네트워크 보안 과제1

패킷 분석하기

202246109
김기현
2025년 3월 16일

사용 소프트웨어

- VMware workstation 17 Player (WIndows 11에서 실행)
- WireShark (패킷 캡처 및 분석)
- Cisco Packet Tracer(네트워크 시뮬레이터)

실습 환경

Server: Ubuntu 22.04.5 LTS (VMware)

Client: Windows10 (VMware)

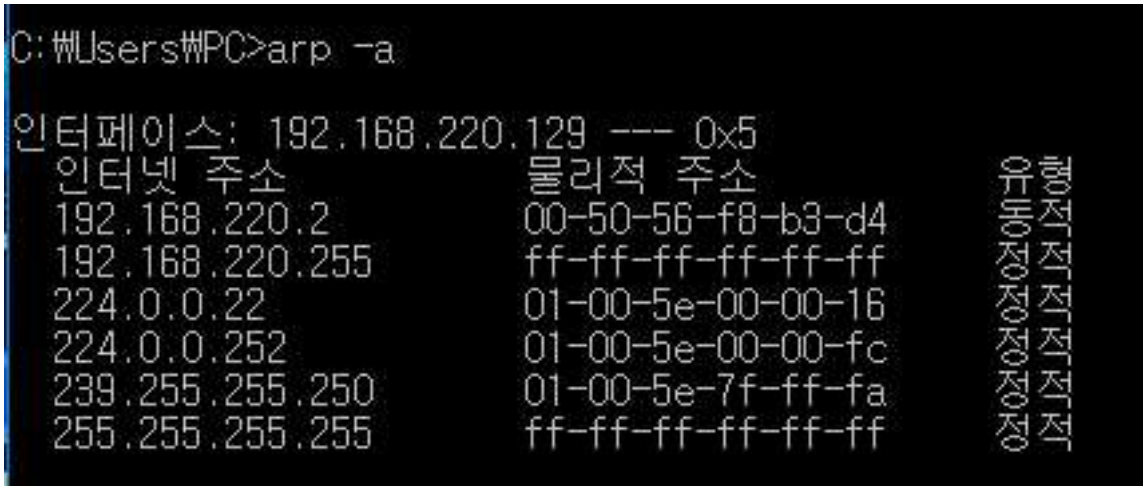
네트워크 설정

	Server(Ubuntu)	**Client(Windows)**
IP address	192.168.220.**128**	192.168.220.**129**
MAC address	00:0c:29:4c:29:3a	00-0C-29-C8-EC-2C

데이터링크 계층은 직접 연결된 장치들 간의 통신을 담당하는 계층임. 이 계층에서는 랜 카드나 네트워크 장비의 하드웨어 주소 (MAC주소)만으로 통신합니다.

대표적인 프로토콜로 Ethernet 프로토콜이 있습니다.

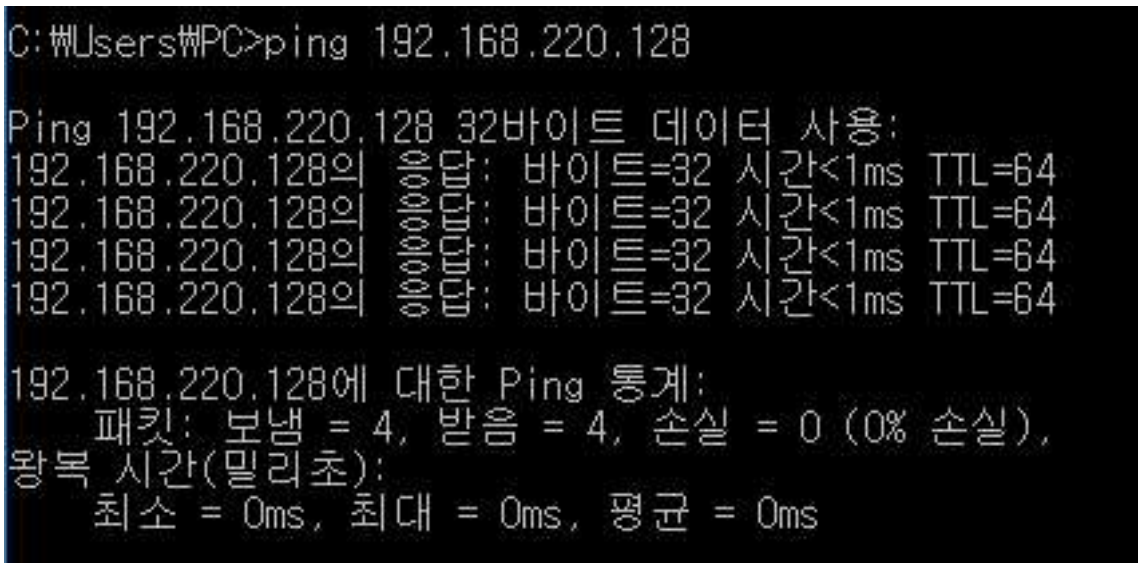
ARP 프로토콜을 사용해 특정 IP 주소에 대해 MAC주소를 찾을 수 있습니다



