Computer Network Homework

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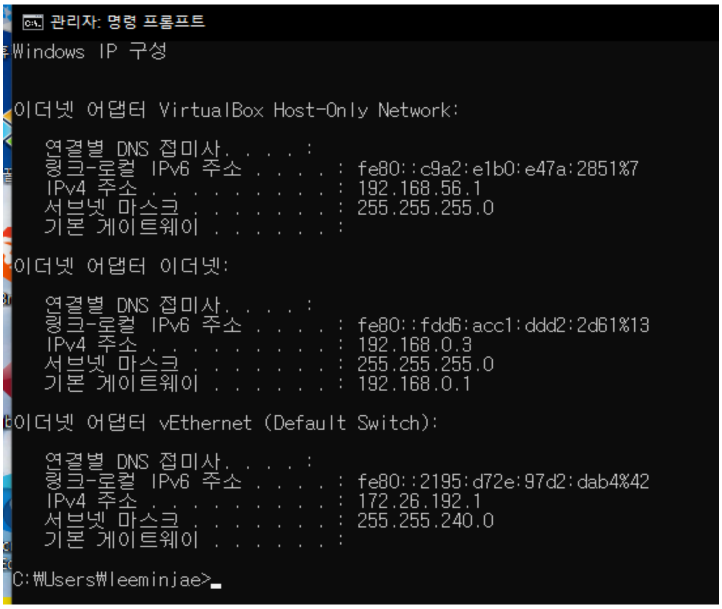
My homework is analyze different seven network applications by running Wireshark. WireShark is a program that allows to analyze packet. I downloaded the Stable Release (3.4.9 October6, 2121) version. My execution environment is as follows.

- OS : Windows 10 Pro (x64bit)
- Processor : Intel(R) Core(TM) i7-7700 CPU @ 3.60GHz
- Ram : 16.0GB
- SSD : 128GB
- HDD : 2000GB
- G-Card : NVIDIA GeForce GTX 660

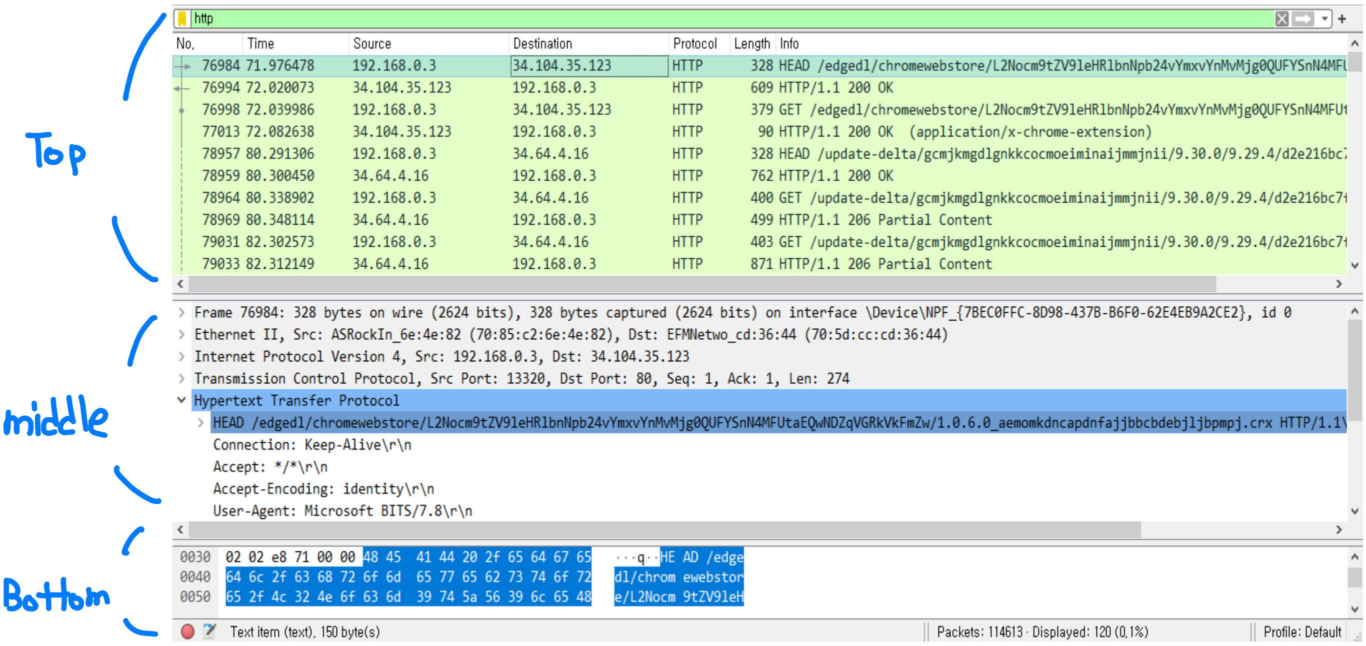
I test 7 network applications Web, E-mail, DNS, network games, video conferencing, video streaming and social networking. While analyzing, there were some network applications that used similar protocols, but I tried to analyze the differences as much as possible. When some questions arise, I searched to find out why this result occured. I also enter some command in cmd for more accurate analysis

Before starting the analysis, using the ipconfig command at the cmd terminal, my ip address(192.168.0.3) was checked.



