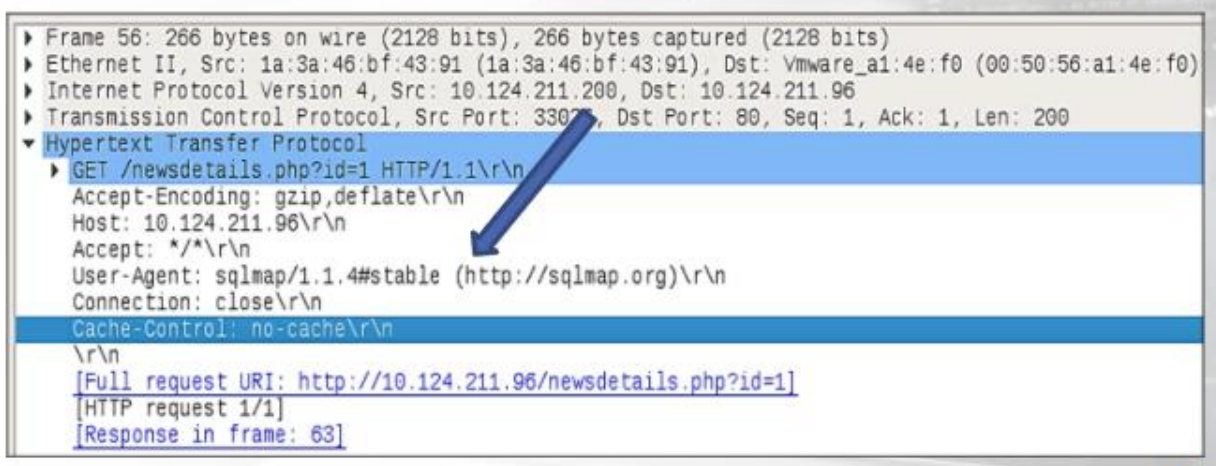
No.	Time	Source	Destination	Protocol	Length	Info
56	34.163959	10.124.211.200	10.124.211.96	HTTP	266	GET /newsdetails.php?id=1 HTTP/1.1
57	34.169322	10.124.211.96	10.124.211.200	TCP	74	80 → 33028 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=230739 TSecr=134145 WS=4
58	34.169364	10.124.211.200	10.124.211.96	TCP	66	33028 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=134156 TSecr=230739
59	34.188457	10.124.211.200	10.124.211.96	TCP	74	33030 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=134158 TSecr=0 WS=128
60	34.202983	10.124.211.96	10.124.211.200	TCP	66	80 → 33026 [ACK] Seq=1 Ack=201 Win=15552 Len=0 TSval=230747 TSecr=134154
61	34.206414	10.124.211.96	10.124.211.200	TCP	1391	[TCP segment of a reassembled PDU]
62	34.206432	10.124.211.200	10.124.211.96	TCP	66	33026 → 80 [ACK] Seq=201 Ack=1326 Win=32128 Len=0 TSval=134165 TSecr=230748
63	34.206495	10.124.211.96	10.124.211.200	HTTP	82	HTTP/1.1 200 OK (text/html)
64	34.206501	10.124.211.200	10.124.211.96	TCP	66	33026 → 80 [ACK] Seq=201 Ack=1342 Win=32128 Len=0 TSval=134165 TSecr=230748
65	34.206508	10.124.211.96	10.124.211.200	TCP	66	80 → 33026 [FIN, ACK] Seq=1342 Ack=201 Win=15552 Len=0 TSval=230748 TSecr=134154
66	34.207131	10.124.211.200	10.124.211.96	TCP	66	33026 → 80 [FIN, ACK] Seq=201 Ack=1343 Win=32128 Len=0 TSval=134165 TSecr=230748
67	34.218945	10.124.211.96	10.124.211.200	TCP	74	80 → 33030 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=230751 TSecr=134158 WS=4
68	34.218972	10.124.211.200	10.124.211.96	TCP	66	33030 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=134168 TSecr=230751
69	34.230022	10.124.211.200	10.124.211.96	TCP	74	33032 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=134171 TSecr=0 WS=128
70	34.248217	10.124.211.96	10.124.211.200	TCP	66	80 → 33026 [ACK] Seq=1343 Ack=202 Win=15552 Len=0 TSval=230758 TSecr=134165
71	34.269905	10.124.211.96	10.124.211.200	TCP	74	80 → 33032 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=230764 TSecr=134171 WS=4
72	34.269934	10.124.211.200	10.124.211.96	TCP	66	33032 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=134181 TSecr=230764
73	35.126264	10.124.211.200	10.124.211.96	HTTP	266	GET /newsdetails.php?id=1 HTTP/1.1
74	35.126569	10.124.211.200	10.124.211.96	TCP	74	33034 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=134395 TSecr=0 WS=128
75	35.166226	10.124.211.96	10.124.211.200	TCP	66	80 → 33028 [ACK] Seq=1 Ack=201 Win=15552 Len=0 TSval=230988 TSecr=134395
76	35.166267	10.124.211.96	10.124.211.200	TCP	74	80 → 33034 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=230988 TSecr=134395 WS=4
77	35.166341	10.124.211.200	10.124.211.96	TCP	66	33034 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=134405 TSecr=230988
78	35.166806	10.124.211.96	10.124.211.200	TCP	1391	[TCP segment of a reassembled PDU]
79	35.166835	10.124.211.200	10.124.211.96	TCP	66	33028 → 80 [ACK] Seq=201 Ack=1326 Win=32128 Len=0 TSval=134405 TSecr=230988
80	35.166926	10.124.211.96	10.124.211.200	HTTP	82	HTTP/1.1 200 OK (text/html)
81	35.166943	10.124.211.200	10.124.211.96	TCP	66	33028 → 80 [ACK] Seq=201 Ack=1342 Win=32128 Len=0 TSval=134405 TSecr=230988
82	35.166962	10.124.211.96	10.124.211.200	TCP	66	80 → 33028 [FIN, ACK] Seq=1342 Ack=201 Win=15552 Len=0 TSval=230988 TSecr=134395
83	35.178154	10.124.211.200	10.124.211.96	TCP	66	33028 → 80 [FIN, ACK] Seq=201 Ack=1343 Win=32128 Len=0 TSval=134406 TSecr=230988

Shared example with the THP course

2.2.2.1.1 Malicious HTTP Traffic Example

Detection

Let's take a closer look at packet #56. Indeed no SQL injection attempt is visible within this packet, but something else should have already alarmed us, the User-Agent. The User-Agent for this HTTP GET Request is Sqlmap. So the attacker didn't quit, he/she escalated.



Shared example with the THP course

https://github.com/sqlmapproject/sqlmap

OUTLINE

2.2.2.1.1 Malicious HTTP Traffic Example

Detection

A few of the subsequent HTTP GET Requests that follows will also look like legit HTTP traffic but these will also contain the same User-Agent within the packet details, Sqlmap.

In addition, they will most probably contain overly long URI requests.

Shared example with the THP course

2.2.2.2 HTTPS

Now we'll look at HTTPS traffic within the upcoming slides.

We'll look into some pointers to remember about HTTPS traffic and some tips about normal and suspicious HTTPS traffic.

Finally we'll study traffic captures of both normal and suspicious HTTPS traffic.

2.2.2.2 HTTPS

A few things to remember about HTTPS:

- HTTPS is the secure version of HTTP.
  - The “S” refers to Secure Socket Layer/Transport Layer Security (SSL/TLS).

- HTTPS also establishes a handshake similar to TCP but more complicated. Below is a brief summary:
  - Both the client and the server need to agree on the protocol version.
  - Both the client and the server need to select cryptographic algorithms.
  - Optionally authenticate to each other.
  - Use public key encryption techniques to establish secure communications.

2.2.2.2 HTTPS

Some facts to help distinguish normal and suspicious HTTPS traffic

Normal HTTPS Traffic	Suspicious HTTPS Traffic
Port 443, TCP Port 8443, TCP (used as alternate)	Malicious binaries (backdoors), scripts, web shells, etc. will use this port because typically in all corporate environments the port is open.
Encrypted traffic	If the traffic is not encrypted and Secure Sockets Layer packet details are empty within packet details then that will fall under suspicious.
Web server typically in FQDN format.	Server will point to an IP address instead of FQDN format.

