Analyze Network Attacks

Scenario

You work as a security analyst for a travel agency that advertises sales and promotions on the company's website. The employees of the company regularly access the company's sales webpage to search for vacation packages their customers might like.
One afternoon, you receive an automated alert from your monitoring system indicating a problem with the web server. You attempt to visit the company's website, but you receive a connection timeout error message in your browser.
You use a packet sniffer to capture data packets in transit to and from the web server. You notice a large number of TCP SYN requests coming from an unfamiliar IP address. The web server appears to be overwhelmed by the volume of incoming traffic and is losing its ability to respond to the abnormally large number of SYN requests. You suspect the server is under attack by a malicious actor.
You take the server offline temporarily so that the machine can recover and return to a normal operating status. You also configure the company's firewall to block the IP address that was sending the abnormal number of SYN requests. You know that your IP blocking solution won't last long, as an attacker can spoof other IP addresses to get around this block. You need to alert your manager about this problem quickly and discuss the next steps to stop this attacker and prevent this problem from happening again. You will need to be prepared to tell your boss about the type of attack you discovered and how it was affecting the web server and employees.

Log Read: Wireshark TCP/HTTP log

In this reading, you'll learn how to read a Wireshark TCP/HTTP log for network traffic between employee website visitors and the company's web server. Most network protocol/traffic analyzer tools used to capture packets will provide this same information.

Log entry number and time

No.	Time
47	3.144521
48	3.195755
49	3.246989

This Wireshark TCP log section provided to you starts at log entry number (No.) 47, which is three seconds and .144521 milliseconds after the logging tool started recording. This indicates that approximately 47 messages were sent and received by the web server in the 3.1 seconds after starting the log. This rapid traffic speed is why the tool tracks time in milliseconds.

Source and destination IP addresses

Source	**Destination**
198.51.100.23	192.0.2.1
192.0.2.1	198.51.100.23
198.51.100.23	192.0.2.1

The source and destination columns contain the source IP address of the machine that is sending a packet and the intended destination IP address of the packet. In this log file, the IP address 192.0.2.1 belongs to the company's web server. The range of IP addresses in 198.51.100.0/24 belong to the employees' computers.

Protocol type and related information

Protocol	**Info**
TCP	42584->443 [SYN] Seq=0 Win-5792 Len=120...
TCP	443->42584 [SYN, ACK] Seq=0 Win-5792 Len=120...
TCP	42584->443 [ACK] Seq=1 Win-5792 Len=120...

The Protocol column indicates that the packets are being sent using the TCP protocol, which is at the transport layer of the TCP/IP model. In the given log file, you will notice that the protocol will eventually change to HTTP, at the application layer, once the connection to the web server is successfully established.

The Info column provides information about the packet. It lists the source port followed by an arrow → pointing to the destination port. In this case, port 443 belongs to the web server. Port 443 is normally used for encrypted web traffic.

The next data element given in the Info column is part of the three-way handshake process to establish a connection between two machines. In this case, employees are trying to connect to the company's web server:

- The [SYN] packet is the initial request from an employee visitor trying to connect to a web page hosted on the web server. SYN stands for “synchronize.”
- The [SYN, ACK] packet is the web server’s response to the visitor’s request agreeing to the connection. The server will reserve system resources for the final step of the handshake. SYN, ACK stands for “synchronize acknowledge.”
- The [ACK] packet is the visitor’s machine acknowledging the permission to connect. This is the final step required to make a successful TCP connection. ACK stands for “acknowledge.”

The next few items in the Info column provide more details about the packets. However, this data is not needed to complete this activity. If you would like to learn more about packet properties, please visit Microsoft’s Introduction to Network Trace Analysis.

Normal website traffic

A normal transaction between a website visitor and the web server would be like:

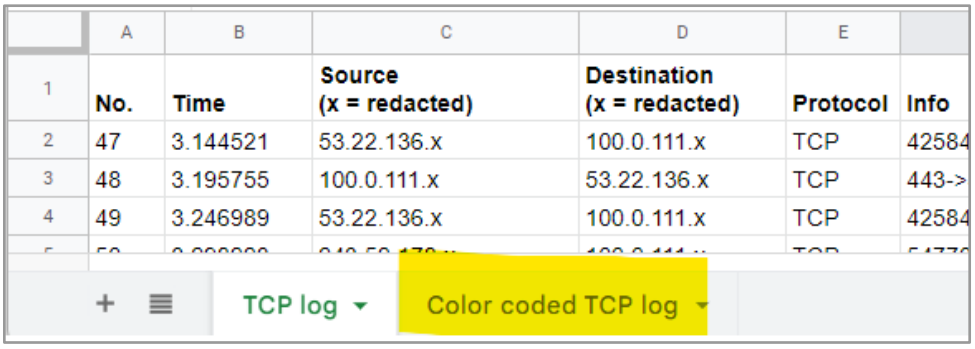
No.	Time	Source	Destination	Protocol	Info
47	3.144521	198.51.100.23	192.0.2.1	TCP	42584->443 [SYN] Seq=0 Win=5792 Len=120...
48	3.195755	192.0.2.1	198.51.100.23	TCP	443->42584 [SYN, ACK] Seq=0 Win-5792 Len=120...
49	3.246989	198.51.100.23	192.0.2.1	TCP	42584->443 [ACK] Seq=1 Win-5792 Len=120...
50	3.298223	198.51.100.23	192.0.2.1	HTTP	GET /sales.html HTTP/1.1
51	3.349457	192.0.2.1	198.51.100.23	HTTP	HTTP/1.1 200 OK (text/html)

Notice that the handshake process takes a few milliseconds to complete. Then, you can identify the employee’s browser requesting the sales.html webpage using the HTTP protocol at the application level of the TCP/IP model. Followed by the web server responding to the request.

The Attack

As you learned previously, malicious actors can take advantage of the TCP protocol by flooding a server with SYN packet requests for the first part of the handshake. However, if the number of SYN requests is greater than the server resources available to handle the requests, then the server will become overwhelmed and unable to respond to the requests. This is a network level denial of service (DoS) attack, called a SYN flood attack, that targets network bandwidth to slow traffic. A SYN flood attack simulates a TCP connection and floods the server with SYN packets. A DoS direct attack originates from a single source. A distributed denial of service (DDoS)

attack comes from multiple sources, often in different locations, making it more difficult to identify the attacker or attackers.



There are two tabs at the bottom of the log file. One is labeled “Color coded TCP log.” If you click on that tab, you will find the server interactions with the attacker’s IP address (203.0.113.0) marked with red highlighting (and the word “red” in column A).

Color as text	No.	Time	Source (x = redacted)	Destination (x = redacted)	Protocol	Info
red	52	3.390692	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	53	3.441926	192.0.2.1	203.0.113.0	TCP	443->54770 [SYN, ACK] Seq=0 Win-5792 Len=120...
red	54	3.493160	203.0.113.0	192.0.2.1	TCP	54770->443 [ACK Seq=1 Win=5792 Len=0...
green	55	3.544394	198.51.100.14	192.0.2.1	TCP	14785->443 [SYN] Seq=0 Win-5792 Len=120...
green	56	3.599628	192.0.2.1	198.51.100.14	TCP	443->14785 [SYN, ACK] Seq=0 Win-5792 Len=120...
red	57	3.664863	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
green	58	3.730097	198.51.100.14	192.0.2.1	TCP	14785->443 [ACK] Seq=1 Win-5792 Len=120...
red	59	3.795332	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win-5792 Len=120...
green	60	3.860567	198.51.100.14	192.0.2.1	HTTP	GET /sales.html HTTP/1.1
red	61	3.939499	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win-5792 Len=120...

green	62	4.018431	192.0.2.1	198.51.100.14	HTTP	HTTP/1.1 200 OK (text/html)

Initially, the attacker's SYN request is answered normally by the web server (log items 52-54). However, the attacker keeps sending more SYN requests, which is abnormal. At this point, the web server is still able to respond to normal visitor traffic, which is highlighted and labeled as green. An employee visitor with the IP address of 198.51.100.14 successfully completes a SYN/ACK connection handshake with the webserver (log item nos. 55, 56, 58). Then, the employee's browser requests the sales.html webpage with the GET command and the web server responds (log item no. 60 and 62).

Color as text	No.	Time	Source	Destination	Protocol	Info
green	63	4.097363	198.51.100.5	192.0.2.1	TCP	33638->443 [SYN] Seq=0 Win-5792 Len=120...
red	64	4.176295	192.0.2.1	203.0.113.0	TCP	443->54770 [SYN, ACK] Seq=0 Win-5792 Len=120...
green	65	4.255227	192.0.2.1	198.51.100.5	TCP	443->33638 [SYN, ACK] Seq=0 Win-5792 Len=120...
red	66	4.256159	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
green	67	5.235091	198.51.100.5	192.0.2.1	TCP	33638->443 [ACK] Seq=1 Win-5792 Len=120...
red	68	5.236023	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
green	69	5.236955	198.51.100.16	192.0.2.1	TCP	32641->443 [SYN] Seq=0 Win-5792 Len=120...
red	70	5.237887	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
green	71	6.228728	198.51.100.5	192.0.2.1	HTTP	GET /sales.html HTTP/1.1
red	72	6.229638	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
yellow	73	6.230548	192.0.2.1	198.51.100.16	TCP	443->32641 [RST, ACK] Seq=0 Win-5792 Len=120...
red	74	6.330539	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
green	75	6.330885	198.51.100.7	192.0.2.1	TCP	42584->443 [SYN] Seq=0 Win=5792 Len=0...