★ Web

I did a web analysis. In Wireshark, too many packets are displayed. Because I only wanted to get information about web, I used capture filter “http”. (There are another method) And access google and surfing. The result is are as follows. Through the Info part, it can be seen that it is a packet related to the chrome web.



- Top part

At the first line. Source (My ip address 192.168.0.3) send to Destination (address is 34.104.35.123) a packet(Length is 328 and use HTTP protocal). So (192.168.0.3) request to (34.104.35.123).

At the second line, (34.104.35.123) respone to (192.168.0.3). The conent is 200 OK that mean request succeeded, requested object later in this message.

- Middle part (if you want more detail using double click, my case is HTTP)

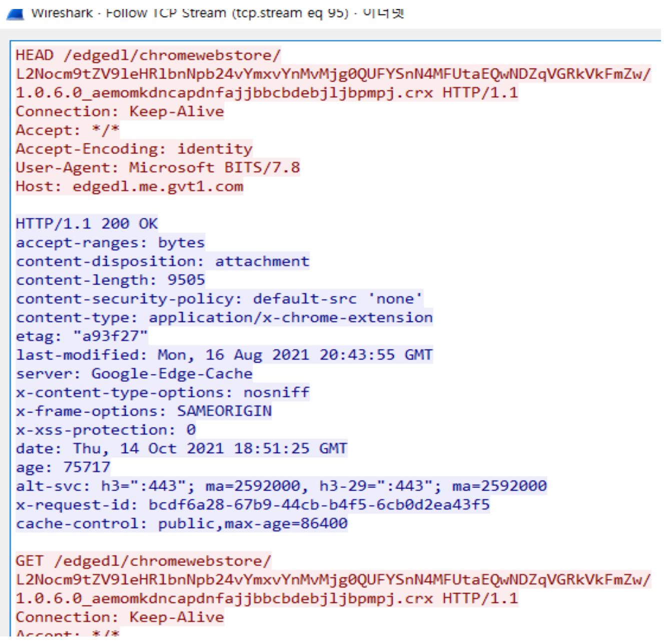
The first line show information about Frame, bytes and so on. The second line show data link Layer(my case is Ethernet) The third line show about network layer. This include protocal version, total length, source address, destination address and so on.

The forth line show transport layer(TCP protocal) that has source port, destination port, sequence number, ack number, headerlength, code bits and so on. As we learned HTTP uses TCP and port number is 80. Client initiates TCP connection to server and port 80.(HTTP’s basic port num is 80)

And at the fifth line, I can see more detail Hypertext Transfer Protocol by double click. As we know HTTP request message is human-readable format. After looking at the other shapes, HTTP request message's general format is request line, header lines, body. It also has \r\n that carrage return character, line-feed charcter. It was the same as learned in class. More detail, I can see web page consists of base HTML-file which includes several referenced objects. Each object is addressable by a URL too.

-Bottom part

The numbers at the bottom are change of request and response message contents to hexadecimal.



```
Wireshark · Follow TCP Stream (tcp.stream eq 95) · 이더넷

HEAD /edgedl/chromewebstore/
L2Nocm9tZV9leHRlbnNpb24vYmxvYnMvMjg0QUFYSnN4MFUtaEQwNDZqVGRkVkFmZw/
1.0.6.0_aemomkdncapdnfajjbbcbdebjljbpmpj.crx HTTP/1.1
Connection: Keep-Alive
Accept: */*
Accept-Encoding: identity
User-Agent: Microsoft BITS/7.8
Host: edgedl.me.gvt1.com

HTTP/1.1 200 OK
accept-ranges: bytes
content-disposition: attachment
content-length: 9505
content-security-policy: default-src 'none'
content-type: application/x-chrome-extension
etag: "a93f27"
last-modified: Mon, 16 Aug 2021 20:43:55 GMT
server: Google-Edge-Cache
x-content-type-options: nosniff
x-frame-options: SAMEORIGIN
x-xss-protection: 0
date: Thu, 14 Oct 2021 18:51:25 GMT
age: 75717
alt-svc: h3=":443"; ma=2592000, h3-29=":443"; ma=2592000
x-request-id: bcdf6a28-67b9-44cb-b4f5-6cb0d2ea43f5
cache-control: public,max-age=86400

GET /edgedl/chromewebstore/
L2Nocm9tZV9leHRlbnNpb24vYmxvYnMvMjg0QUFYSnN4MFUtaEQwNDZqVGRkVkFmZw/
1.0.6.0_aemomkdncapdnfajjbbcbdebjljbpmpj.crx HTTP/1.1
Connection: Keep-Alive
```

I want to see more deep. So using follow -> tcp Stream I capture this TCP screen. Red letter is data that client send to server ,the blue letter is data that server send to client.

