# Q1. Internet working

For this assignment I decided to use a website that doesn't serve HTTPS by default. The reason being I wanted to see how HTTP data can be intercepted and modified. I used the website
`neverssl.com`.

## 1.1 DNS lookup

The first step in the process is to resolve the domain name to an IP address. This is done by querying a DNS server. The DNS server is specified in the network settings of the computer. In my case, the DNS server is `comcast.net`. The DNS server is queried using the `dig` command. The command is shown below:

```
dig neverssl.com
```

The output of the command is shown below:

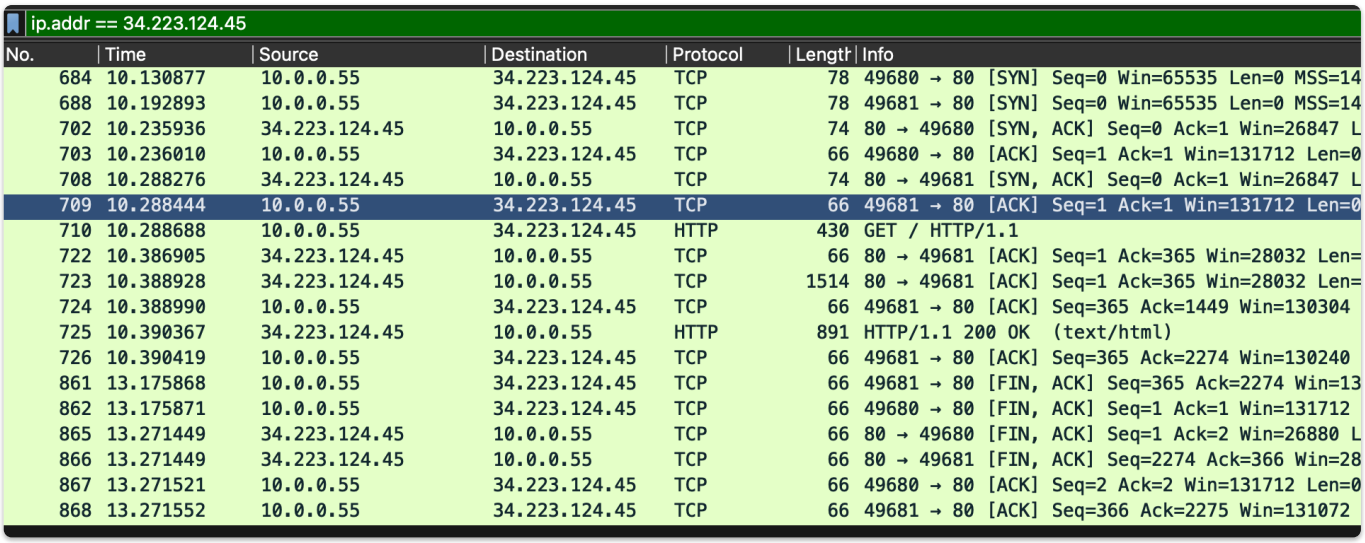
```
; <<>> DiG 9.10.6 <<>> neverssl.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 11543
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 512
;; QUESTION SECTION:
;neverssl.com.                  IN      A

;; ANSWER SECTION:
neverssl.com.           60      IN      A       34.223.124.45

;; Query time: 153 msec
;; SERVER: 2001:558:feed::1#53(2001:558:feed::1)
;; WHEN: Wed Jan 17 18:48:20 EST 2024
;; MSG SIZE  rcvd: 57
```

Then I did a reverse DNS lookup to find the domain name of the IP address.
`dig -x 2001:558:feed::1`

Therefore, the DNS server responds with the IP address of the website. In this case the IP address is for neverSSL.com is `34.223.124.45`