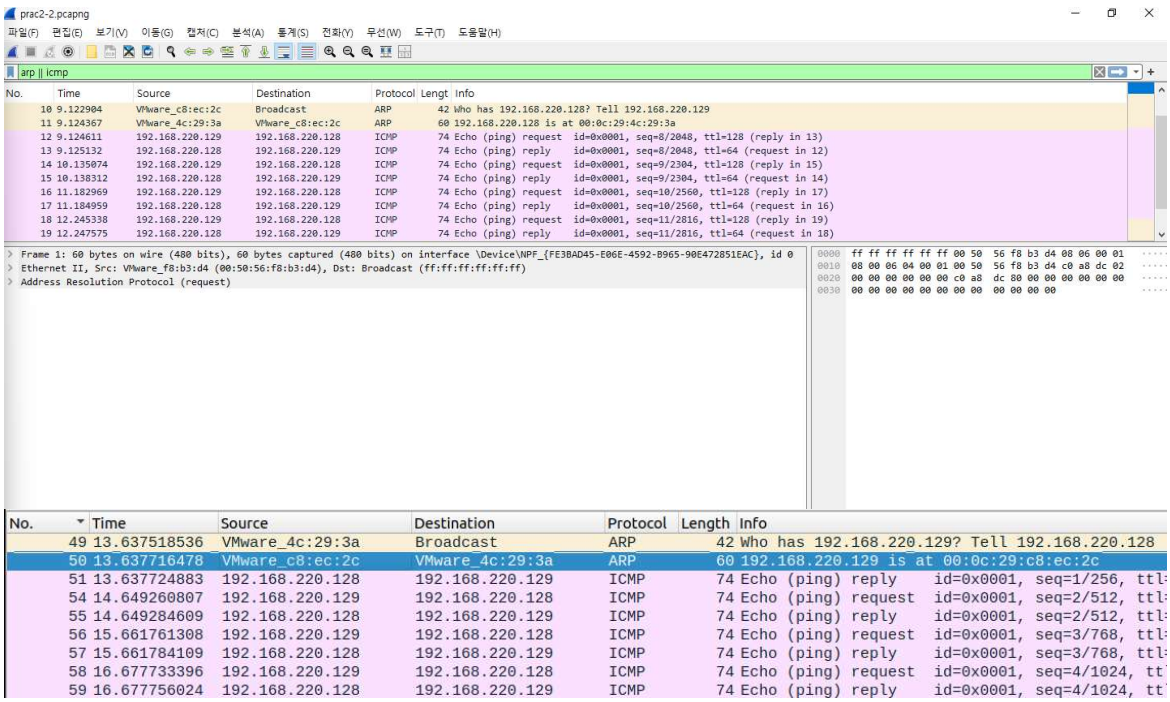
1. 패킷 캡쳐하기

먼저 Client(129)에서 ARP 테이블을 확인

현재 ARP 테이블엔 Server(128)의 IP와 MAC 주소가 없는걸 확인했습니다.