Server send information that HTTP version is 1.1, respone is 200 OK, accept-rnages is bytes, content-length is 9505, last-modified is MON, 16 Aug 2021 20:43:55 GMT… and so on.

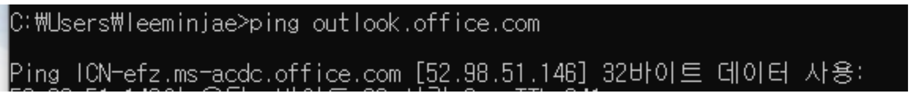
-Summary

As learned in class, http is made of human-readable ASCII. The format was also expressed as request line, header lines, and body. Carriage return character and line-feed character could also be checked for each line. And HTTP used TCP.

And most of them used persistent connection (HTTP 1.1)(one RTT for all the referenced objects) more efficient than Non-persistent connection(2 RTT per object).

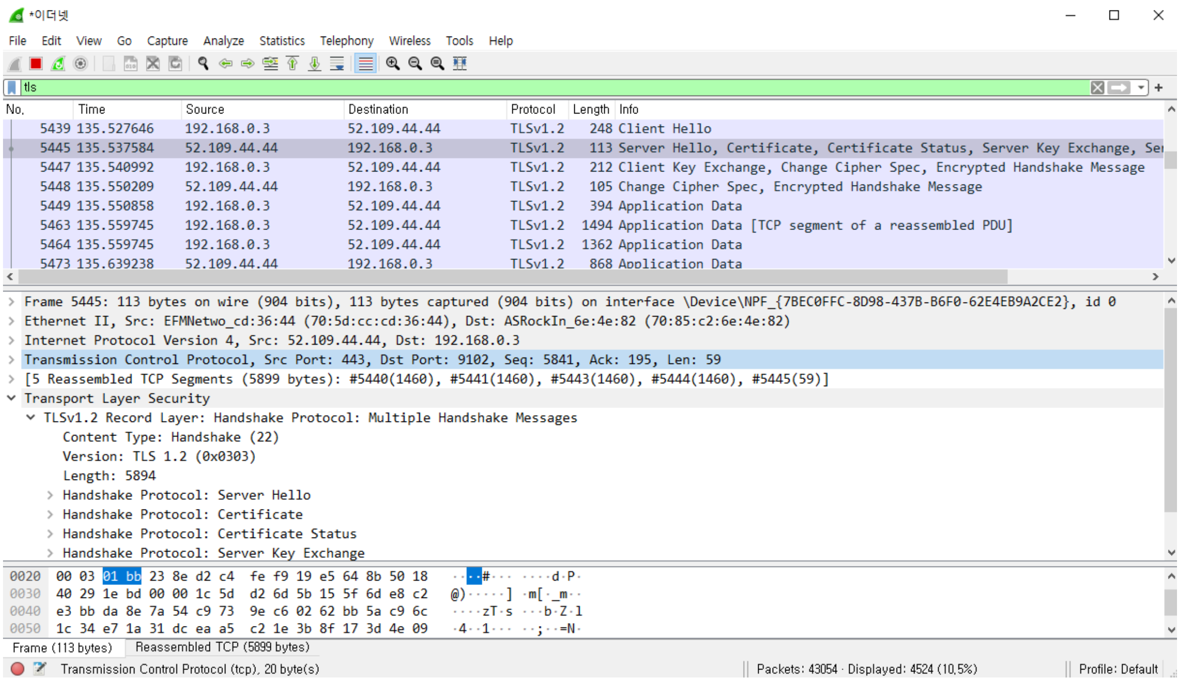
★ E-Mail

I did an e-mail analysis through “Outlook”. To do this, at the cmd I used the command “ping outlook.office.com” to find out the address of Outlook. The Outlook address was 52.98.51.146.



I heard that the mail service uses the SMTP protocol in class, but it was not easy to find it. Upon investigation, the actual mail client uses the TLS protocol. This is because SMTP does not provide encryption, which poses a high risk of hacking.

-TLS’s handshaking process



1. Client hello : My ip request version info, cipher suites, random, compression method to server.

2. Server hello : Server respone chipher suites, certificate status, server key exchange to my ip and server hello, end.

3. Client key exchange : after this process, they(server and client) decide the TLS version, cipher suite and end identification each other.

4. Client chipper spec : Send encryption and hash algorithm to server. Notification that encryption will proceed in the manner negotiated so far.

5. Change Cipher Spec : Send algorithm to client and close handshake process .

6. Encrypted communication : Encrypted messages are delivered in an application data

packet. After the message delivery is completed, the server and the client are disconnected after a 4-way handshake process by transmitting a pin flag.