## 1.2 TCP connection

Once the IP address is known, the client initiates a TCP connection with the server. I used a browser to connect to the IP address and wire shark to capture the packets. The packets are shown below:



ip.addr == 34.223.124.45

| No. | Time | Source | Destination | Protocol | Length | Info |
|---|---|---|---|---|---|---|
| 684 | 10.130877 | 10.0.0.55 | 34.223.124.45 | TCP | 78 | 49680 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=14 |
| 688 | 10.192893 | 10.0.0.55 | 34.223.124.45 | TCP | 78 | 49681 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=14 |
| 702 | 10.235936 | 34.223.124.45 | 10.0.0.55 | TCP | 74 | 80 → 49680 [SYN, ACK] Seq=0 Ack=1 Win=26847 L |
| 703 | 10.236010 | 10.0.0.55 | 34.223.124.45 | TCP | 66 | 49680 → 80 [ACK] Seq=1 Ack=1 Win=131712 Len=0 |
| 708 | 10.288276 | 34.223.124.45 | 10.0.0.55 | TCP | 74 | 80 → 49681 [SYN, ACK] Seq=0 Ack=1 Win=26847 L |
| 709 | 10.288444 | 10.0.0.55 | 34.223.124.45 | TCP | 66 | 49681 → 80 [ACK] Seq=1 Ack=1 Win=131712 Len=0 |
| 710 | 10.288688 | 10.0.0.55 | 34.223.124.45 | HTTP | 430 | GET / HTTP/1.1 |
| 722 | 10.386905 | 34.223.124.45 | 10.0.0.55 | TCP | 66 | 80 → 49681 [ACK] Seq=1 Ack=365 Win=28032 Len= |
| 723 | 10.388928 | 34.223.124.45 | 10.0.0.55 | TCP | 1514 | 80 → 49681 [ACK] Seq=1 Ack=365 Win=28032 Len= |
| 724 | 10.388990 | 10.0.0.55 | 34.223.124.45 | TCP | 66 | 49681 → 80 [ACK] Seq=365 Ack=1449 Win=130304 |
| 725 | 10.390367 | 34.223.124.45 | 10.0.0.55 | HTTP | 891 | HTTP/1.1 200 OK (text/html) |
| 726 | 10.390419 | 10.0.0.55 | 34.223.124.45 | TCP | 66 | 49681 → 80 [ACK] Seq=365 Ack=2274 Win=130240 |
| 861 | 13.175868 | 10.0.0.55 | 34.223.124.45 | TCP | 66 | 49681 → 80 [FIN, ACK] Seq=365 Ack=2274 Win=13 |
| 862 | 13.175871 | 10.0.0.55 | 34.223.124.45 | TCP | 66 | 49680 → 80 [FIN, ACK] Seq=1 Ack=1 Win=131712 |
| 865 | 13.271449 | 34.223.124.45 | 10.0.0.55 | TCP | 66 | 80 → 49680 [FIN, ACK] Seq=1 Ack=2 Win=26880 L |
| 866 | 13.271449 | 34.223.124.45 | 10.0.0.55 | TCP | 66 | 80 → 49681 [FIN, ACK] Seq=2274 Ack=366 Win=28 |
| 867 | 13.271521 | 10.0.0.55 | 34.223.124.45 | TCP | 66 | 49680 → 80 [ACK] Seq=2 Ack=2 Win=131712 Len=0 |
| 868 | 13.271552 | 10.0.0.55 | 34.223.124.45 | TCP | 66 | 49681 → 80 [ACK] Seq=366 Ack=2275 Win=131072 |