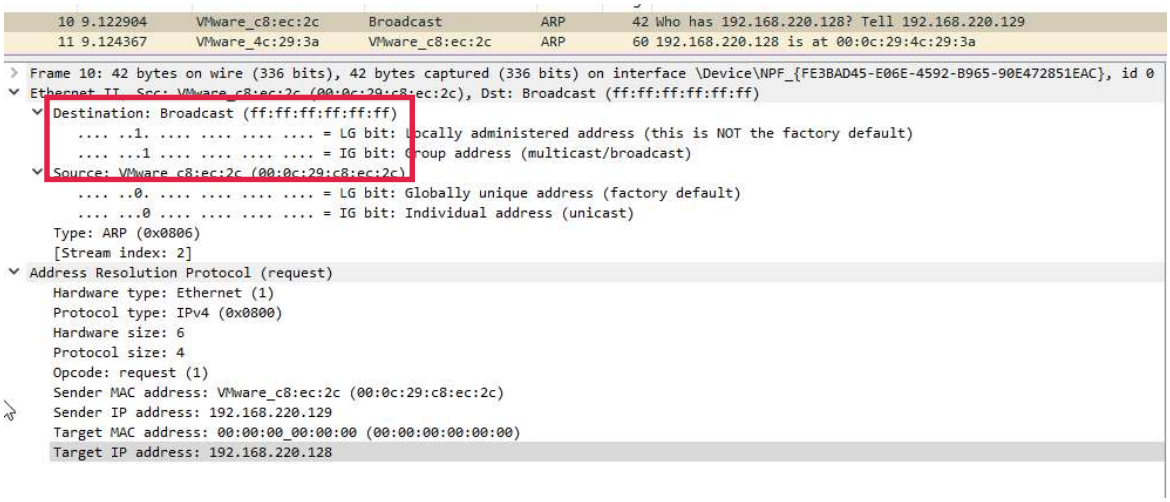
Client(129)에서 서버 IP(128)로 ping 명령어를 통해 ICMP 패킷 전송



Wireshark를 통해 패킷의 송수신을 확인했습니다.

2. 패킷 분석하기

① ARP를 통해 MAC 주소를 확인을 요청하는 패킷

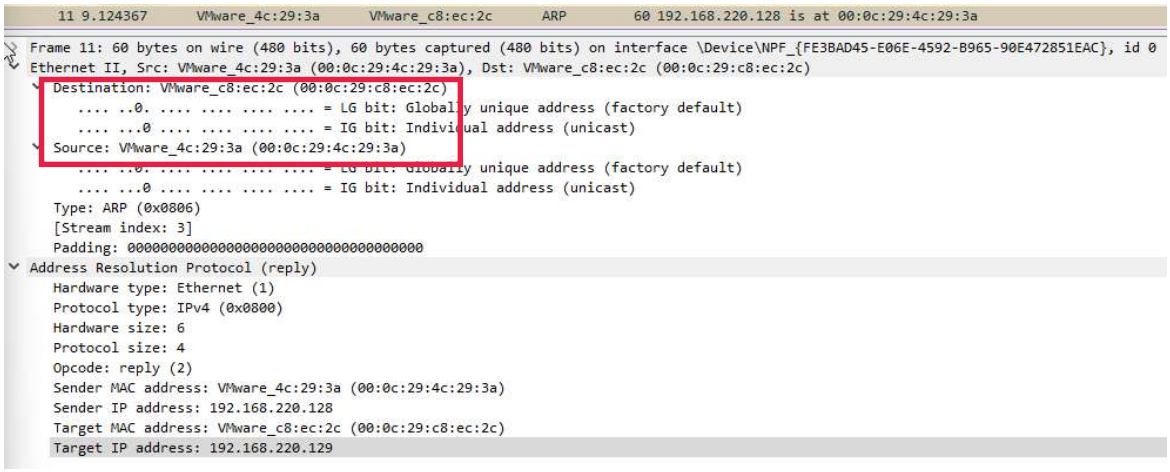


Src: VMware_c8:ec:2c Dst: Broadcast인걸 보아하니

Client(129)가 192.168.220.128이 누구냐고 묻는 브로드캐스팅인걸 확인할수 있습니다.