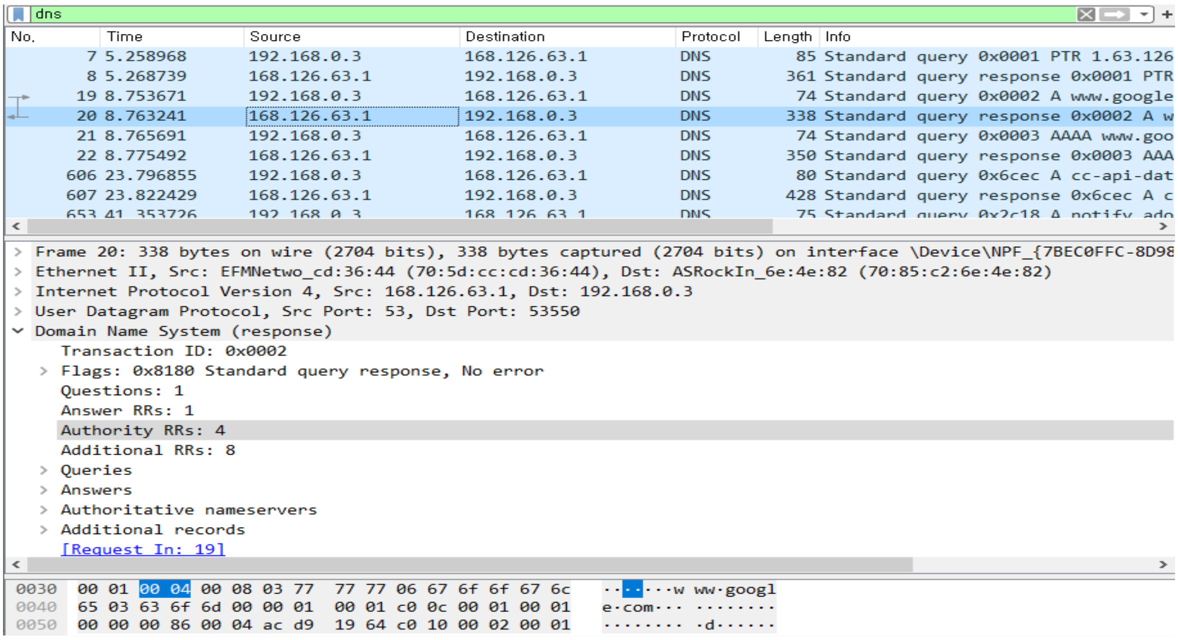
-Summary

Before exchanging data, the Tls protocol certificate each other, and encryption decryption key exchange. Data is exchanged using encryption algorithms. As a result of the investigation after the communication, the SMTP protocol was slightly used, mainly the TLS protocol used. Looking at the Tls protocol version, Tlsv1.2 and Tlsv1.3 were used. It is said that Tlsv1.2 version was old and the vulnerabilities came out, so Tlsv1.3 appeared.

★ DNS(Domain Name System)

When we use the Internet, we use domain names that are easy to memorize instead of IP addresses that are difficult to memorize. However, an IP address is actually needed. DNS implements to replace domain names with IP addresses used on the actual network.

At the terminal, I used the “nslookup” command and typed the Google address that domain name we know. Therefore, it informed me of Google's IP address of 172.217.25.100. And I caught the DNS packets on the wire shark.



-DNS analysis

I taught DNS use both UDP and TCP. However, in my case, most of them were using UDP. Research has shown that UDP is used for general DNS inquiries, and TCP is used for sending packets exceeding 512 bytes with Zone transfer. I used UDP because I had a simple inquiry. Port number was using number 53 as learned in class.

-Transaction ID : This field identifies whether the query sent by the client and the received response match, and uses numbers in the range of 16 bits.

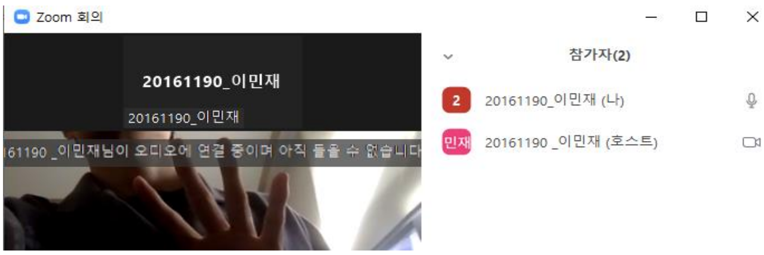
-Flags : This field consists of numerous fields that define the characteristics of the query and has eight flags. QR, Opcode, AA, TC, RD, RA, Z, RCODE

-Queries : Name, type, and class are displayed in this field. I learned about four types in class. My case was type A, name is hostname and value is IP address. And class is IN(General case) mean Internat class.

-Remainder case : Answers, Authoritative nameservers, Additional records are all same format. Name, Type, Class field is same as Queries. And also has TTl, RDLength, Rdata.

★ Video Conferencing(Zoom)

To analyze video conference, I used the zoom used in our course. I held a zoom meeting on my MacBook and turned on the camera. And I accessed the Zoom meeting that I had already opened by MacBook on my desktop. The process captured packets through wired sharks.