### 1.2.1 TCP handshake

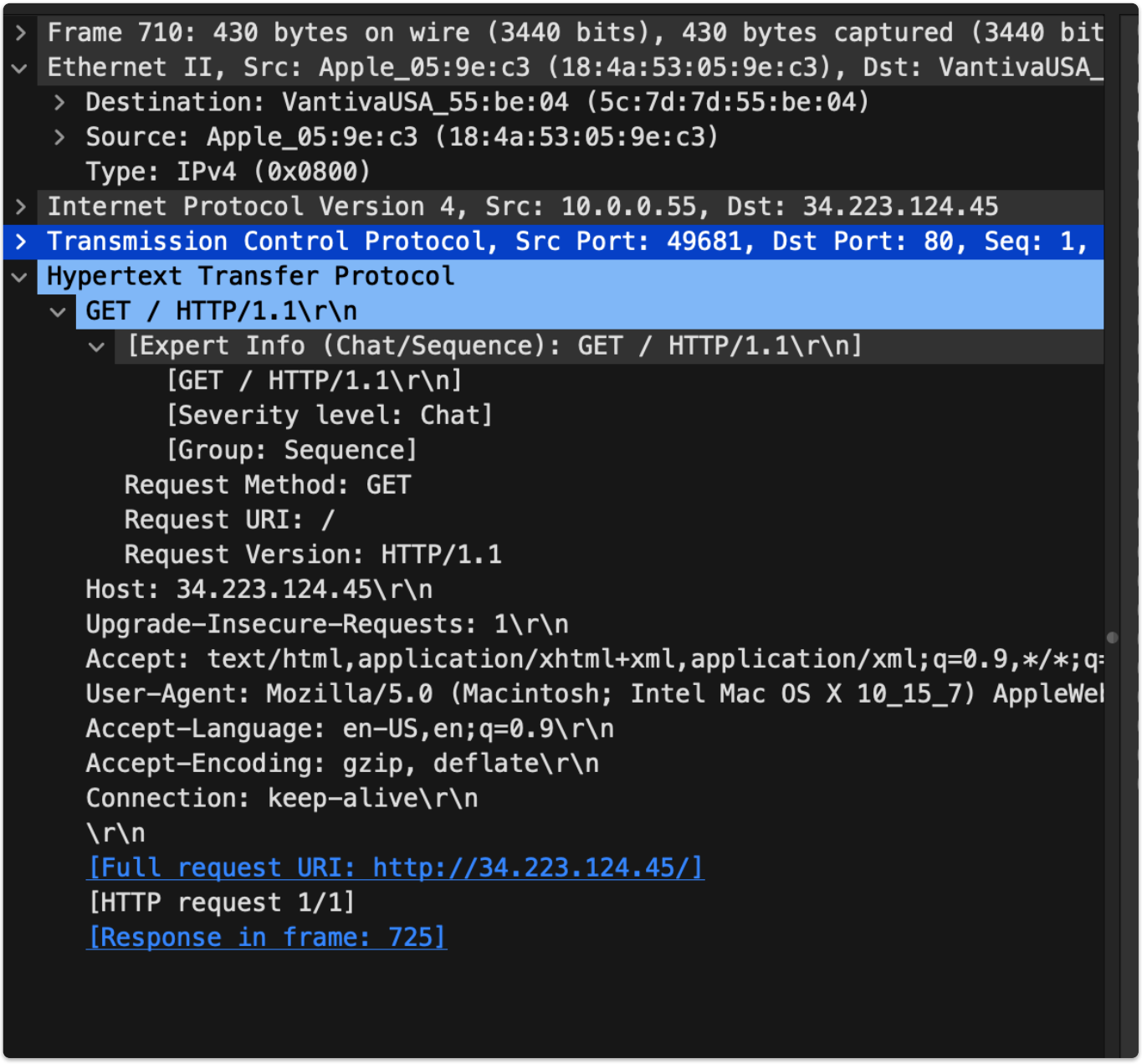
1. Source sends a SYN packet to the destination's IP address and port.
2. The source continues sending SYN packets until the destination replies with a SYN-ACK packet with the acknowledgment number set to 1.
    - It keeps sending SYN packets until it receives a SYN-ACK packet from the destination.
    - We can see that the source sends 2 SYN packets before receiving a SYN-ACK packet.
3. Source responds with an ACK packet, establishing the TCP connection.
4. Destination sends another SYN-ACK packet.
5. Source sends an ACK packet, finalizing the TCP handshake.

