Introduction to Digital Forensics Assignment 2

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Introduction to Digital Forensics for Cybercrime

Motivation and Goals

DDoS attacks, short for Distributed Denial of Service attacks, are a type of cyber attack during which an attacker attempts to flood a server with traffic to overwhelm its infrastructure. These attacks are an ever growing problem, with an increasing number of targets falling victim to such attacks. A report from Zayo Group Holdings, Inc. reveals that in the early part of 2023, DDoS attacks were up to 200% in comparison to 2022 (Jackson, 2023). Microsoft alone mitigated upward to 520,000 unique attacks against their global infrastructure in the year 2022 (Azure Network Security Team, 2023) . According to Microsoft in 2022, the majority of the DDoS attacks were TCP attack vectors, making up 63% of all attack traffic (Azure Network Security Team, 2023).

There are different types of DDoS attacks. Three categories that can be defined are User Datagram Protocol (UDP)-based attacks, Transmission Control Protocol (TCP)-based attacks and Application layer attacks. During this experiment, a look will be taken at SYN-flood attacks, which fall under the category TCP-based attacks.

Most people do not have the resources to perform a large DDoS attack themselves, but booter and stressor services are easily available online. In order to make use of these illegal services, a user does not have to go to the dark web, as an individual can type in “booter”, “stresser”, “DDoSer” or a similar query into a search engine like Google, and get a list of booter services available to them. A person can then pay these providers a small sum of money, even as little as 5 USD, to perform a DDoS attack on a target.

DDoS attacks happen across a lot of different sectors, like governmental organisations, financial institutions like banks, but also in gaming communities and in schools. These attacks can have a large impact on the workings of these organisations as their services become unavailable when they are DDoS’ed. Making, selling and spreading DDoS attacks is a punishable offence according to the Dutch law. Still, a lot of DDoS attacks are not tracked and punished, either because the victim of the attack does not contact authorities - think of gamers that were DDoS’ed during an online game - or because the perpetrator of the attack cannot be found. This could be either because of a lack of resources or because it can be difficult to trace an attack back to the individual who bought the booter services.

Considering the fact that DDoS attacks are a growing problem that can have severe consequences on society and the lives of individual people, it is important to take action to protect against these attacks. In order to be able to do this, it is important to have a good understanding of how these attacks are performed, how to identify specific kinds of DDoS attacks, how to analyse them and to know which information about the perpetrator and the attack can be found during an analysis. The goal of this experiment is to gain this understanding by performing a DDoS attack and analysing the capture of the attack.

Methodology and Results

In order to investigate and understand the phenomenon of DDoS attacks, a mock-attack was performed on September 27th during the second lecture of Introduction to Digital Forensics for the minor Cybersecurity and Cybercrime. The idea behind this was to give students hands-on experience with DDoS attacks and what happens when an attack is performed. The teacher set up a local network within the University network so the actual University network was not used or damaged in any way.

The software used to perform this attack was the Anon Cannon software, which is a DoS software that allows users to perform a DoS attack on a target. Roughly 17 participants used their laptop with the Anon Cannon software, together performing a DDoS attack on the teacher's router. The 'attackers' all selected the same IP-address of the router, selected the same port, port 80, and at the same time, started to attack the router.

This type of attack, where a port is flooded with connection requests (SYN) packets, is called a SYN flood attack. With this attack, an attacker takes advantage of the three way handshake process of a TCP connection. The attacker exploits the fact that, after sending an initial SYN packet, a server will respond with one or more SYN/ACK packets and will wait for the final step, which is the receiving of the ACK. By sending a lot of SYN packets, the server temporarily has to open a lot of open ports, which results in legitimate users not being able to connect and also possibly to the crashing of the server.

Port 80 is the port number assigned to the Hypertext Transfer Protocol (HTTP) under TCP protocol.

During the attack, the teacher ran a wireshark capture to capture all traffic over the router. The teacher then sent the capture of the attack to their students with the questions below.

1. How many records are in the entire trace?

   There are a total of 620304 packets (See Fig. 1).

   Statistics

Measurement	Captured
Packets	620304
Time span, s	90.174

   Fig. 1. Capture File Properties.