In class, I learned that TCP guarantees high reliability but slow, and UDP does not guarantee 100% reliability but faster than TCP. Therefore, it was speculated that UDP would be used for Zoom in the voice and video areas, where fast data delivery is more important than 100% reliability. And I checked if my thoughts were right.

-UDP Analysis

```
3.80.20.200    192.168.0.3    TLSv1.2  1514 Server Hello
3.80.20.200    192.168.0.3    TCP      1514 443 → 13684 [ACK] Seq=1461 Ack=518 Win=28672
192.168.0.3    3.80.20.200    TCP        54 13684 → 443 [ACK] Seq=518 Ack=2921 Win=13132
3.80.20.200    192.168.0.3    TLSv1.2  1230 Certificate [TCP segment of a reassembled PD
3.80.20.200    192.168.0.3    TLSv1.2   725 Certificate Status, Server Key Exchange, Ser
192.168.0.3    3.80.20.200    TCP        54 13684 → 443 [ACK] Seq=518 Ack=4768 Win=13132
192.168.0.3    3.80.20.200    TLSv1.2   147 Client Key Exchange, Change Cipher Spec, Enc
3.235.82.212   192.168.0.3    TCP        60 443 → 13685 [ACK] Seq=1 Ack=518 Win=28672 Le
3.235.82.212   192.168.0.3    TLSv1.2  1514 Server Hello
3.235.82.212   192.168.0.3    TCP      1514 443 → 13685 [ACK] Seq=1461 Ack=518 Win=28672
192.168.0.3    3.235.82.212   TCP        54 13685 → 443 [ACK] Seq=518 Ack=2921 Win=13132
3.235.82.212   192.168.0.3    TLSv1.2  1514 Certificate [TCP segment of a reassembled PD
3.235.82.212   192.168.0.3    TLSv1.2   470 Certificate Status, Server Key Exchange, Ser
192.168.0.3    3.235.82.212   TCP        54 13685 → 443 [ACK] Seq=518 Ack=4797 Win=13132
192.168.0.3    3.235.82.212   TLSv1.2   180 Client Key Exchange, Change Cipher Spec, Enc
3.80.20.200    192.168.0.3    TLSv1.2   105 Change Cipher Spec, Encrypted Handshake Mess
192.168.0.3    3.80.20.200    TLSv1.2  1169 Application Data
3.235.82.212   192.168.0.3    TLSv1.2   105 Change Cipher Spec, Encrypted Handshake Mess
192.168.0.3    3.235.82.212   TCP      1514 13685 → 443 [ACK] Seq=644 Ack=4848 Win=13132
192.168.0.3    3.235.82.212   TLSv1.2   193 Application Data
```

When accessing Zoom for the first time, packet exchange was performed with IP adress 3.800.20200 and 3.235.82.212. Packets were exchanged between TCP and the TLSv12 protocol. As I saw earlier, client and server handshake through TLSv.12. Client hello, Server hello, Client key exchange, Client chipper spec, Change cipher spec... And they exchanged encrypted Application Data.

```
2319 27.776858  134.224.228.21  192.168.0.3     UDP   292 8801 → 58574 Len=250
2320 27.776925  192.168.0.3     134.224.228.21  UDP  1078 58573 → 8801 Len=1036
2321 27.785884  134.224.228.21  192.168.0.3     UDP  1076 8801 → 58573 Len=1034
2322 27.785948  134.224.228.21  192.168.0.3     UDP  1076 8801 → 58573 Len=1034
2323 27.796002  134.224.228.21  192.168.0.3     UDP  1075 8801 → 58573 Len=1033
2324 27.796064  134.224.228.21  192.168.0.3     UDP  1075 8801 → 58573 Len=1033
2325 27.796137  192.168.0.3     134.224.228.21  UDP  1078 58573 → 8801 Len=1036
2326 27.796164  192.168.0.3     134.224.228.21  UDP  1078 58573 → 8801 Len=1036
2327 27.796179  192.168.0.3     134.224.228.21  UDP  1078 58573 → 8801 Len=1036
2328 27.797130  134.224.228.21  192.168.0.3     UDP   299 8801 → 58574 Len=257

> Frame 2323: 1075 bytes on wire (8600 bits), 1075 bytes captured (8600 bits) on interface \Device\NPF_{
> Ethernet II, Src: EFMNetwo_cd:36:44 (70:5d:cc:cd:36:44), Dst: ASRockIn_6e:4e:82 (70:85:c2:6e:4e:82)
> Internet Protocol Version 4, Src: 134.224.228.21, Dst: 192.168.0.3
v User Datagram Protocol, Src Port: 8801, Dst Port: 58573
    Source Port: 8801
    Destination Port: 58573
    Length: 1041
    Checksum: 0xf56f [unverified]
    [Checksum Status: Unverified]
    [Stream index: 18]
  > [Timestamps]
    UDP payload (1033 bytes)

0000  70 85 c2 6e 4e 82 70 5d  cc cd 36 44 08 00 45 00   p··nN·p] ··6D··E·
0010  04 25 0c 38 40 00 22 11  1c ef 86 e0 e4 15 c0 a8   ·%·8@·"· ········
```

Then I accessed the meeting I left open on my MacBook. Likewise, the server and client went through a handshake process using the TLSv.12 protocol. After that, (192.168.0.3)client and (134.228.21)server exchanged numerous UDP protocols.