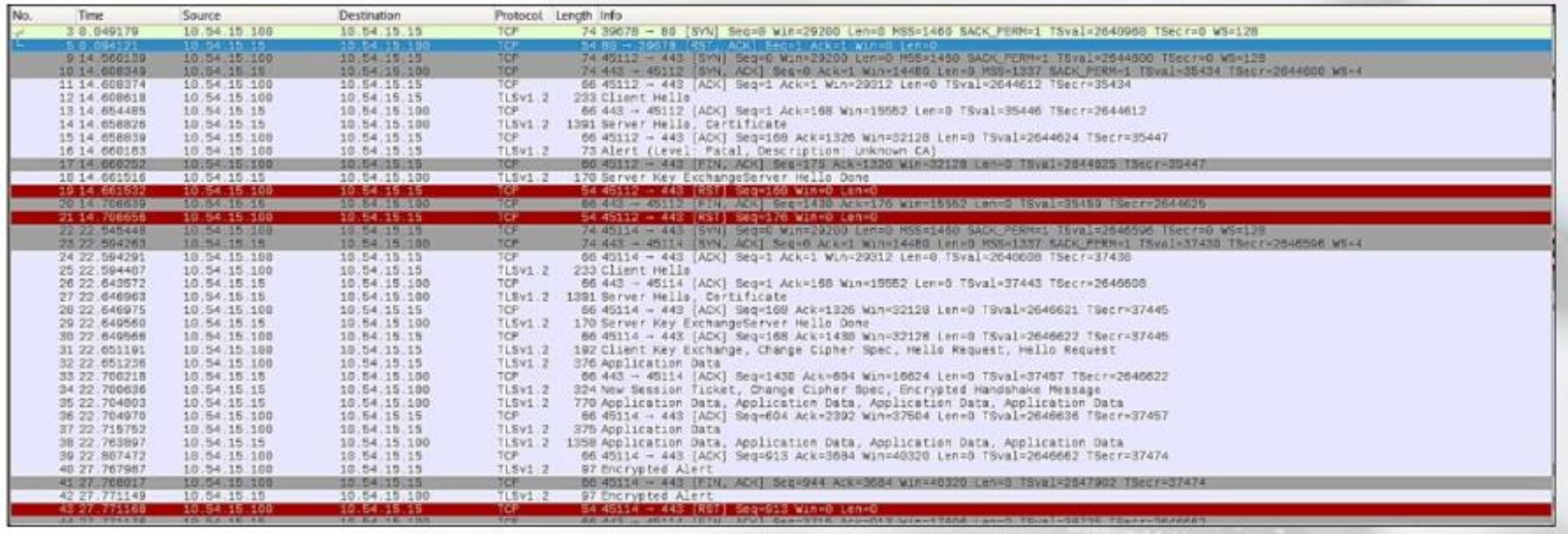
2.2.2.2 HTTPS

We will not dive too deep into the handshake used by HTTPS traffic but there are certain details within the packets that we should be familiar with. Those details will be pointed out in the upcoming slides.

If you want to dive deeper into how HTTPS establishes secure communications please refer to RFC 6101 for SSL 3.0, RFC 5246 for TLS 1.2 and RFC 8446 for TLS 1.3.

https://tools.ietf.org/html/rfc6101
https://tools.ietf.org/html/rfc5246
https://datatracker.ietf.org/doc/rfc8446/

2.2.2.2 HTTPS



No.	Time	Source	Destination	Protocol	Length	Info
3	8.049179	10.54.15.100	10.54.15.15	TCP	74	39678 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=2640968 TSecr=0 WS=128
8	8.084121	10.54.15.15	10.54.15.100	TCP	74	80 → 39678 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0
9	14.560139	10.54.15.100	10.54.15.15	TCP	74	45112 → 443 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=2644600 TSecr=0 WS=128
10	14.608349	10.54.15.15	10.54.15.100	TCP	74	443 → 45112 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=35434 TSecr=2644600 WS=4
11	14.608374	10.54.15.100	10.54.15.15	TCP	66	45112 → 443 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=2644612 TSecr=35434
12	14.608618	10.54.15.100	10.54.15.15	TLSv1.2	233	Client Hello
13	14.654485	10.54.15.15	10.54.15.100	TCP	66	443 → 45112 [ACK] Seq=1 Ack=168 Win=15552 Len=0 TSval=35446 TSecr=2644612
14	14.658826	10.54.15.15	10.54.15.100	TLSv1.2	1391	Server Hello, Certificate
15	14.658839	10.54.15.100	10.54.15.15	TCP	66	45112 → 443 [ACK] Seq=168 Ack=1326 Win=32128 Len=0 TSval=2644624 TSecr=35447
16	14.660163	10.54.15.100	10.54.15.15	TLSv1.2	73	Alert (Level: Fatal, Description: Unknown CA)
17	14.660252	10.54.15.100	10.54.15.15	TCP	66	45112 → 443 [FIN, ACK] Seq=175 Ack=1326 Win=32128 Len=0 TSval=2644625 TSecr=35447
18	14.661516	10.54.15.15	10.54.15.100	TLSv1.2	170	Server Key ExchangeServer Hello Done
19	14.661522	10.54.15.100	10.54.15.15	TCP	54	45112 → 443 [RST] Seq=160 Win=0 Len=0
20	14.706639	10.54.15.15	10.54.15.100	TCP	66	443 → 45112 [FIN, ACK] Seq=1430 Ack=176 Win=15552 Len=0 TSval=35459 TSecr=2644625
21	14.706658	10.54.15.100	10.54.15.15	TCP	54	45112 → 443 [RST] Seq=176 Win=0 Len=0
22	22.545448	10.54.15.100	10.54.15.15	TCP	74	45114 → 443 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=2646596 TSecr=0 WS=128
23	22.594263	10.54.15.15	10.54.15.100	TCP	74	443 → 45114 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1337 SACK_PERM=1 TSval=37438 TSecr=2646596 WS=4
24	22.594291	10.54.15.100	10.54.15.15	TCP	66	45114 → 443 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=2646608 TSecr=37438
25	22.594407	10.54.15.100	10.54.15.15	TLSv1.2	233	Client Hello
26	22.643572	10.54.15.15	10.54.15.100	TCP	66	443 → 45114 [ACK] Seq=1 Ack=168 Win=15552 Len=0 TSval=37443 TSecr=2646608
27	22.646963	10.54.15.15	10.54.15.100	TLSv1.2	1391	Server Hello, Certificate
28	22.646975	10.54.15.100	10.54.15.15	TCP	66	45114 → 443 [ACK] Seq=168 Ack=1326 Win=32128 Len=0 TSval=2646621 TSecr=37445
29	22.649560	10.54.15.15	10.54.15.100	TLSv1.2	170	Server Key ExchangeServer Hello Done
30	22.649568	10.54.15.100	10.54.15.15	TCP	66	45114 → 443 [ACK] Seq=168 Ack=1430 Win=32128 Len=0 TSval=2646622 TSecr=37445
31	22.651191	10.54.15.100	10.54.15.15	TLSv1.2	192	Client Key Exchange, Change Cipher Spec, Hello Request, Hello Request
32	22.651236	10.54.15.100	10.54.15.15	TLSv1.2	376	Application Data
33	22.700218	10.54.15.15	10.54.15.100	TCP	66	443 → 45114 [ACK] Seq=1430 Ack=694 Win=16624 Len=0 TSval=37457 TSecr=2646622
34	22.700636	10.54.15.15	10.54.15.100	TLSv1.2	324	New Session Ticket, Change Cipher Spec, Encrypted Handshake Message
35	22.704003	10.54.15.15	10.54.15.100	TLSv1.2	770	Application Data, Application Data, Application Data, Application Data
36	22.704970	10.54.15.100	10.54.15.15	TCP	66	45114 → 443 [ACK] Seq=694 Ack=2392 Win=37504 Len=0 TSval=2646636 TSecr=37457
37	22.715752	10.54.15.100	10.54.15.15	TLSv1.2	375	Application Data
38	22.763897	10.54.15.15	10.54.15.100	TLSv1.2	1358	Application Data, Application Data, Application Data, Application Data
39	22.807472	10.54.15.100	10.54.15.15	TCP	66	45114 → 443 [ACK] Seq=913 Ack=3684 Win=40320 Len=0 TSval=2646662 TSecr=37474
40	27.767987	10.54.15.100	10.54.15.15	TLSv1.2	97	Encrypted Alert
41	27.768017	10.54.15.100	10.54.15.15	TCP	66	45114 → 443 [FIN, ACK] Seq=944 Ack=3684 Win=40320 Len=0 TSval=2647902 TSecr=37474
42	27.771149	10.54.15.15	10.54.15.100	TLSv1.2	97	Encrypted Alert
43	27.771180	10.54.15.100	10.54.15.15	TCP	54	45114 → 443 [RST] Seq=913 Win=0 Len=0

- When analyzing HTTPS traffic, we should see encrypted packets. All traffic on port 443 should look this way.