2. What is the duration of the entire trace?

   The duration of the entire trace is 90.174052 seconds (see Fig. 1).

3. Add print-screens of 3 examples of packets that are NOT part of the attack. Explain what those packets are.

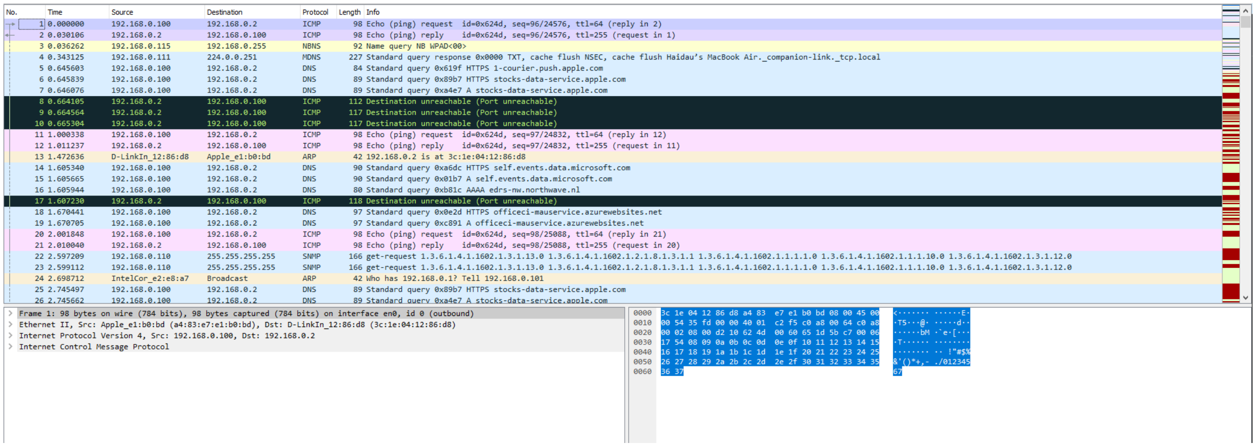


Fig. 2. Packet 1, A ping request from Apple_e1:b0:bd to D-LinkIn_12:86:d8.

Fig.2 displays packet 1, which is a ping request from an Apple device to a D-Link device.