If you look at the source port, it is 8801. Port num 1024~49151 is a registered port and 8801 is already registered by zoom. Destination port is 58573 that mean me. Port num 49152 ~ 65535 are dynamically assigned ports. It is dynamically assigned and can change every time when someone access it.

-Summary

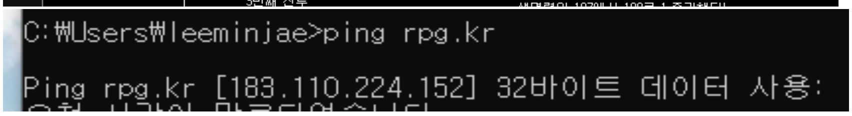
Of course, video streaming does not use UDP in all, When communicate at loggin or initiall accessing, use TLS and TCP protocal.

As learned in course, after accessing the video, it was communicated through UDP. Because UDP is used, the video may be cut off for a while and information may be lost, but because real-time delivery is important, an immediate video came out again.

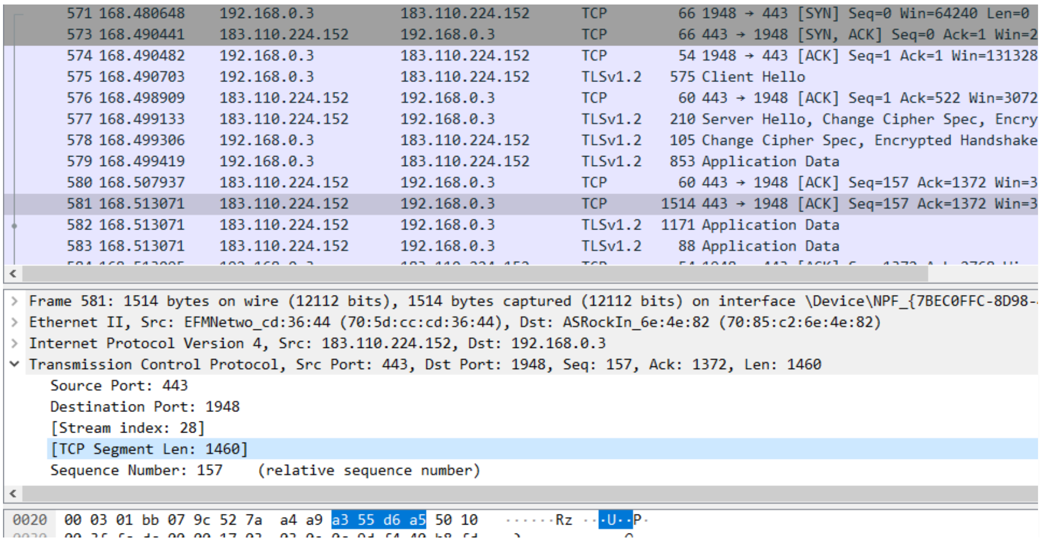
I think when designing a network, it is important to select well TCP or UDP depending on the situation.

★ Network Games

I analyzed the RPG.kr network game. It is a nurturing rpg game that allows you to catch monsters or duel with other people. The IP address(183.110.224.152) was found through the “ping” command in cmd, and packets were collected through filtering in wireshark. Based on what I learned in class, I guessed that network games would use TCP.



-TCP Analysis



As a result of checking through the wire shark, TCP was actually used in this network game. As in the previous analysis, the client and server go through a handshake operation with TLSv.12.

There are six TCP flags, which are initially synchronized through the SYN flag. During the next game, most of them send a packet related to the response to the ACK flag. And the connection termination request is made through the FIN flag and the connection is disconnected to the RST flag.