2.2.2.2 HTTPS

Let’s now take a glance at packets for HTTPS traffic.

OUTLINE

2.2.2.2 HTTPS

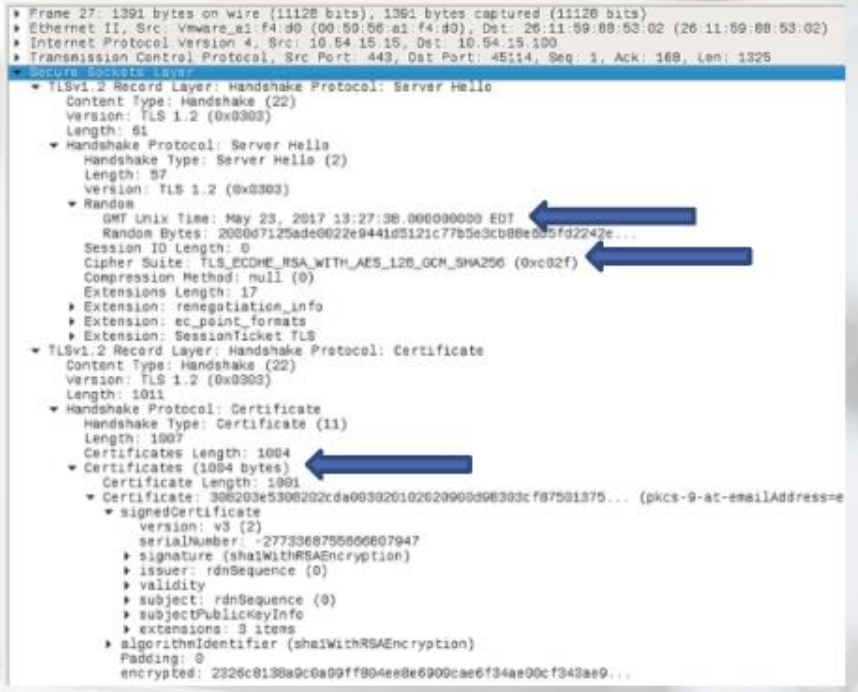
As you may remember, the **Secure Sockets Layer** portion of the packet details should **not** be empty. Here we see pertinent info as to what the client has available in order to attempt to establish secure communications with the server, **Client Hello packet**. We see the following:

- Content Type = Handshake
- Handshake Protocol: Client Hello
- Version: TLS 1.2
- Cipher Suites (11 suites)
- Compression Method (1 method)

OUTLINE

2.2.2.2 HTTPS

Here is the server's response, **Server Hello** packet. These Hello messages again will contain the availability and agreement of encryption algorithms to work with and exchange of random values that will be used for generation of key.

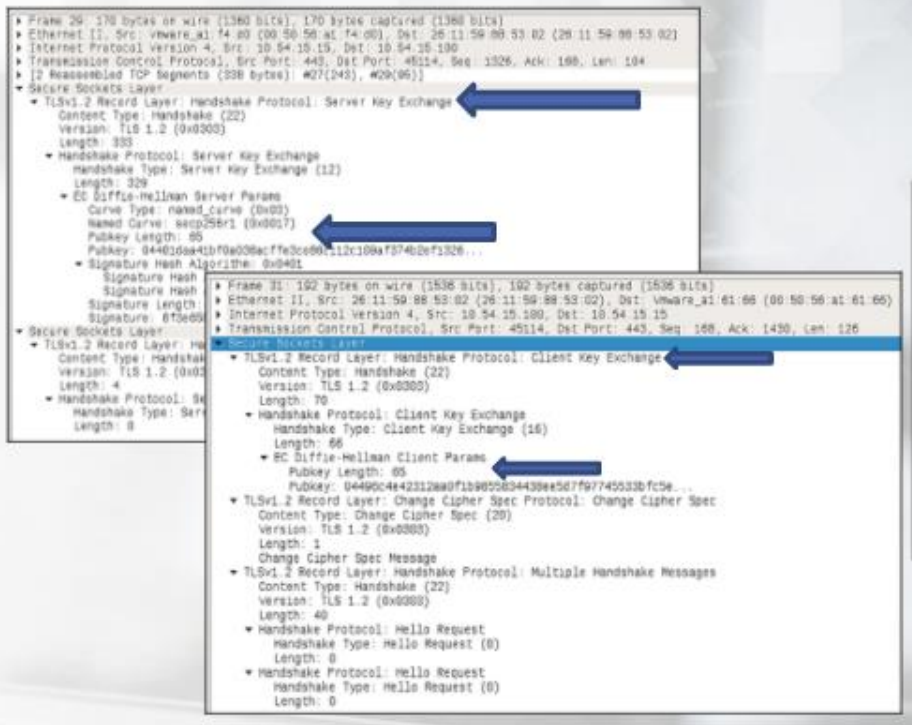


OUTLINE

2.2.2.2 HTTPS

Here we see the **Server Key Exchange** which will be followed by the **Client Key Exchange** packet.

This will be considered step #3 in the establishment of an SSL/TLS session between a server and a client.

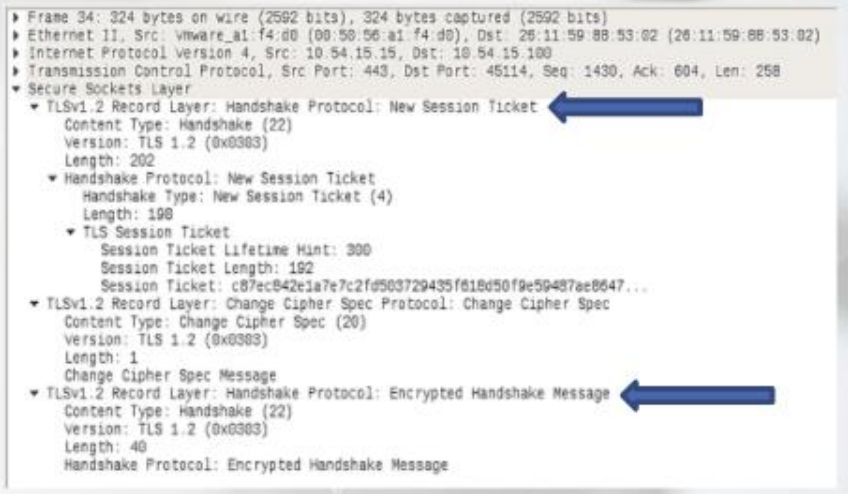


OUTLINE

2.2.2.2 HTTPS

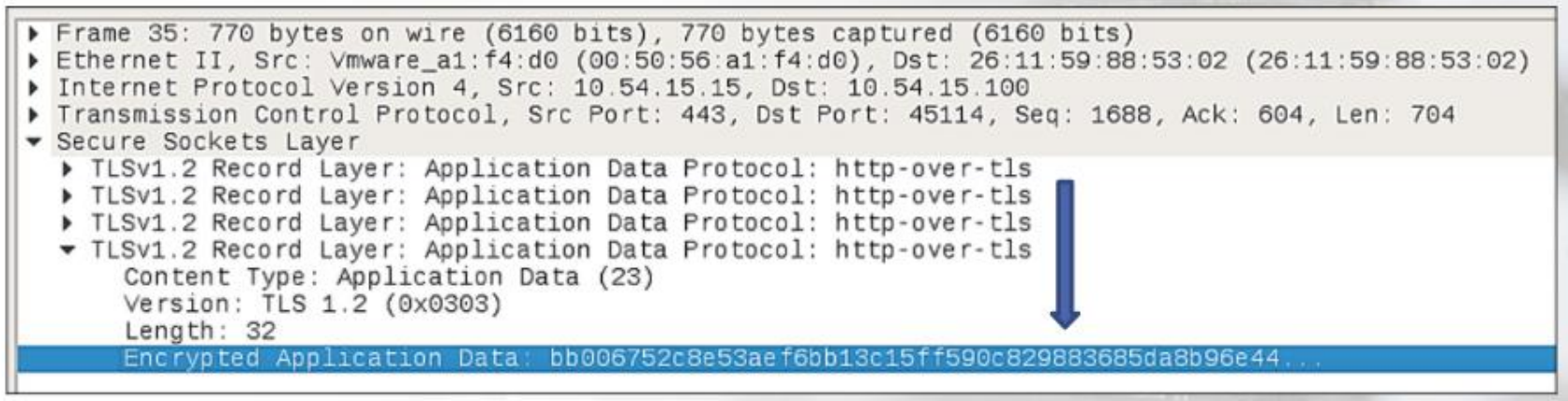
This is the last packet and the handshake between the server and client is now complete.