192.168.220.128의 MAC 주소를 모르기 때문에 Target MAC address가 00:00:00_00:00:00 인걸 확인했습니다.

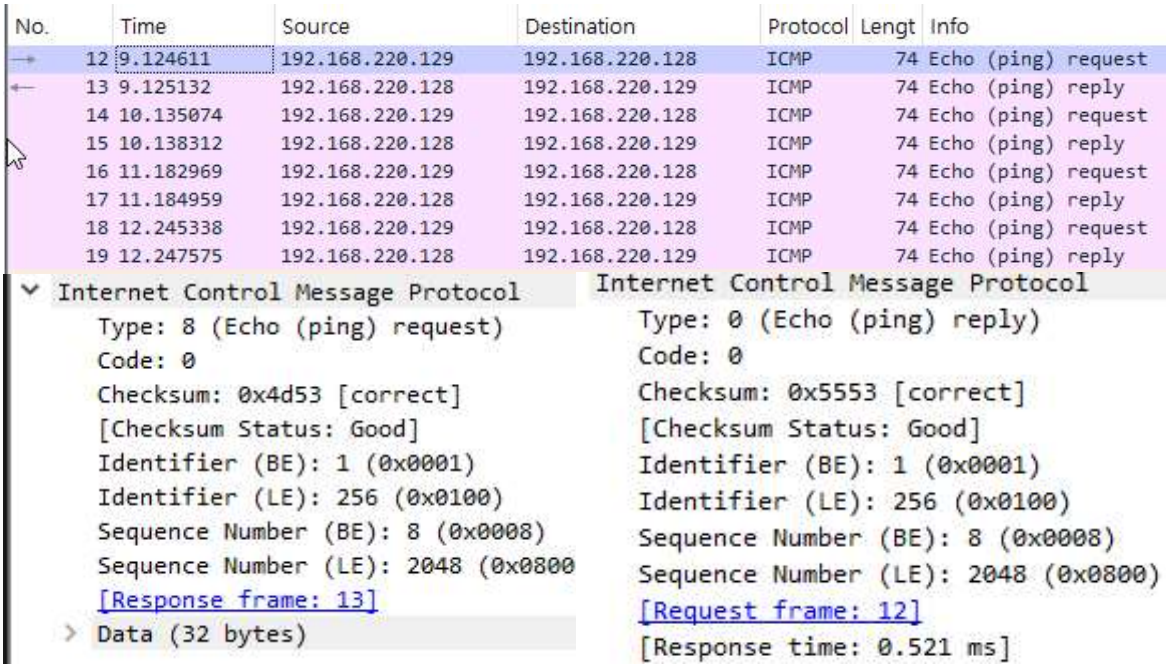
② ARP를 통해 MAC 주소를 응답하는 패킷



Src: VMware_4c:29:3a Dst: VMware_c8:ec:2c

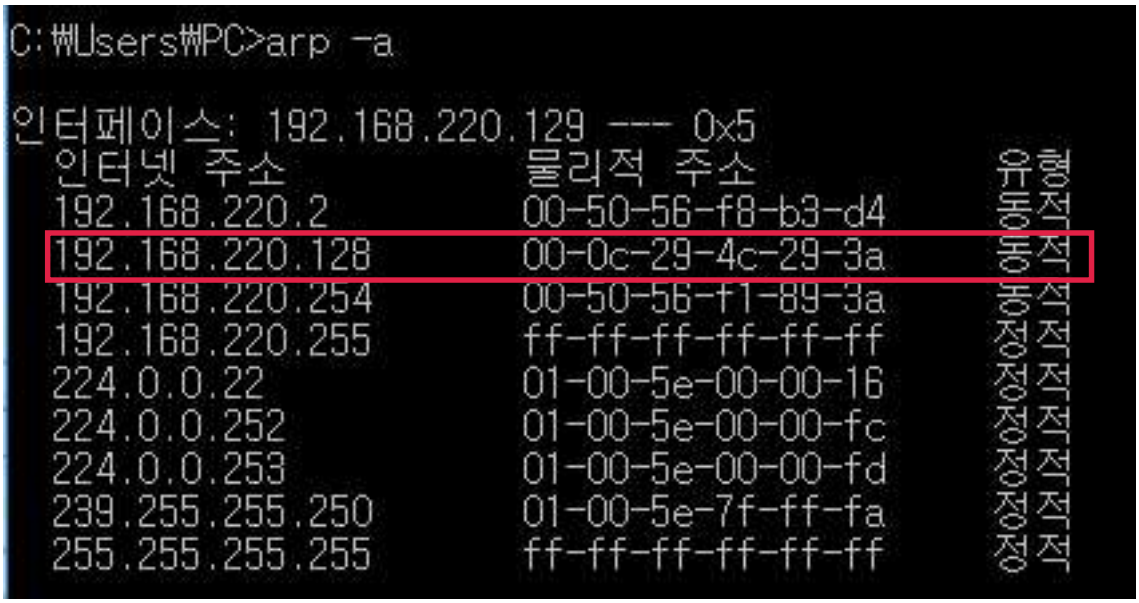
Server가 응답으로 자신의 MAC 주소를 Client에게 보낸걸 확인했습니다.