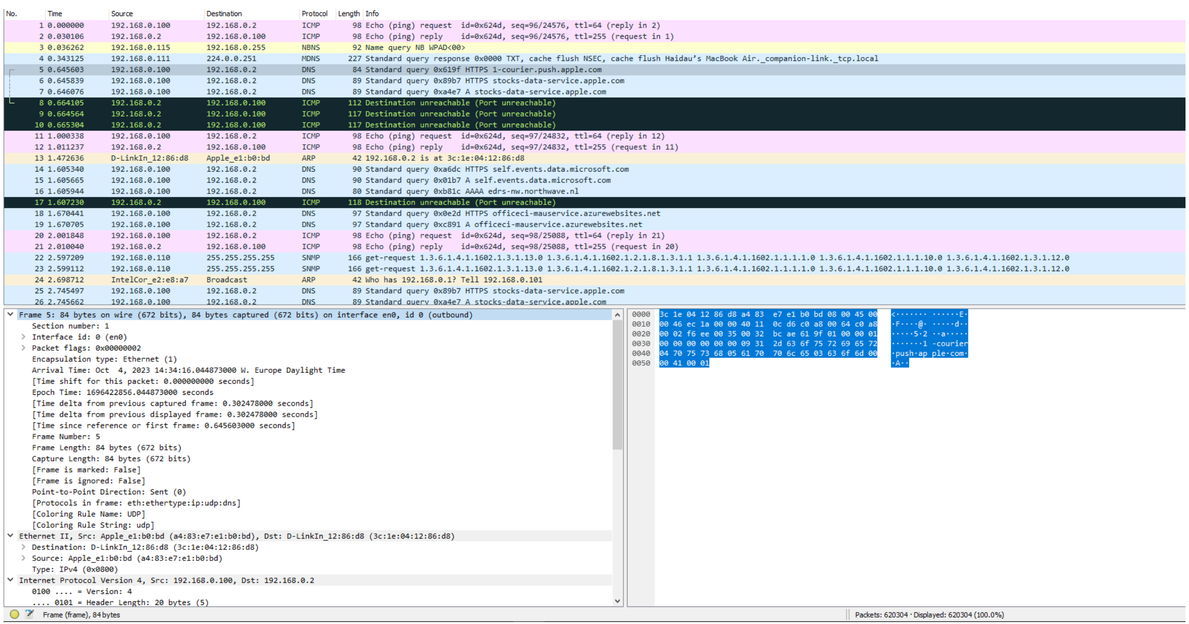


Fig. 3. Packet 5, query to the DNS for https connection to 1-courier.push.apple.com.

Fig. 3 shows packet 5, which is a DNS query, requesting an HTTPS connection to "*1-courier.push.apple.com*".

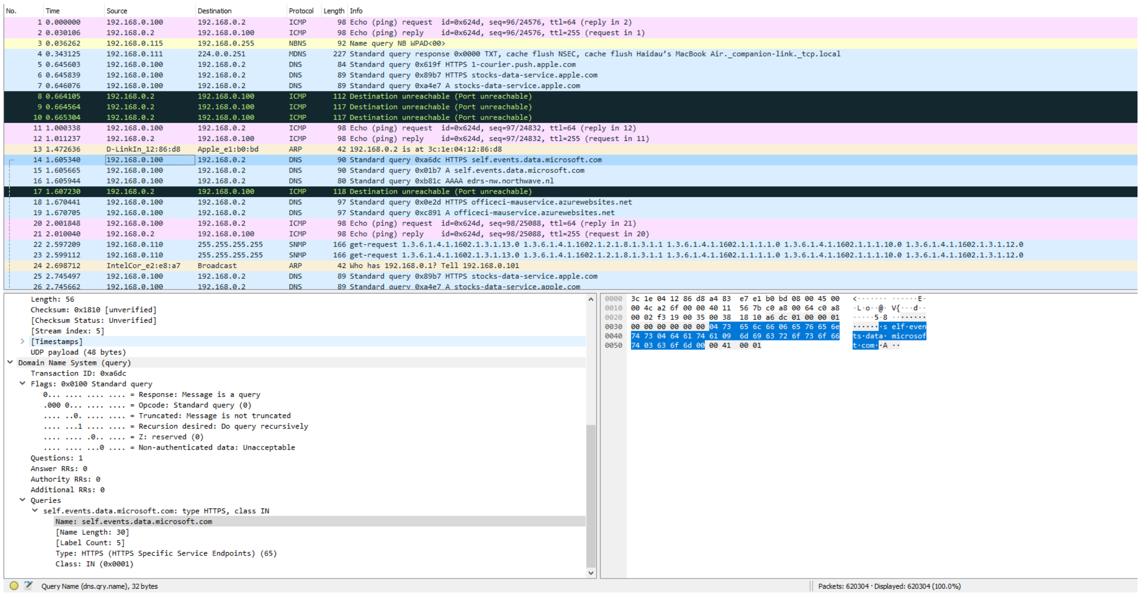


Fig. 4. Packet 14, query to the DNS for https connection to self.events.data.microsoft.com.

In Fig. 4, a packet can be seen that is a DNS query requesting an HTTPS connection to "self.events.data.microsoft.com"

4. What are the characteristics of the attack (aka fingerprint)? Remember: the fingerprint are the characteristics that most repeats targeting a single destination IP. Traffic FROM the victim to the IP addresses in the network trace are NOT part of the attack. Tip: isolate 1 source and 1 destination IP and see if the same pattern applies to the other source IP addresses.

   The attack's fingerprint can be marked by several characteristics. Firstly, all the source addresses that are coming from the same Network ID, 192.168.0, indicate that it is a coordinated attack from people from the same network. Secondly, traffic to the IP address all uses the Transmission Control Protocol (TCP) as its main communication protocol. Lastly, the attack only targets the destination port 80.