The rest of the packets between these two devices will now be encrypted.



2.2.2.2 HTTPS

The traffic is unreadable, but if this is internal traffic within our corporate environment, then, it is feasible to decrypt this traffic using the private key from the internal server.



OUTLINE

2.2.2.2.1 Malicious HTTPS Traffic Example

Consider the *SSL_renegotiation.pcap* file found in this module's resources. Can you spot any abnormalities?

Hint: Apply the following filter in Wireshark.
ssl.record.content_type == 22

2.2.2.2 HTTPS

Detection

ssl.record.content_type == 22

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	215.255.186.158	251.217.119.170	SSL	364	Client Hello
2	0.040015	215.255.186.158	251.217.119.170	SSL	364	Client Hello
14	0.543463	215.255.186.158	251.217.119.170	TLSv1.2	364	Client Hello
17	0.545287	215.255.186.158	251.217.119.170	TLSv1.2	364	Client Hello
22	0.764012	215.255.186.158	251.217.119.170	SSL	364	Client Hello
23	0.850374	251.217.119.170	215.255.186.158	TLSv1.2	1514	Server Hello
26	0.850399	251.217.119.170	215.255.186.158	TLSv1.2	645	CertificateServer Key Exchange, Server Hello Done
31	0.851933	215.255.186.158	251.217.119.170	TLSv1.2	192	Client Key Exchange, Change Cipher Spec, Encrypted Handshake Message
33	0.908004	215.255.186.158	251.217.119.170	SSL	364	Client Hello
34	0.952042	215.255.186.158	251.217.119.170	SSL	364	Client Hello
36	1.016351	251.217.119.170	215.255.186.158	TLSv1.2	292	New Session Ticket, Change Cipher Spec, Encrypted Handshake Message
42	1.222375	251.217.119.170	215.255.186.158	TLSv1.2	1514	Server Hello

- When it comes to SSL/TLS handshakes, you should remember two things:
  - Each SSL/TLS handshake is effectively a new connection (consuming resources)
  - SSL/TLS handshakes are quite CPU intensive operations (server-side)
- The number of new **Client Hello** messages is abnormal.
- Taking into consideration both the above, it looks like we are dealing with a SSL Renegotiation Attack

https://blog.qualys.com/ssllabs/2011/10/31/tls-renegotiation-and-denial-of-service-attacks

2.2.3 SMTP

SMTP (Simple Mail Transfer Protocol) is the internet's Postman.

It's the protocol responsible for sending emails.

OUTLINE

2.2.3 SMTP

When connecting to the SMTP server, the client has to identify itself and authenticate through a password.

Before discussing SMTP, it is important to remember that the protocol's implementation may differ from one product to another.

2.2.3 SMTP

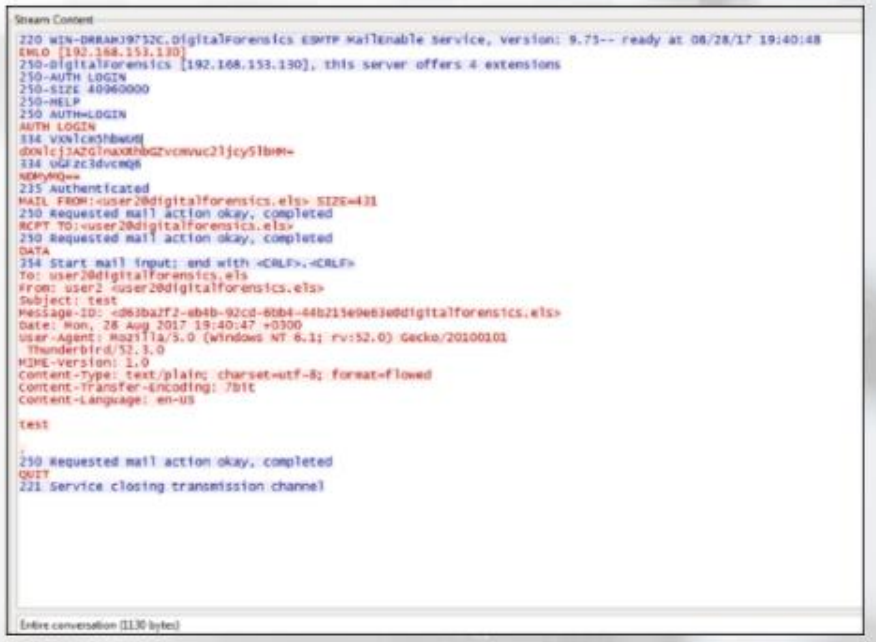
SMTP is a text-based protocol, meaning that it relies on exchanging ASCII based strings as commands between the server and the client.

HELO	Sent by a client to identify itself, usually with a domain name.
MAIL FROM	Identifies the sender of the message; used in the form MAIL FROM:.
RCPT TO	Identifies the message recipients; used in the form RCPT TO:.
VRFY	Verifies that a mailbox is available for message delivery;.

2.2.3 SMTP

Later, in the 1995, ESMTP was developed. ESMTP was an extension to the original SMTP protocol with some modifications. Some of the modifications included new commands such as using EHLO instead of HELO for identification.

On your right, you can see an example of SMTP traffic.

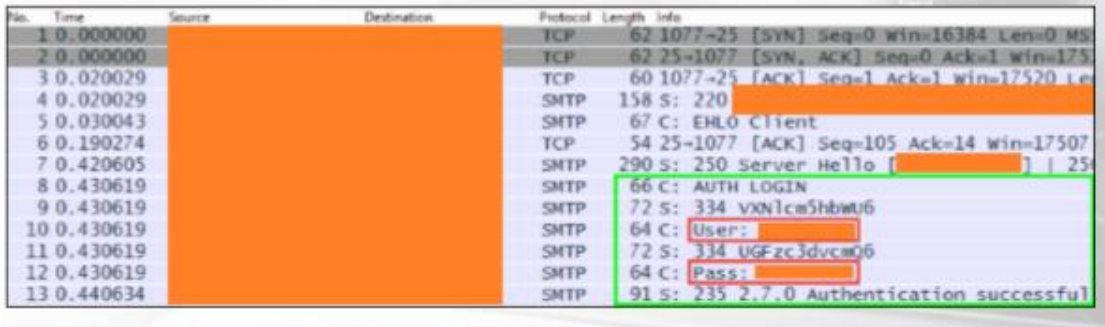


OUTLINE

2.2.3 SMTP

The SMTP server starts the conversation, once the TCP three-way handshake is completed, by sending its banner, containing the server's name and version.

The above will look similar to the below on the wire.



OUTLINE

2.2.3 SMTP

Back to our example, the client starts the conversation with the **EHLO** command, which is the extended version of the **HELO** command.

The server replies with the options that an SMTP client can pick from.

Among these options is the authentication login option, where the client asks for authentication to login.

2.2.3 SMTP

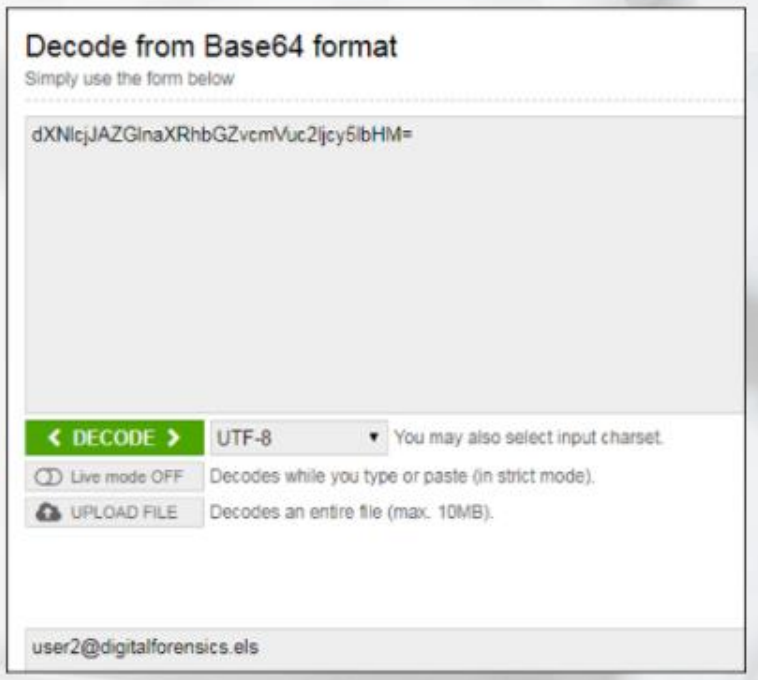
Next, we can see the server asking the client for the username. However, the word *username* was encoded using base 64 encoding.

