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HTTP Basic Authentication

In this paper, we describe the interactions between the browser and cs338.jeffondich.com's nginx server, and detail how nginx password protection works.

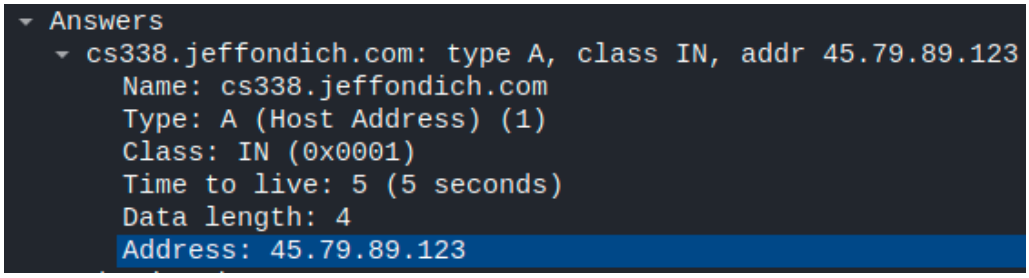
Sequence of events description

1. DNS queries

When we go to http://cs338.jeffondich.com/basicauth/ for the first time, we can see DNS standard queries. Those are issued to get the IP address of the domain name. The client (Kali) sends those DNS queries to the router's address (192.168.8.2), which responds back.

Source	Destination	Protocol	Length	Info
192.168.8.128	192.168.8.2	DNS	80	Standard query 0x782f A cs338.jeffondich.com
192.168.8.128	192.168.8.2	DNS	80	Standard query 0x0bcb AAAA cs338.jeffondich.com
192.168.8.2	192.168.8.128	DNS	390	Standard query response 0x782f A cs338.jeffondich.c
192.168.8.2	192.168.8.128	DNS	159	Standard query response 0x0bcb AAAA cs338.jeffondic

The DNS query response includes the IP address of our host: 45.79.89.123. The type A indication means that the hostname corresponds to an IPv4 address, and class IN refers to the internet. The type AAAA is related to the IPv6 address of the server.



2. TCP Handshake

The image below shows the TCP handshake between the client (Kali) and the server (http://cs338.jeffondich.com/basicauth/). On the first two lines, Kali is trying to connect to the server by sending a [SYN] packet. In the following two lines, the server is responding back to Kali by acknowledging the connection (through [ACK]) and also trying to establish a connection with Kali by sending a [SYN] packet. In the last two lines, Kali is responding back to the server by saying that the connection has been established ([ACK] packet).

```
192.168.8.128    45.79.89.123     TCP    74 43104 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 S
192.168.8.128    45.79.89.123     TCP    74 43106 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 S
45.79.89.123     192.168.8.128    TCP    60 80 → 43104 [SYN, ACK] Seq=0 Ack=1 Win=64240 Len=0
45.79.89.123     192.168.8.128    TCP    60 80 → 43106 [SYN, ACK] Seq=0 Ack=1 Win=64240 Len=0
192.168.8.128    45.79.89.123     TCP    54 43104 → 80 [ACK] Seq=1 Ack=1 Win=64240 Len=0
192.168.8.128    45.79.89.123     TCP    54 43106 → 80 [ACK] Seq=1 Ack=1 Win=64240 Len=0
```

The reason the frames double (2 [SYN], 2 [SYN, ACK], and 2 [ACK]) is that for each pair, one has a Complete status and another has an Incomplete status. This means that Kali and the server try to communicate with each other and fail on the first attempt, so they retry again and complete it on the second attempt.

```
Transmission Control Protocol, Src Port: 43106, Dst Por
  Source Port: 43106
  Destination Port: 80
  [Stream index: 1]
  [Conversation completeness: Incomplete, DATA (15)]
```

```
Transmission Control Protocol, Src Port: 43104, Dst Por
  Source Port: 43104
  Destination Port: 80
  [Stream index: 0]
  [Conversation completeness: Complete, NO_DATA (23)]
```