red	76	6.331231	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
yellow	77	7.330577	192.0.2.1	198.51.100.5	TCP	HTTP/1.1 504 Gateway Time-out (text/html)
red	78	7.331323	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
green	79	7.340768	198.51.100.22	192.0.2.1	TCP	6345->443 [SYN] Seq=0 Win=5792 Len=0...
yellow	80	7.340773	192.0.2.1	198.51.100.7	TCP	443->42584 [RST, ACK] Seq=1 Win-5792 Len=120...
red	81	7.340778	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	82	7.340783	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	83	7.439658	192.0.2.1	203.0.113.0	TCP	443->54770 [RST, ACK] Seq=1 Win=5792 Len=0...

In the next 20 rows, the log begins to reflect the struggle the web server is having to keep up with the abnormal number of SYN requests coming in at a rapid pace. The attacker is sending several SYN requests every second. The rows highlighted and labeled yellow are failed communications between legitimate employee website visitors and the web server.

The two types of errors in the logs include:

- An HTTP/1.1 504 Gateway Time-out (text/html) error message. This message is generated by a gateway server that was waiting for a response from the web server. If the web server takes too long to respond, the gateway server will send a timeout error message to the requesting browser.
- An [RST, ACK] packet, which would be sent to the requesting visitor if the [SYN, ACK] packet is not received by the web server. RST stands for reset, acknowledge. The visitor will receive a timeout error message in their browser and the connection attempt is dropped. The visitor can refresh their browser to attempt to send a new SYN request.

Color as text	**No.**	**Time**	**Source (x = redacted)**	**Destination (x = redacted)**	**Protocol**	**Info**
red	119	19.198705	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...

red	120	19.521718	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
yellow	121	19.844731	192.0.2.1	198.51.100.9	TCP	443->4631 [RST, ACK] Seq=1 Win=5792 Len=0...
red	122	20.167744	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	123	20.490757	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	124	20.81377	192.0.2.1	203.0.113.0	TCP	443->54770 [RST, ACK] Seq=1 Win=5792 Len=0...
red	125	21.136783	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	126	21.459796	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	127	21.782809	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	128	22.105822	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	129	22.428835	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	130	22.751848	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	131	23.074861	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	132	23.397874	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...

red	133	23.720887	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	134	24.0439	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	135	24.366913	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	136	24.689926	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	137	25.012939	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	138	25.335952	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	139	25.658965	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	140	25.981978	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	141	26.304991	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	142	26.628004	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	143	26.951017	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	144	27.27403	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	145	27.597043	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...

red	146	27.920056	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	147	28.243069	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	148	28.566082	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	149	28.889095	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	150	29.212108	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	151	29.535121	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...
red	152	29.858134	203.0.113.0	192.0.2.1	TCP	54770->443 [SYN] Seq=0 Win=5792 Len=0...

As you scroll through the rest of the log, you will notice the web server stops responding to legitimate employee visitor traffic. The visitors receive more error messages indicating that they cannot establish or maintain a connection to the web server. From log item number 125 on, the web server stops responding. The only items logged at that point are from the attack. As there is only one IP address attacking the web server, you can assume this is a direct DoS SYN flood attack.

Analyze network attacks

Section 1: Identify the type of attack that may have caused this network interruption
One potential explanation for the website's connection timeout error message is a DoS attack. The logs show that the web server stops responding after it is overloaded with SYN packet requests. This event could be a type of DoS attack called SYN flooding.

Section 2: Explain how the attack is causing the website malfunction
When the website visitors try to establish a connection with the web server, a three-way handshake occurs using the TCP protocol. The handshake consists of three steps: 1. A SYN packet is sent from the source to the destination, requesting to connect. 2. The destination replies to the source with a SYN-ACK packet to accept the connection request. The destination will reserve resources for the source to connect. 3. A final ACK packet is sent from the source to the destination acknowledging the permission to connect. In the case of a SYN flood attack, a malicious actor will send a large number of SYN packets all at once, which overwhelms the server's available resources to reserve for the connection. When this happens, there are no server resources left for legitimate TCP connection requests. The logs indicate that the web server has become overwhelmed and is unable to process the visitors' SYN requests. The server is unable to open a new connection to new visitors who receive a connection timeout message.