We can verify that by decoding the string which the server sent to the client.

OUTLINE

2.2.3 SMTP

The client responded to that request by sending their SMTP username encoded using base 64 encoding.



OUTLINE

2.2.3 SMTP

After receiving the username, the server asks the client for the password also in base 64 encoding.

OUTLINE

2.2.3 SMTP

The client responded to that request by sending the password encoded in Base 64.

OUTLINE

2.2.3 SMTP

Once both the username and the password is verified, the server acknowledges that, by telling the client that they have been "authenticated."

2.2.3 SMTP

Using the **MAIL FROM** and **RCPT TO** command, the client tells the server that it wants to send an email.

After that, the mail body is specified using the **DATA** command.

OUTLINE

2.2.3 SMTP

We can see that the email header specifies the **source**, **recipient**, **subject** and a **message ID**.

It also specifies the **date** and, more importantly, the **user-agent** field, which tells what mail client was used to send that email.

Finally, the type of content being sent is specified.

OUTLINE

2.2.3 SMTP

It is important to mention that without the proper security configuration, an attacker may be able to manually connect to the SMTP server and send a forged email to a client either on the local SMTP server or to another SMTP server.

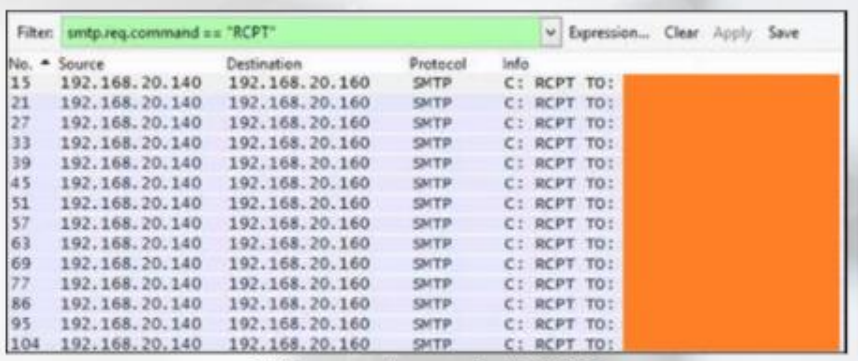
In such a case the SMTP server will act as an open relay.

2.2.3.1 Malicious SMTP Traffic Example

Detection

The lack of proper security configuration may also allow the attacker to connect to the SMTP server and manually enumerate the users on that server using the **VRFY**, **EXPN** or **RCPT TO** commands.

User enumeration may be used as part of a social engineering attack or as a first step of a brute force attack against account passwords on that server.



SMTP enumeration example via RCPT TO

2.2.4 DNS

DNS (Domain Name System) is a protocol that resolves names to IP addresses. We will not dive into how DNS works exactly but we'll simply focus on how to recognize normal DNS traffic and suspicious DNS traffic.

You can learn more, or freshen up, on DNS here and here.

https://www.ietf.org/rfc/rfc1034.txt
https://www.ietf.org/rfc/rfc1035.txt

2.2.4 DNS

A few things to point out regarding **DNS (Domain Name System)**:

- DNS is a query-response protocol.
- DNS traffic normally uses UDP on port 53.
- DNS traffic should go to DNS servers only.

2.2.4 DNS

Some facts to help distinguish normal and suspicious DNS traffic

Normal DNS Traffic	Suspicious DNS Traffic
Port 53, UDP	Traffic on port 53 but using TCP instead of UDP.
Should only go to DNS Servers.	DNS traffic not going to DNS Servers.
Should see DNS Responses to DNS Queries.	A lot of DNS Queries with no DNS responses or vice versa.

2.2.4 DNS

Here we see 4 packets: 2 packets for DNS Queries and 2 for DNS Responses.

dns

No.	Time	Source	Destination	Protocol	Length	Info
16	26.200151138	172.16.5.100	172.16.5.10	DNS	83	Standard query 0xde40 PTR 5.5.16.172.in-addr.arpa
19	26.272980431	172.16.5.10	172.16.5.100	DNS	127	Standard query response 0xde40 PTR 5.5.16.172.in-addr.arpa PTR wkst-techsupport.sportsfoo.com
41	56.605405613	172.16.5.100	172.16.5.10	DNS	94	Standard query 0xa620 PTR 5.5.16.172.in-addr.arpa OPT
42	56.639661726	172.16.5.10	172.16.5.100	DNS	138	Standard query response 0xa620 PTR 5.5.16.172.in-addr.arpa PTR wkst-techsupport.sportsfoo.com OPT

Also notice that there are 2 different transaction IDs for the packets: 0xde40 & 0xa620.

https://technet.microsoft.com/en-us/library/dd197470(v=ws.10).aspx

OUTLINE

2.2.4 DNS

Below we can verify that this is a UDP packet and it's using an expected port, 53.

```
▸ Frame 16: 83 bytes on wire (664 bits), 83 bytes captured (664 bits) on interface 0
▸ Ethernet II, Src: b2:fe:ed:db:02:32 (b2:fe:ed:db:02:32), Dst: Vmware_a1:a4:5f (00:50:56:a1:a4:5f)
▸ Internet Protocol Version 4, Src: 172.16.5.100, Dst: 172.16.5.10
▸ User Datagram Protocol, Src Port: 42653, Dst Port: 53
▾ Domain Name System (query)
    [Response In: 19]
    Transaction ID: 0xde40
  ▸ Flags: 0x0100 Standard query
    Questions: 1
    Answer RRs: 0
    Authority RRs: 0
    Additional RRs: 0
  ▾ Queries
    ▾ 5.5.16.172.in-addr.arpa: type PTR, class IN
        Name: 5.5.16.172.in-addr.arpa
        [Name Length: 23]

0000  00 50 56 a1 a4 5f b2 fe  ed db 02 32 08 00 45 00   .PV.._.. ...2..E.
0010  00 45 ae 11 00 00 40 11  6a 08 ac 10 05 64 ac 10   .E....@. j....d..
0020  05 0a a6 9d 00 35 00 31  2d 00 de 40 01 00 00 01   .....5.1 -..@....
0030  00 00 00 00 00 00 01 35  01 35 02 31 36 03 31 37   .......5 .5.16.17
0040  32 07 69 6e 2d 61 64 64  72 04 61 72 70 61 00 00   2.in-add r.arpa..
0050  0c 00 01                                          ...
```

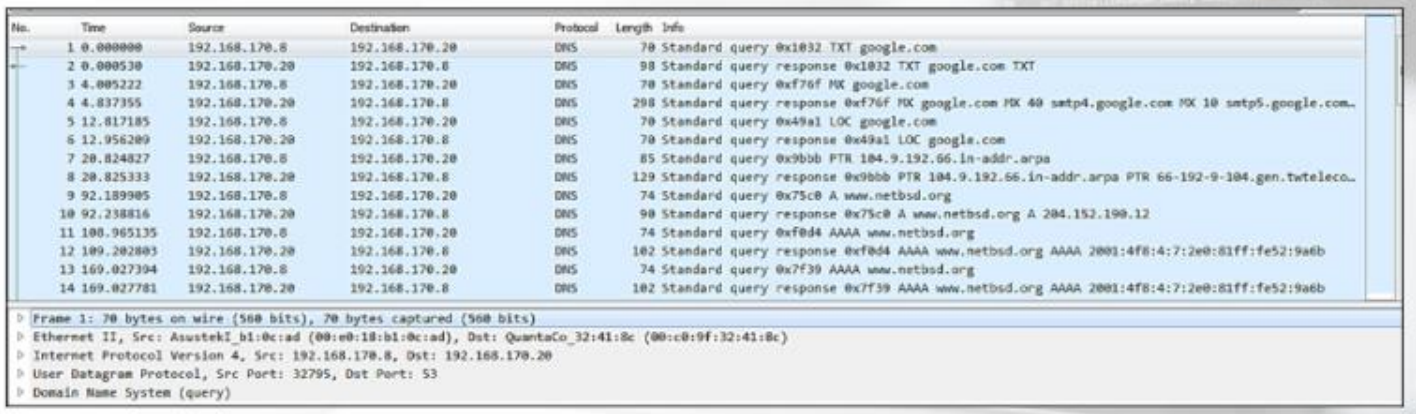
2.2.4 DNS

This is the DNS Response to the DNS Query in packet #16. All looks normal as far as the DNS protocol is concerned.
A question you would ask yourself is would this be a recon scan or normal behavior within your network?