3. <u>Displaying the page</u>

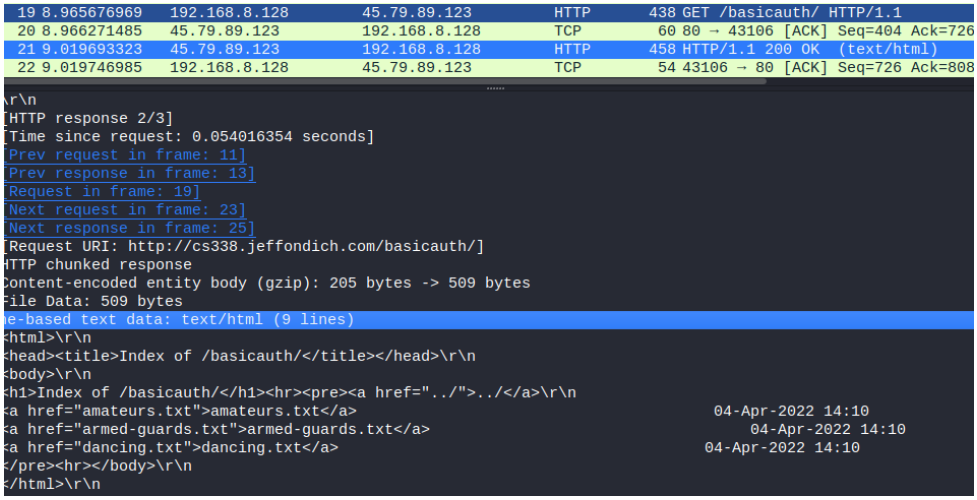
After the TCP handshake, Kali sends a GET request for the page to be displayed. The server then responds with a [ACK] packet, saying that it has received the request and is about to send the response over. In the next frame, the server sends over the content that the user requests if the login credentials are valid; but here, since we are not yet authorized to look at the actual page, the server sends over a HTTP response with code 401(Unauthorized) and a login page for us to type in our username and password as the content.

```
   11 0.139397187   192.168.8.128    45.79.89.123     HTTP     395 GET /basicauth/ HTTP/1.1
   12 0.149558833   45.79.89.123     192.168.8.128    TCP       60 80 → 43106 [ACK] Seq=1 Ack=342 Wi
   13 0.196633715   45.79.89.123     192.168.8.128    HTTP     457 HTTP/1.1 401 Unauthorized  (text/

Hypertext Transfer Protocol
▸ HTTP/1.1 401 Unauthorized\r\n
```

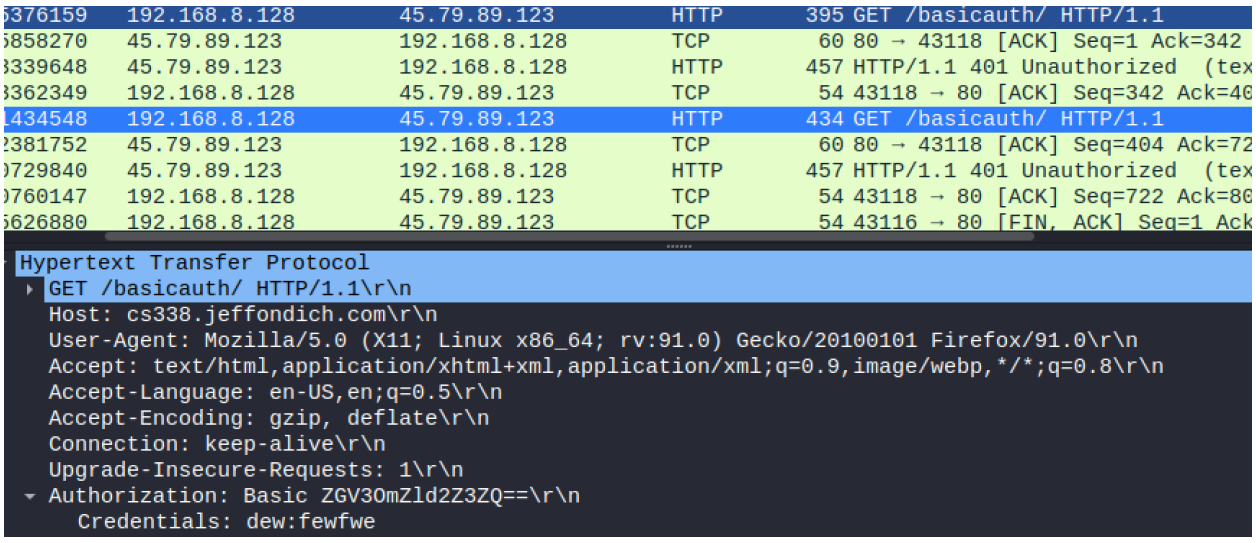
4. <u>After the password is typed by the user</u>