5. How a Wireshark filter of the attack looks like?

   In order to filter for the attack, a filter needs to be made for SYN packets without an acknowledgement. This means that the the filter needs to look for packets that do contain a SYN, but that do not contain an acknowledgement:

   tcp.flags.syn == 1 and tcp.flags.ack == 0

6. What is the target (destination) IP of the attack?

   The target IP of the attack is 192.168.0.100.

7. How many records are part of the attack?

   When we filter for the attack in specific, we can see that a total of 308074 packets have been sent in the attack (see Fig.5).

Wireshark · Protocol Hierarchy Statistics · attack.pcap

Protocol	Percent Packets	Packets	Percent Bytes	Bytes	Bits/s	End Packets	End Bytes	End Bits/s	PDUs
Frame	100.0	308074	100.0	21977340	2252 k	0	0	0	308074
Ethernet	100.0	308074	23.0	5056044	518 k	0	0	0	308074
Internet Protocol Version 4	100.0	308074	28.0	6161480	631 k	0	0	0	308074
Transmission Control Protocol	100.0	308061	49.0	10758168	1102 k	307972	10754996	1102 k	308061
VSS Monitoring Ethernet trailer	0.0	89	0.0	712	72	89	712	72	89
Internet Control Message Protocol	0.0	13	0.0	936	95	13	936	95	13

Display filter: tcp.flags.syn == 1 and tcp.flags.ack == 0

Fig. 5, The Protocol Hierarchy with the aforementioned filter shows that 308074 packets were sent in the attack.

8. How many unique (source) IP addresses performed the attack?

Wireshark · Source and Destination Addresses · attack.pcap

Topic / Item	Count	Average	Min Val	Max Val	Rate (ms)	Percent	Burst Rate	Burst Start
Source IPv4 Addresses	308074				3.9473	100%	79.3500	84.029
192.168.0.117	42845				0.5490	13.91%	24.2000	80.986
192.168.0.104	31431				0.4027	10.20%	21.4800	84.037
192.168.0.107	30389				0.3894	9.86%	17.2500	77.947
192.168.0.108	29190				0.3740	9.47%	26.5300	84.029
192.168.0.110	27744				0.3555	9.01%	14.7300	62.034
192.168.0.116	27109				0.3473	8.80%	26.5600	87.104
192.168.0.112	24783				0.3175	8.04%	21.6500	87.103
192.168.0.106	18883				0.2419	6.13%	20.4300	89.468
192.168.0.109	15058				0.1929	4.89%	7.0000	47.674
192.168.0.111	14635				0.1875	4.75%	6.6100	87.104
192.168.0.102	14072				0.1803	4.57%	7.4300	13.017
192.168.0.114	13866				0.1777	4.50%	11.9800	58.995
192.168.0.115	8057				0.1032	2.62%	8.8400	58.993
192.168.0.101	5857				0.0750	1.90%	6.1700	13.557
192.168.0.105	4114				0.0527	1.34%	6.1900	78.213
192.168.0.100	28				0.0004	0.01%	0.0100	45.287
192.168.0.2	13				0.0002	0.00%	0.0100	45.331
Destination IPv4 Addresses	308074				3.9473	100%	79.3500	84.029
192.168.0.100	308046				3.9469	99.99%	79.3500	84.029
5.79.104.167	28				0.0004	0.01%	0.0100	45.287

Display filter: tcp.flags.syn == 1 and tcp.flags.ack == 0

Fig. 6. IPv4 Source and Destination Addresses of the attack.

Looking at the IPv4 statistics from the source and destination addresses and filtering on the attack (see Fig. 6), it can be seen that a total of 17 unique IP addresses performed the attack.

9. Which top 3 source IP addresses sent more packets in the attack?

   The top 3 source IP addresses that sent the most packets in the attack are:

   192.168.0.117

   192.168.0.104

   192.168.0.107

10. What is the distribution of <u>vendors</u> related to the source IP addresses involved in the attack? Tip: use MAC address to Vendor. Ask Google or ChatGPT

    14:4f:8a:dc:a0:87 = Intel

    64:6e:e0:cf:6b:c4 = Intel

    a4:83:e7:26:69:86 = Apple

    d4:57:63:d3:6b:02 = Apple

    10:6f:d9:2f:32:a9 = Cloud network technology singapore

    14:85:7f:e2:e8:a7 = Intel

    14:85:7f:e3:99:14 = Intel

    14:85:7f:e3:99:41 = Intel

    34:cf:f6:f9:a3:12 = Intel

    3c:1e:04:12:86:d8 = D-Link international

    3c:22:fb:62:ad:66 = Apple

    80:65:7c:d5:2a:2b = Apple

8a:04:32:9a:ed:63 = Not Found -This device has a Locally Administered Address, instead of a Globally Unique Address like the other devices. This is likely why the vendor of the address cannot be found.