OUTLINE

2.2.4 DNS

Here is another packet capture displaying various DNS queries but you see the pattern of DNS Query followed by DNS Response.



No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.170.8	192.168.170.20	DNS	70	Standard query 0x1032 TXT google.com
2	0.000530	192.168.170.20	192.168.170.8	DNS	98	Standard query response 0x1032 TXT google.com TXT
3	4.005222	192.168.170.8	192.168.170.20	DNS	70	Standard query 0xf76f MX google.com
4	4.837355	192.168.170.20	192.168.170.8	DNS	298	Standard query response 0xf76f MX google.com MX 40 smtp4.google.com MX 10 smtp5.google.com…
5	12.817185	192.168.170.8	192.168.170.20	DNS	70	Standard query 0x49a1 LOC google.com
6	12.956209	192.168.170.20	192.168.170.8	DNS	70	Standard query response 0x49a1 LOC google.com
7	20.824827	192.168.170.8	192.168.170.20	DNS	85	Standard query 0x9bbb PTR 104.9.192.66.in-addr.arpa
8	20.825333	192.168.170.20	192.168.170.8	DNS	129	Standard query response 0x9bbb PTR 104.9.192.66.in-addr.arpa PTR 66-192-9-104.gen.twteleco…
9	92.189905	192.168.170.8	192.168.170.20	DNS	74	Standard query 0x75c0 A www.netbsd.org
10	92.238816	192.168.170.20	192.168.170.8	DNS	90	Standard query response 0x75c0 A www.netbsd.org A 204.152.190.12
11	100.965135	192.168.170.8	192.168.170.20	DNS	74	Standard query 0xf0d4 AAAA www.netbsd.org
12	109.202803	192.168.170.20	192.168.170.8	DNS	102	Standard query response 0xf0d4 AAAA www.netbsd.org AAAA 2001:4f8:4:7:2e0:81ff:fe52:9a6b
13	169.027394	192.168.170.8	192.168.170.20	DNS	74	Standard query 0x7f39 AAAA www.netbsd.org
14	169.027781	192.168.170.20	192.168.170.8	DNS	102	Standard query response 0x7f39 AAAA www.netbsd.org AAAA 2001:4f8:4:7:2e0:81ff:fe52:9a6b

```
▷ Frame 1: 70 bytes on wire (560 bits), 70 bytes captured (560 bits)
▷ Ethernet II, Src: AsustekI_b1:0c:ad (00:e0:18:b1:0c:ad), Dst: QuantaCo_32:41:8c (00:c0:9f:32:41:8c)
▷ Internet Protocol Version 4, Src: 192.168.170.8, Dst: 192.168.170.20
▷ User Datagram Protocol, Src Port: 32795, Dst Port: 53
▷ Domain Name System (query)
```

2.2.4.1 Malicious DNS Traffic Example

A good example of usually suspicious DNS traffic is DNS Zone Transfers.

DNS zone transfers, are a way to replicate DNS databases across a group of DNS servers.

Click to go back to slide 152

2.2.4.1 Malicious DNS Traffic Example

While DNS records are not sensitive individually, if an attacker manages to obtain a copy of the entire DNS zone for a domain (for example by means of an attacker-initiated AXFR request), they may obtain a complete listing of all hosts in that zone.

2.2.4.1 Malicious DNS Traffic Example

Detection

Here we see 3 packets & all packets share one transaction ID. We also see some AXFR which let's us know that this DNS Query is pertaining to a DNS Zone Transfer.

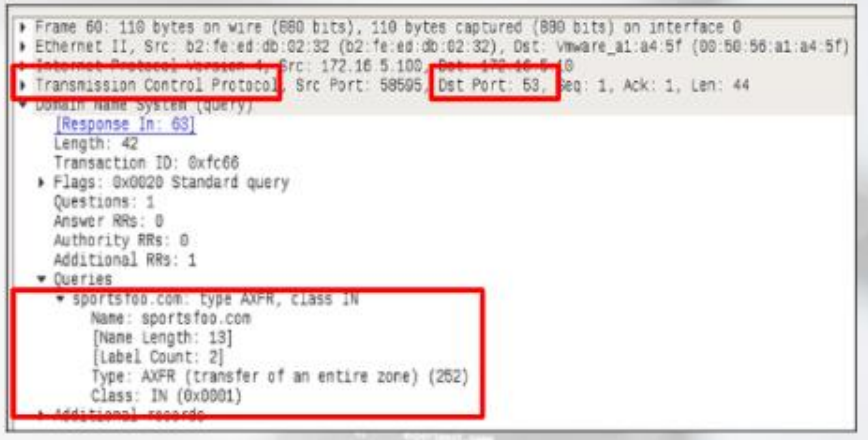
Let's take a closer look at the packet details for this zone transfer.

2.2.4.1 Malicious DNS Traffic Example

Detection

Here we see details of packet #60, which is a zone transfer. We also see that instead of using UDP/53 this DNS Query used TCP/53. Also in case you didn't know that AXFR referred to a zone transfer the clue is within the packet details.

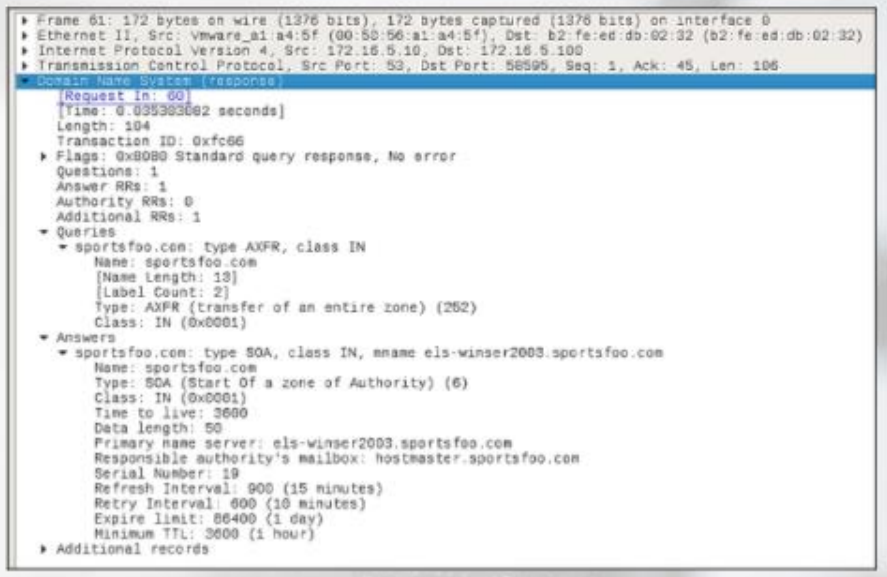
So why was TCP used instead of UDP? This occurs when the response to a DNS query is too large to fit within a single UDP packet. So the query is resubmitted via TCP to retrieve the entire contents of the response. DNS Responses for zone transfer occur over TCP/53.



2.2.4.1 Malicious DNS Traffic Example

Detection

Here we see details of packet #61, which is the response to the zone transfer.



OUTLINE

2.2.4 DNS

There are other techniques in which DNS can be used for nefarious purposes, such as **DNS tunnels**. We will cover those later in the course.

2.3

Effectively Using Open Source IDS

OUTLINE

2.3 Effectively Using Open Source IDS

Now that we have seen our fair share of packets on the wire, it's time to automate the detection of malicious traffic, by using open source Intrusion Detection Systems.

Specifically, we will cover Snort, Bro & Suricata through a serious of extensive, in-depth and hands-on labs.