③ 서로의 MAC 주소를 확인 후 최초로 전송되는 ICMP 패킷



Source와 Destination IP를 보면 Client와 Server 상호간 ICMP Echo Request/ Reply 메시지를 주고받는걸 볼 수 있습니다.

⑤ **ARP 테이블 확인하기**



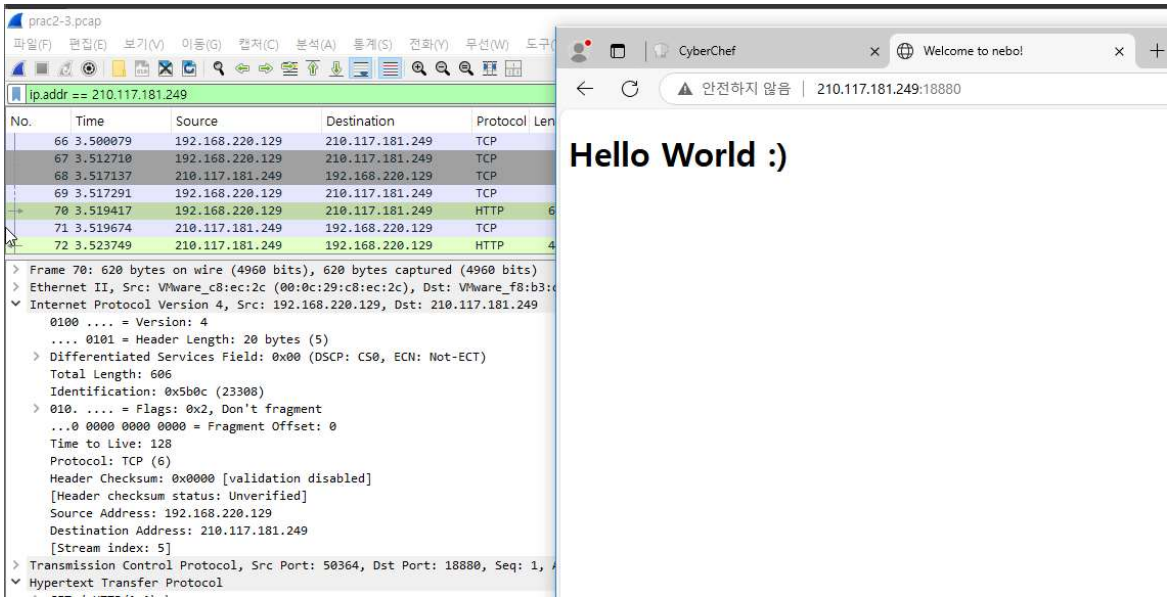
Client 의 ARP 테애블에 Server(128)에 대한 정보가 추가된 것을 확인 했습니다.