Once we type the correct username and password, we are now authorized to access the content of the page. The authorization happens on the server-side. The browser does this by sending an encrypted username and password over to the server (more on this below) along with the GET request for the homepage. If the credentials are correct, the server sends back the content of the page. We also see some ACK packets in between, which just means that the server/client received the requests/responses.



5. Extra: When the credentials are wrong

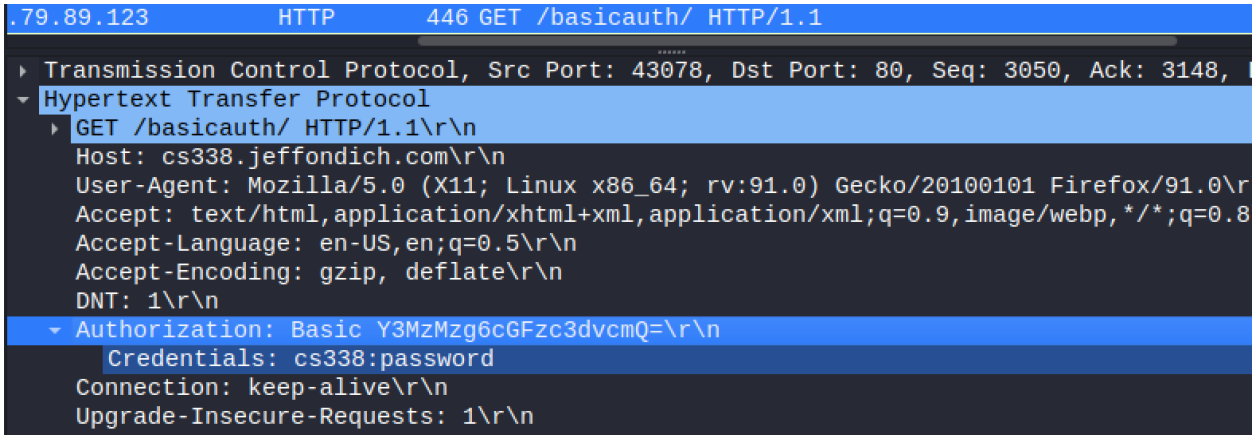
We also observed what happens when we typed the wrong login and password. The first part is the same: the client sends a GET request to the host to get the page /basicauth/, and as it is not authorized, the server responds with the login page. Once we type a wrong credential, the client sends the same GET request to the host, but this time includes the Authorization header with a wrong credential. Again, the server acknowledges, but since the credential is incorrect, the server responds back with the HTTP response with code 401(Unauthorized) and sends back the login page again.



"Authorization" header

When we typed the password and pressed “sign-in”, the client sent a GET request that contained the Authorization header with the password encrypted in base 64 (the hash after “Basic”). We verified that this is the correct encryption by typing Y3MzMzg6cGFzc3dvcmQ= in

the decode section of this Base64 Decoder website. Since base64 is standardized encryption, the client doesn't have to tell the server what the encryption key is. Both the server and client just have to know that the credentials are being sent over with base64 encryption. This is probably a standardized protocol for how credentials are supposed to be sent over through HTTP.



Throughout this exercise, we have observed how the Authentication Credentials are used in the header of HTTP requests. We saw in action how the server would only return a protected page when the GET request for the page has valid credentials inside the Authorization Header field. Finally, we observed all three steps of the TCP handshake.

Citations

https://nginx.org/en/docs/http/ngx_http_auth_basic_module.html