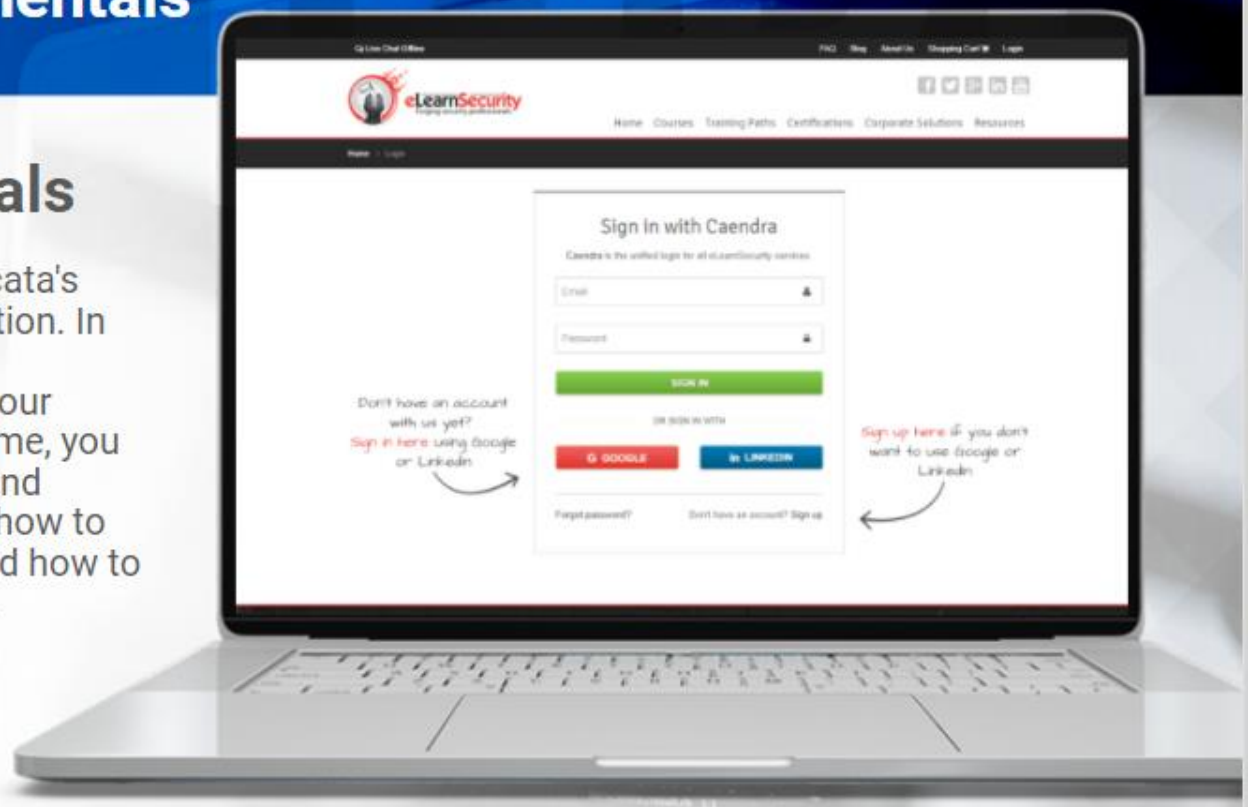
2.3 Effectively Using Open Source IDS

During those labs, you will not only get familiar with their detection capabilities, but you will also learn effective rule writing and how to detect whole classes of attacks.

LAB: Suricata Fundamentals

Suricata Fundamentals

In this lab, you will learn about Suricata's capabilities, features and configuration. In addition, you will get familiar with configuring Suricata, according to your detection needs and, at the same time, you will learn all about Suricata Inputs and Outputs. Finally, you will be shown, how to effectively parse Suricata output and how to extract critical information out of it.



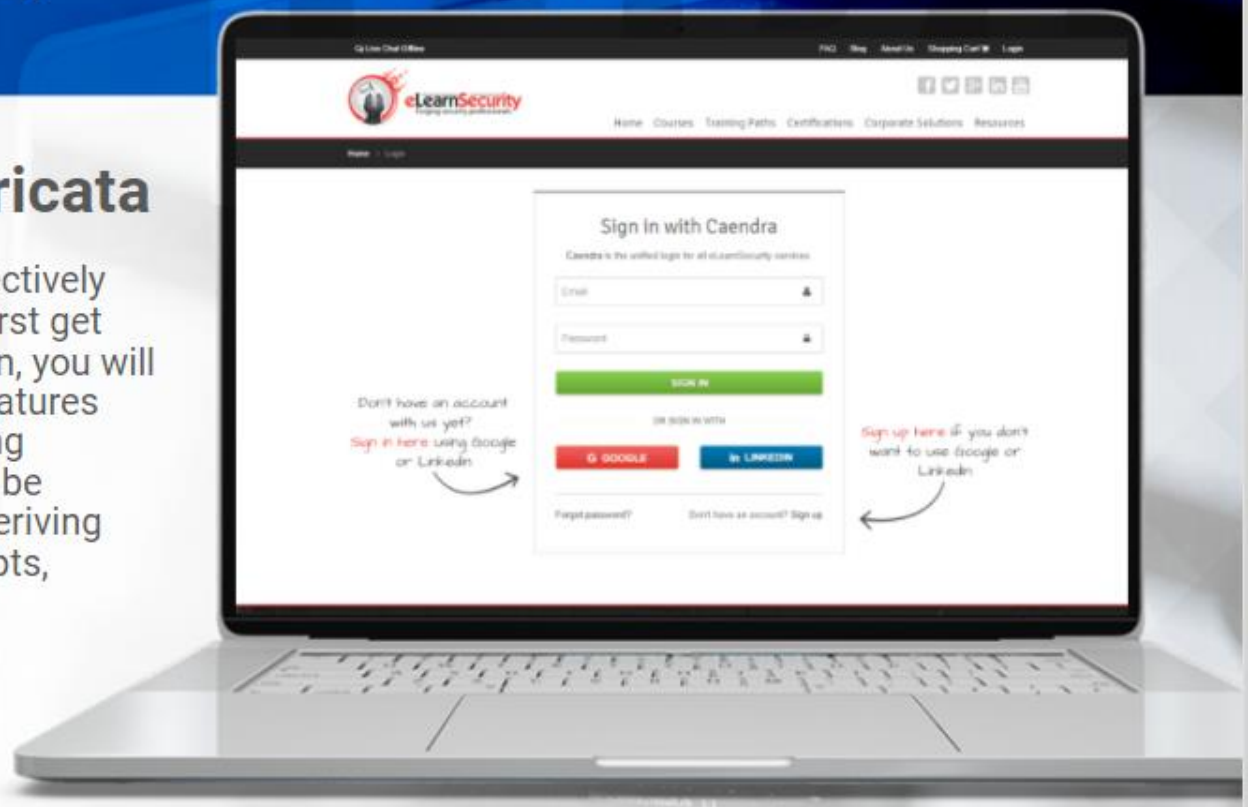
To access, go to the course in your members area and click the lab drop-down in the appropriate module line to access a lab, or go to the virtual labs tab on the left navigation.

OUTLINE

LAB: Effectively Using Suricata

Effectively Using Suricata

In this lab, you will learn how to effectively use Suricata. Specifically, you will first get familiar with Suricata rules, and then, you will learn how to develop your own signatures after analyzing PCAP files containing malicious traffic. Suricata rules will be written to detect malicious traffic deriving from Ransomware, Phishing Attempts, Trojans and Malicious Documents.