네트워크 계층은 LAN을 벗어난 원격자 간 통신을 하기 위한 핵심 계층입니다.

이 계층에서 가장 중요한 역할은 IP주소를 사용해 패킷이 목적지에 도달하도록 라우팅 하는 것입니다.

대표적인 프로토콜로 IPv4 또는 IPv6가 있습니다.

1. 패킷 캡쳐하기



패킷이 성공적으로 송수신될 걸 확인할 수 있습니다.

2. 패킷 분석하기

웹 서버에 접속 할 땐 TCP통신을 위해 3-way handshake과정을 거치는데

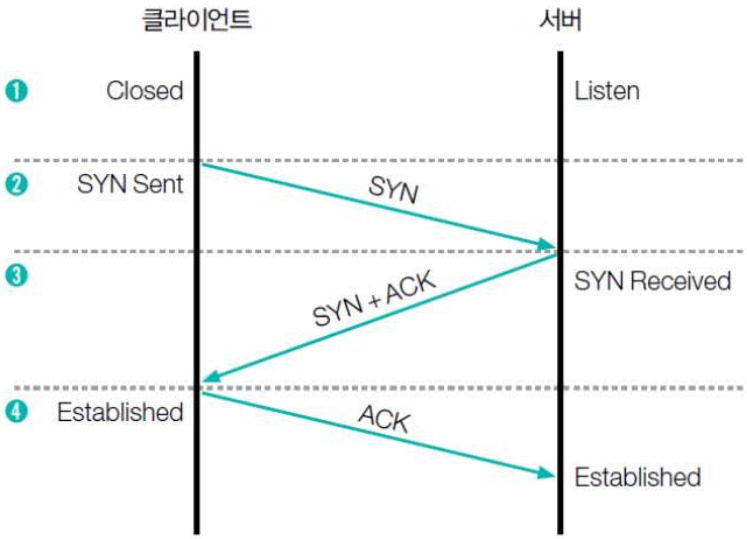


그림 2-32 TCP에서 연결 생성 과정

클라이언트가 서버와 연결을 위해 SYN패킷을 보내고

SYN패킷을 수신한 서버는 SYN+ACK패킷을 보내고

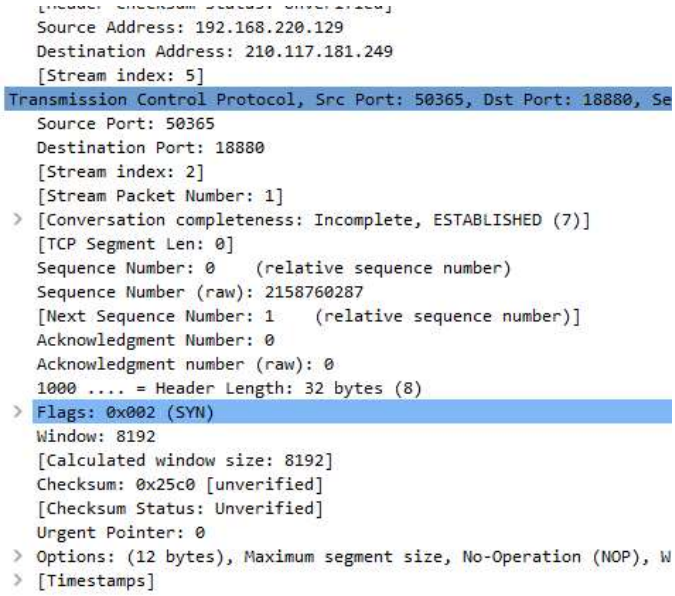
SYN+ACK패킷을 수신한 클라이언트는 ACK패킷을 전송합니다.

이제 직접 확인해 보겠습니다.