## 1.3 HTTP request

Once the TCP connection is established, the client sends an HTTP request to the server. The HTTP request is shown below:

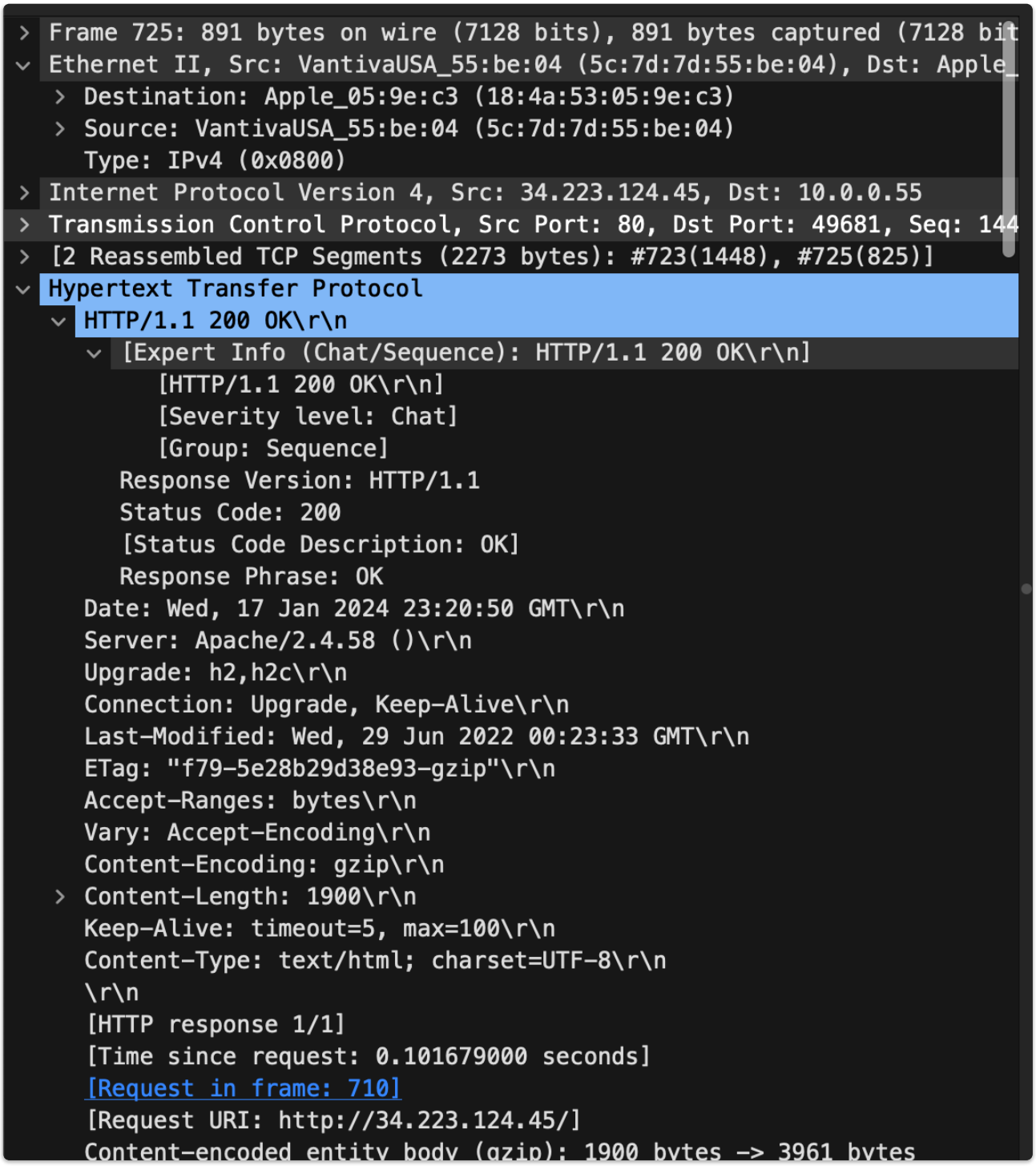
### 1.2.2 HTTP request

1. Source sends an HTTP GET request to the destination, specifying the desired resource (e.g., /index.html).
2. Destination acknowledges the request with an ACK packet.