    94:e2:3c:87:a3:6b = Intel

    a4:34:d9:4e:0b:88 = Intel

a4:83:e7:e1:b0:bd = Apple

b0:a4:60:f4:14:60 = Intel

There are 9 MAC addresses linked to Intel devices, 5 to Apple devices, 1 to D-Link international, 1 to Cloud Network Technology Singapore and 1 not found.

11. What is/are the source and destination port(s) involved in the attack?

    The attack is targeted at destination port 80, the source ports involved in the attack have a very large range of ports.

12. Why there are many packets from the victim to the attackers?

    There are many packets from the victim to the attackers, because those consist of the second step of the TCP handshake, where the victim sends SYN/ACK packets after receiving SYN packets.

13. How this attack could have been more successful?

    Several strategies could have been implemented to make the attack more successful. Firstly, increasing the amount of packets. Secondly, increasing the amount of devices participating in the attack could have boosted the attack's impact. Moreover, increasing the length of the attack could have increased its chances of success.

14. How much was the data rate peak of the attack [Mbits/second]?

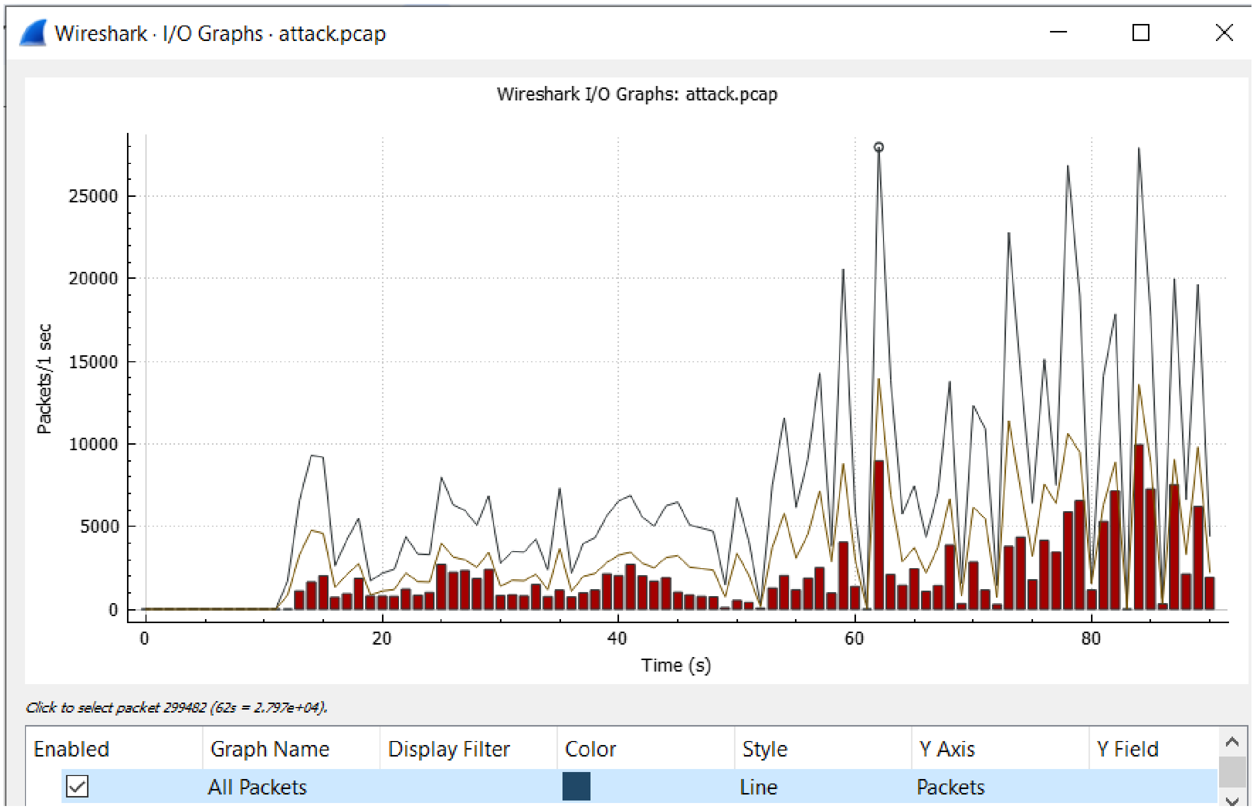


Fig. 7. An overview of the amount of packets that were sent per second.

At the 62nd second, 7.8 Mbits/s was the highest amount of Mbits/s during this attack (see Fig. 7).

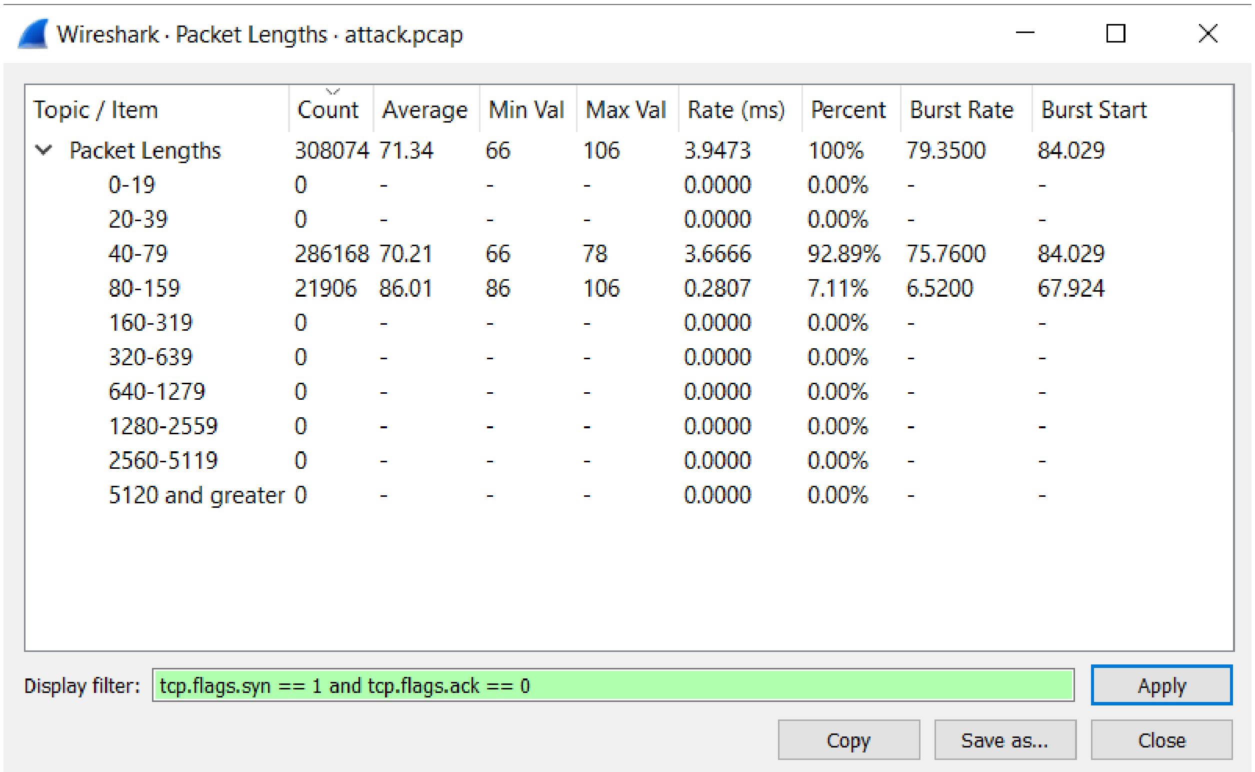
15. What is the distribution/frequency of TCP flags involved in the attack?