-Summary

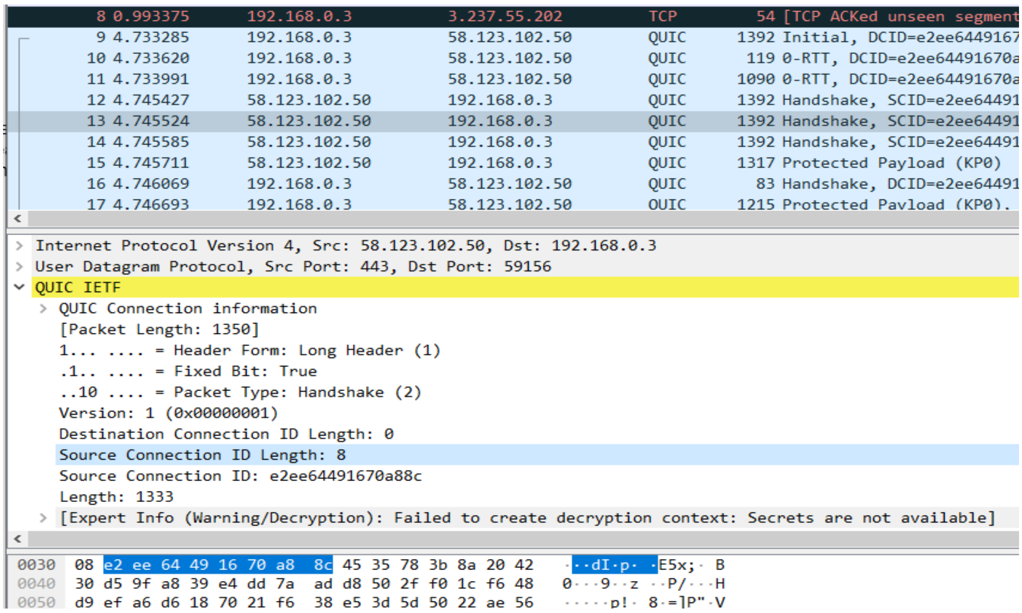
Network games use TCP. If UDP is used, game user information or item capabilities, etc. could be lost. I confirmed that TCP is being used because reliability is particularly important in games.

As a result of further research, real-time streaming game may also consider using UDP in games. Can't we use both TCP for important information and UDP if we don't? However, it is said that using UDP and TCP together is too complicated and can causes certain losses. So these days some games, it is said that methods of implementing TCP characteristics with UDP(reliable UDP) may also be used.

★ Video streaming (Youtube)

I used Youtube to analyze video streaming. I connected to Wire Shark and listened to music on YouTube. Then, very many QUIC packets were caught. I searched thinking this protocol might be related to YouTube. As a result of checking in DNS, the packets used in the ip address related to youtube were QUIC.

-QUIC analysis



Looking at the QUIC IETF section, there are various information that we have looked at above. In particular, there is a phrase called “Failed to create content: Secrets are not available: and I wondered if encryption was used.

Searching at it, QUIC was a protocol encapsulated with UDP and was security equivalent to TLS. It was also a protocol created by Google to reduce latency that occurs due to the nature of TCP. Since QUIC operates on UDP, the theoretically RTT value is 0.(In reality, it is not zero.) Therefore, it is said that the speed is fast because clinet hello, server hello, certificate, chipper spec… process is omitted.

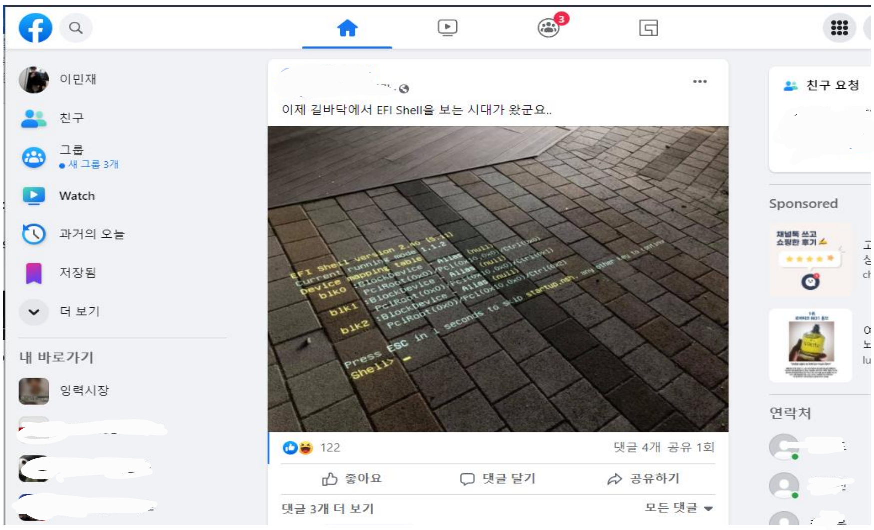
To confirm this, I compared speeds using an Explorer browser using TCP. I compared connecting to YouTube using Chrome vs YouTube using Explorer. As a result, it was shown that QUIC is 6 to 10 times faster than TCP.

-Summary

In network class, I learned that UDP has advantages in fast-deafers because it is not affected by TCP's cohesion control. So, I learned that even if I throw away a little bit of the reality of data, it is used for streaming services where speed is important. In fact, YouTube delivered information at a high speed using the QUIC protocol operating on UDP.

★ Social Networking (Facebook)

I selected Facebook, one of the social networks, as the last analysis. Because Facebook seemed to use various protocols because there were many types of data such as photos, videos, text, and messages.




```
C:₩Users₩leeminjae>ping www.facebook.com

Ping star-mini.c10r.facebook.com [157.240.215.35]
157.240.215.35의 응답: 바이트=32 시간=9ms TTL=49
```

As always, I checked Facebook's ip using the “ping” command and started analyzing it.