실제로 SYN, SYN+ACK, ACK패킷을 볼 수 있습니다.

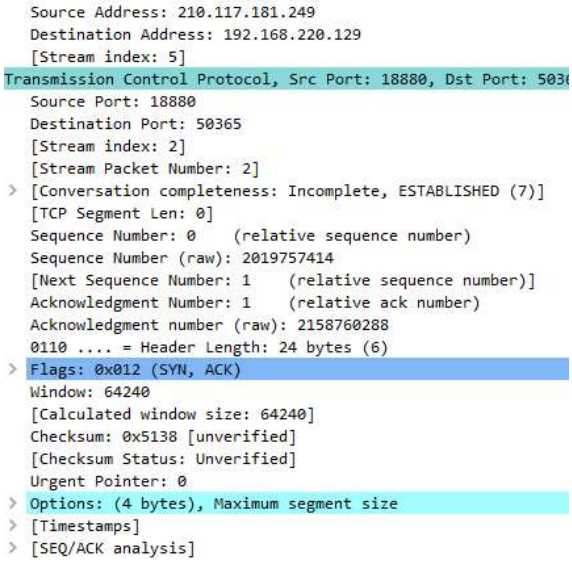
No.	Time	Source	Destination	Protocol	Lengt	Info
67	3.512710	192.168.220.129	210.117.181.249	TCP	66	50365 → 18880 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=256 SACK_PERM
68	3.517137	210.117.181.249	192.168.220.129	TCP	60	18880 → 50365 [SYN, ACK] Seq=0 Ack=1 Win=64240 Len=0 MSS=1460
69	3.517291	192.168.220.129	210.117.181.249	TCP	54	50365 → 18880 [ACK] Seq=1 Ack=1 Win=64240 Len=0
70	3.519417	192.168.220.129	210.117.181.249	HTTP	620	GET / HTTP/1.1
71	3.519674	210.117.181.249	192.168.220.129	TCP	60	18880 → 50364 [ACK] Seq=1 Ack=567 Win=64240 Len=0
72	3.523749	210.117.181.249	192.168.220.129	HTTP	416	HTTP/1.1 304 Not Modified
73	3.574001	192.168.220.129	210.117.181.249	TCP	54	50364 → 18880 [ACK] Seq=567 Ack=363 Win=63878 Len=0

① SYN



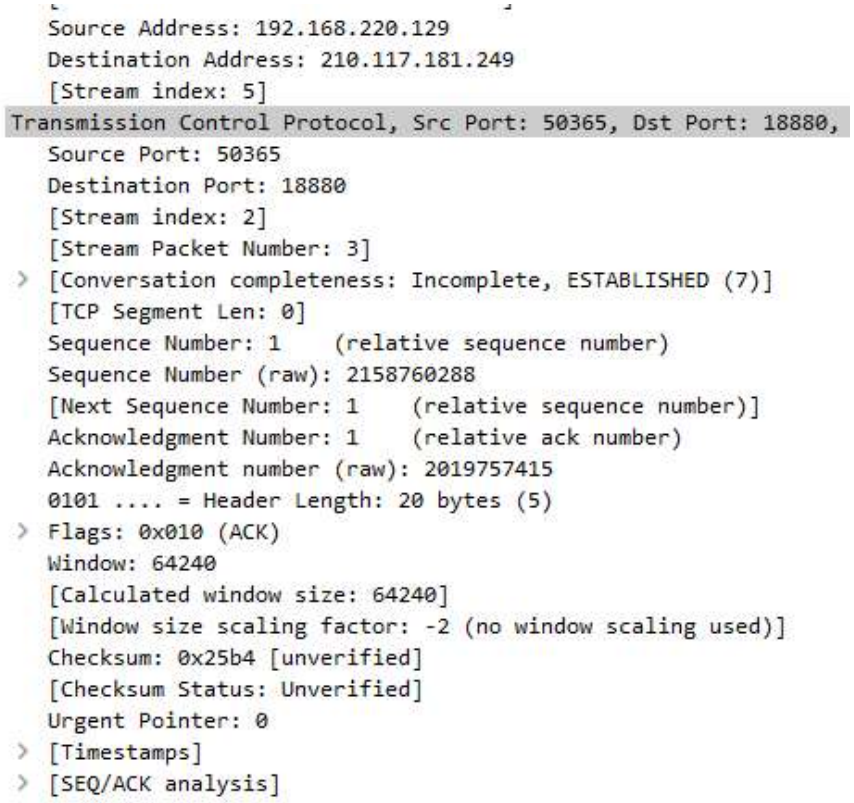
Client가 Web server의 18880포트로 SYN패킷을 보냈습니다.