The total number of TCP packets was 619,412 packets.
tcp.flags.ack == 1 results in 311,351 packets.
The filter tcp.flags.syn == 1 results in 308,061 packets.
311,351 + 308,061 = 619,412 packets, so these flags combined result in all of the packets.
Therefore, the distribution of TCP flags in the attack was:

tcp.flags.ack == 1 : 50.3%

tcp.flags.syn == 1 : 49.7%

16. What is the distribution/frequency of packet length ("total length")?



Topic / Item	Count	Average	Min Val	Max Val	Rate (ms)	Percent	Burst Rate	Burst Start
Packet Lengths	308074	71.34	66	106	3.9473	100%	79.3500	84.029
0-19	0	-	-	-	0.0000	0.00%	-	-
20-39	0	-	-	-	0.0000	0.00%	-	-
40-79	286168	70.21	66	78	3.6666	92.89%	75.7600	84.029
80-159	21906	86.01	86	106	0.2807	7.11%	6.5200	67.924
160-319	0	-	-	-	0.0000	0.00%	-	-
320-639	0	-	-	-	0.0000	0.00%	-	-
640-1279	0	-	-	-	0.0000	0.00%	-	-
1280-2559	0	-	-	-	0.0000	0.00%	-	-
2560-5119	0	-	-	-	0.0000	0.00%	-	-
5120 and greater	0	-	-	-	0.0000	0.00%	-	-

Fig. 8. Statistics of Packet Lengths in Wireshark.

Looking at the statistics of the packet lengths and filtering on the attack (see Fig. 8), it can be seen that the majority of the packets have a length between 40-79, the remaining packets have a length between 80-159.

17. What source IP address sent more packets? and why?

The IP address that sent the most packets is 192.168.0.100, this is the local router against which the attack was performed. It makes sense that a large quantity of packets were sent from here, because the router had to send SYN/ACK packets after all of the received SYN packets.

Conclusion & Reflection

The goal of this experiment was to gain an understanding of how DDoS attacks are performed, how to identify specific kinds of DDoS attacks, how to analyse them and how to know which information about the perpetrator of the attack can be found during an analysis. This goal was tried to be achieved by performing a DDoS attack and analysing the capture of this attack.

In conclusion, the research into the simulated DDoS attack gave insight into how to identify, analyse and find helpful information about these kinds of attacks. With the use of

Wireshark attack characteristics, source and target IP address, top attackers and MAC addresses could be identified.

This assignment showed how easily a DDoS attack can be performed, a group of people can set up an attack by using easily available tools. Therefore, this indicates the importance of cybersecurity measures to combat these attacks.

Because only a singular type of DDoS attack was analysed, most understanding was gained for this type of attack. Doing an experiment that also included other types of attacks could have ensured an understanding of multiple types of attacks and therefore also a greater understanding of DDoS attacks in general.

Furthermore, the way this attack was performed, using a relatively small amount of laptops on one network differs from how most real DDoS attacks are performed. Analysing and finding information about a real world DDoS attack that for example made use of a botnet, might still prove difficult, even with the knowledge gained during this experiment. Additionally, IP-addresses were relatively easy to find during this attack considering no attempts to conceal IP-addresses were made. Analysing this attack did not supply a basis with which an attack that uses a VPN or IP-spoofing could be analysed. Moreover, a lot of DDoS attacks are instigated with the use of a booter service. During this experiment, no further understanding about this phenomenon was gained.

Still, considering the size and timeframe of this experiment and the fact that it served as more of an introduction to DDoS attacks, it might be for the better that all points in the above mentioned paragraph were not added. Adding these other factors might have made the level of experience and understanding needed for this experiment too high and would also mean that the analysis or other ways of acquiring knowledge would take a significantly longer time, which would not be realistic.

References

Azure Network Security Team. (2023, February 21). *2022 in review: DDoS attack trends and insights*. Microsoft. Retrieved October 18, 2023, from https://www.microsoft.com/en-us/security/blog/2023/02/21/2022-in-review-ddos-attack-trends-and-insights/

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