### 1.2.3 HTTP response

1. Destination sends an HTTP response with the requested resource.
2. Source acknowledges the response with an ACK packet




3. A snapshot of the HTTP sent by the destination is shown below:

```
\n
\t<h1 id="status"></h1>\n
\t<script>document.querySelector("#status").textContent = "Connecting ...";</script>\n
\t<noscript>\n
\n
\t\t<h2>What?</h2>\n
\t\t<p>This website is for when you try to open Facebook, Google, Amazon, etc\n
\t\ton a wifi network, and nothing happens. Type "http://neverssl.com"\n
\t\tinto your browser's url bar, and you'll be able to log on.</p>\n
\n
\t\t<h2>How?</h2>\n
\t\t<p>neverssl.com will never use SSL (also known as TLS). No\n
\t\tencryption, no strong authentication, no <a\n
\t\thref="https://en.wikipedia.org/wiki/HTTP_Strict_Transport_Security">HSTS</a>,\n
\t\tno HTTP/2.0, just plain old unencrypted HTTP and forever stuck in the dark\n
\t\tages of internet security.</p>\n
\n
\t\t<h2>Why?</h2>\n
\t\t<p>Normally, that's a bad idea. You should always use SSL and secure\n
\t\tencryption when possible. In fact, it's such a bad idea that most websites\n
\t\tare now using https by default.</p>\n
\n
\t\t<p>And that's great, but it also means that if you're relying on\n
\t\tpoorly-behaved wifi networks, it can be hard to get online.  Secure\n
\t\tbrowsers and websites using https make it impossible for those wifi\n
\t\tnetworks to send you to a login or payment page. Basically, those networks\n
\t\tcan't tap into your connection just like attackers can't. Modern browsers\n
\t\tare so good that they can remember when a website supports encryption and\n
\t\teven if you type in the website name, they'll use https.</p>\n
\n
\t\t<p>And if the network never redirects you to this page, well as you can\n
\t\tsee, you're not missing much.</p>\n
\n
        <a href="https://twitter.com/neverssl">Follow @neverssl</a>\n
\n
```

## 1.4 TCP connection termination

Once the HTTP response is received, the client terminates the TCP connection. The packets are shown below:

```
   861 13.175868    10.0.0.55       34.223.124.45   TCP      66 49681 → 80 [FIN, ACK] Seq=365 Ack=2274 Win=131072 Len=0 TSval=159802
   862 13.175871    10.0.0.55       34.223.124.45   TCP      66 49680 → 80 [FIN, ACK] Seq=1 Ack=1 Win=131712 Len=0 TSval=1345685995
   865 13.271449    34.223.124.45   10.0.0.55       TCP      66 80 → 49680 [FIN, ACK] Seq=1 Ack=2 Win=26880 Len=0 TSval=199406680 TS
   866 13.271449    34.223.124.45   10.0.0.55       TCP      66 80 → 49681 [FIN, ACK] Seq=2274 Ack=366 Win=28032 Len=0 TSval=1994066
   867 13.271521    10.0.0.55       34.223.124.45   TCP      66 49680 → 80 [ACK] Seq=2 Ack=2 Win=131712 Len=0 TSval=1345686091 TSecr
   868 13.271552    10.0.0.55       34.223.124.45   TCP      66 49681 → 80 [ACK] Seq=366 Ack=2275 Win=131072 Len=0 TSval=1598023305
```

### 1.3.1 TCP connection termination

1. Source sends a FIN, ACK packet to the destination.
2. Destination acknowledges the FIN, ACK packet with an ACK packet.