-Social network analysis

53	1.192854	157.240.215.35	192.168.0.3	UDP	67 443 → 57019 Len=25
54	1.260960	157.240.215.35	192.168.0.3	UDP	1274 443 → 57019 Len=1232
55	1.261005	157.240.215.35	192.168.0.3	UDP	1274 443 → 57019 Len=1232
56	1.261065	157.240.215.35	192.168.0.3	UDP	1274 443 → 57019 Len=1232
57	1.261170	157.240.215.35	192.168.0.3	UDP	1274 443 → 57019 Len=1232
58	1.261180	192.168.0.3	157.240.215.35	UDP	83 57019 → 443 Len=41
59	1.261276	157.240.215.35	192.168.0.3	UDP	1274 443 → 57019 Len=1232

```
> Frame 56: 1274 bytes on wire (10192 bits), 1274 bytes captured (10192 bits) on interface \Device\NPF_
> Ethernet II, Src: EFMNetwo_cd:36:44 (70:5d:cc:cd:36:44), Dst: ASRockIn_6e:4e:82 (70:85:c2:6e:4e:82)
> Internet Protocol Version 4, Src: 157.240.215.35, Dst: 192.168.0.3
v User Datagram Protocol, Src Port: 443, Dst Port: 57019
```

7845	57.493373	31.13.76.8	192.168.0.3	QUIC	1274 Protected Payload (KP0)
7846	57.493487	31.13.76.8	192.168.0.3	QUIC	1274 Protected Payload (KP0)
7847	57.493583	31.13.76.8	192.168.0.3	QUIC	1274 Protected Payload (KP0)
7848	57.493664	192.168.0.3	31.13.76.8	QUIC	77 Protected Payload (KP0)
7849	57.493685	31.13.76.8	192.168.0.3	QUIC	1274 Protected Payload (KP0)
7850	57.493790	31.13.76.8	192.168.0.3	QUIC	1274 Protected Payload (KP0)
7851	57.493896	31.13.76.8	192.168.0.3	QUIC	1274 Protected Payload (KP0)
7852	57.494000	31.13.76.8	192.168.0.3	QUIC	1274 Protected Payload (KP0)
7853	57.494112	31.13.76.8	192.168.0.3	QUIC	1274 Protected Payload (KP0)
7854	57.494204	31.13.76.8	192.168.0.3	QUIC	1274 Protected Payload (KP0)

```
> Frame 7847: 1274 bytes on wire (10192 bits), 1274 bytes captured (10192 bits) on interface \Device\NP
> Ethernet II, Src: EFMNetwo_cd:36:44 (70:5d:cc:cd:36:44), Dst: ASRockIn_6e:4e:82 (70:85:c2:6e:4e:82)
> Internet Protocol Version 4, Src: 31.13.76.8, Dst: 192.168.0.3
v User Datagram Protocol, Src Port: 443, Dst Port: 60888
```

5616	38.696607	157.240.215.9	192.168.0.3	TLSv1.2	94 Application Data
5617	38.696607	157.240.215.9	192.168.0.3	TLSv1.2	128 Application Data
5618	38.696676	192.168.0.3	157.240.215.9	TCP	54 6790 → 443 [ACK] Seq=54526
5619	38.697037	157.240.215.9	192.168.0.3	TCP	60 443 → 6790 [ACK] Seq=12524
5620	38.697627	192.168.0.3	157.240.215.9	TLSv1.2	88 Application Data
5621	38.698113	192.168.0.3	157.240.215.9	TLSv1.2	88 Application Data
5622	38.698557	157.240.215.9	192.168.0.3	TLSv1.2	94 Application Data
5623	38.698557	157.240.215.9	192.168.0.3	TLSv1.2	128 Application Data

Frame 5618: 54 bytes on wire (432 bits), 54 bytes captured (432 bits) on interface \Device\NPF_{7BEC0FFC-
Ethernet II, Src: ASRockIn_6e:4e:82 (70:85:c2:6e:4e:82), Dst: EFMNetwo_cd:36:44 (70:5d:cc:cd:36:44)
Internet Protocol Version 4, Src: 192.168.0.3, Dst: 157.240.215.9
Transmission Control Protocol, Src Port: 6790, Dst Port: 443, Seq: 54526, Ack: 12524, Len: 0

On Facebook, different protocols were used depending on the situation. UDP was used to scroll down and read posts. It seemed to be because I had to quickly bring in new posts in real time.

While scrolling down, the QUIC protocol was used when the video was played. As QUIC was used in video streaming, it seems to perform particularly well in videos. The characteristic of QUIC is fast and support encryption so it is a next-generation protocol. According to the survey, after Facebook introduced QUIC, which greatly reduced video request errors and buffering.

Also, I tried chatting with my friend on Facebook. In this case, TCP and TLSv1.2 were used. This is because in the case of chatting, high reliability is more important than speed.

-Summary

The above three protocols were mainly used, and various protocols such as DNS, TLSv1.3, ARP, ICMPv6, and IGMPv2 were also used. Facebook uses different protocols depending on the situation because there are various data forms.