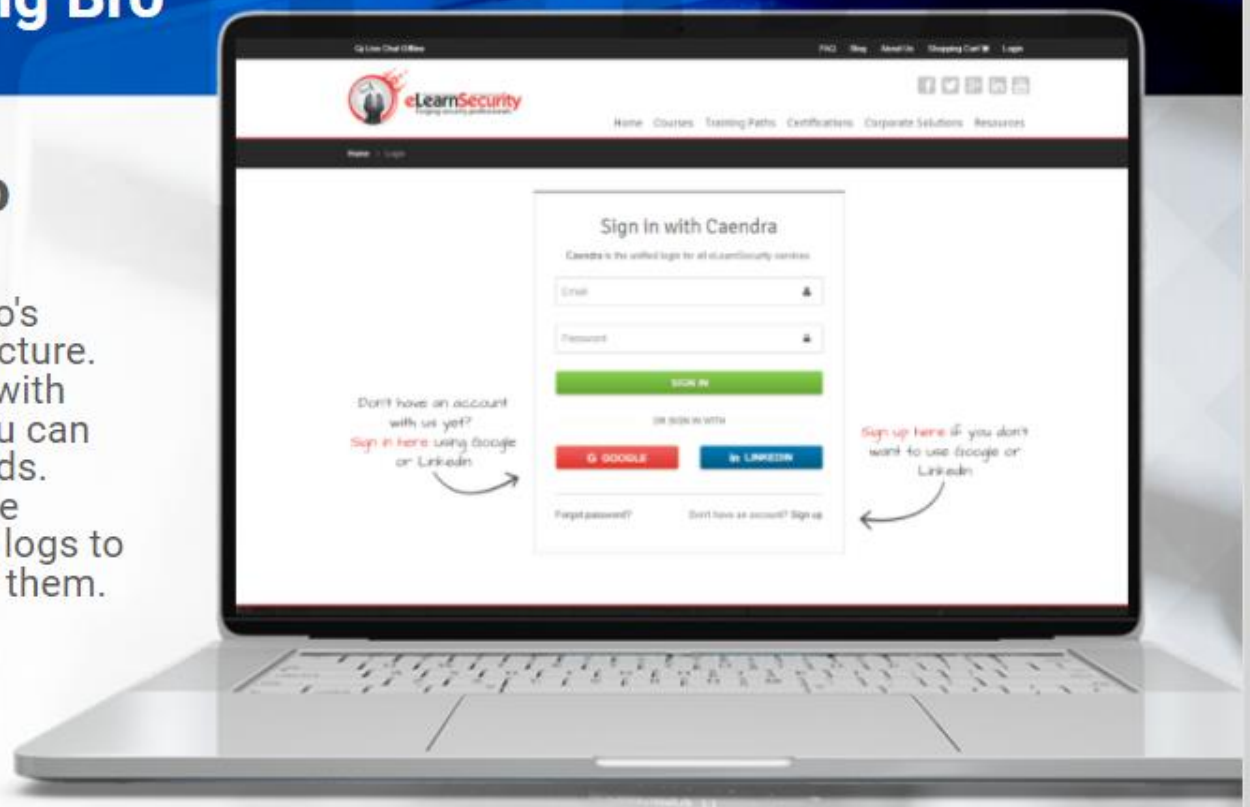
To access, go to the course in your members area and click the lab drop-down in the appropriate module line to access a lab, or go to the virtual labs tab on the left navigation.

OUTLINE

LAB: Effectively Using Bro

Effectively Using Bro

In this lab, you will learn about Bro's capabilities, features, and architecture. Additionally, you will get familiar with effective Bro scripting, so that you can make Bro suit your detection needs. Finally, you will be shown effective manipulation and analysis of Bro logs to extract critical information out of them.



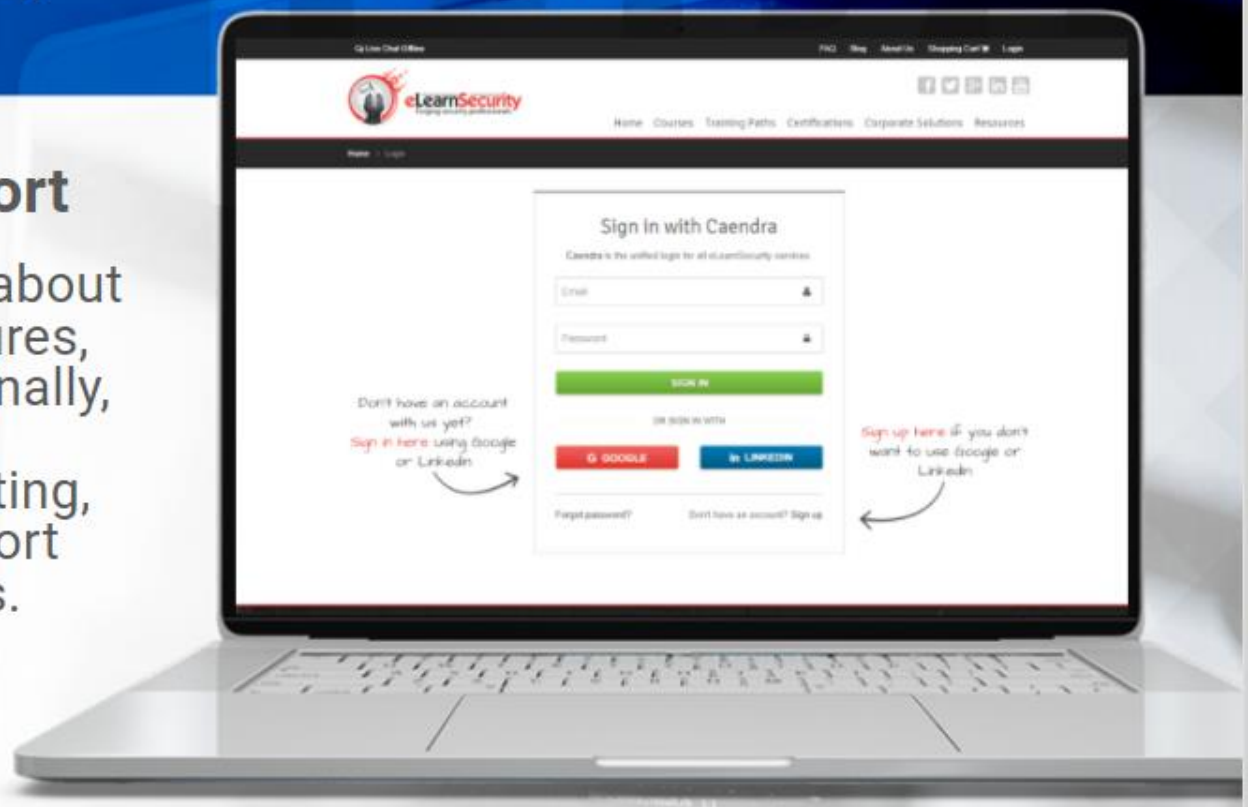
To access, go to the course in your members area and click the lab drop-down in the appropriate module line to access a lab, or go to the virtual labs tab on the left navigation.

OUTLINE

LAB: Effectively Using Snort

Effectively Using Snort

In this lab, you will learn about Snort's capabilities, features, and architecture. Additionally, you will get familiar with effective Snort rule scripting, so that you can make Snort suit your detection needs.



**To access, go to the course in your members area and click the lab drop-down in the appropriate module line to access a lab, or go to the virtual labs tab on the left navigation.*

OUTLINE

References

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https://tools.ietf.org/html/rfc1323

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ONC RPC

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DCE RPC

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References

RFC 2616

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SQL injection

https://www.acunetix.com/websitesecurity/sql-injection/

Sqlmap

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References

RFC 5246

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RFC 8446

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SSL Renegotiation Attack

https://blog.qualys.com/ssllabs/2011/10/31/tls-renegotiation-and-denial-of-service-attacks

Domain names - concepts and facilities

https://www.ietf.org/rfc/rfc1034.txt

References

Domain names - implementation and specification

https://www.ietf.org/rfc/rfc1035.txt

Transaction IDs

https://technet.microsoft.com/en-us/library/dd197470(v=ws.10).aspx

Labs

Suricata Fundamentals

In this lab, you will learn about Suricata's capabilities, features and configuration. In addition, you will get familiar with configuring Suricata, according to your detection needs and, at the same time, you will learn all about Suricata Inputs and Outputs. Finally, you will be shown, how to effectively parse Suricata output and how to extract critical information out of it.

Effectively Using Suricata

In this lab, you will learn how to effectively use Suricata. Specifically, you will first get familiar with Suricata rules, and then, you will learn how to develop your own signatures after analyzing PCAP files containing malicious traffic. Suricata rules will be written to detect malicious traffic deriving from Ransomware, Phishing Attempts, Trojans and Malicious Documents.

**To access, go to the course in your members area and click the lab drop-down in the appropriate module line to access a lab, or go to the virtual labs tab on the left navigation.*

Labs

Effectively Using Bro

In this lab, you will learn about Bro's capabilities, features, and architecture. Additionally, you will get familiar with effective Bro scripting, so that you can make Bro suit your detection needs. Finally, you will be shown effective manipulation and analysis of Bro logs to extract critical information out of them.

Effectively Using Snort

In this lab, you will learn about Snort's capabilities, features, and architecture. Additionally, you will get familiar with effective Snort rule scripting, so that you can make Snort suit your detection needs.

**To access, go to the course in your members area and click the lab drop-down in the appropriate module line to access a lab, or go to the virtual labs tab on the left navigation.*

OUTLINE