② SYN+ACK



SYN패킷을 받은 Web server가 Client에게 연결을 해도 좋다고 SYN+ACK 패킷을 보냈습니다.

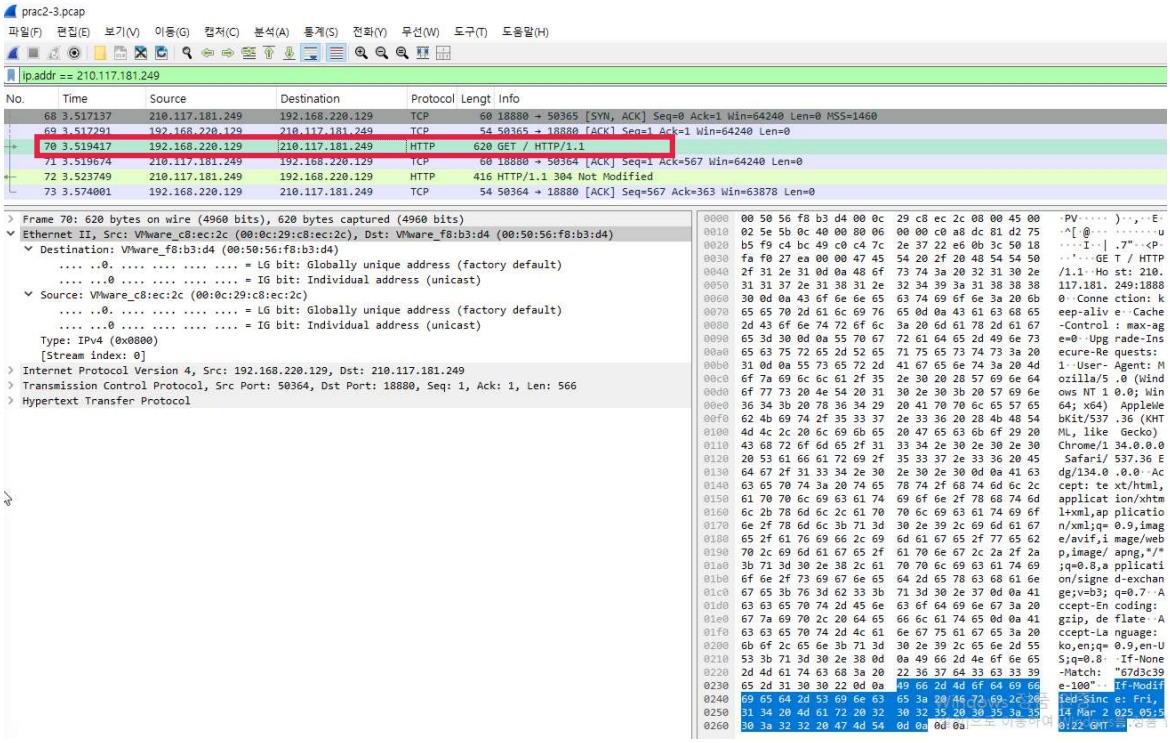
③ ACK



클라이언트가 서버의 응답을 확인했다는 의미로 ACK패킷을 서버로 보냈습니다.

이렇게 직접 3-way handshake 과정을 확인 할 수 있었습니다.

3-way handshake 과정 후에 캡쳐된 HTTP패킷으로 계층별 패킷 구조를 분석해보겠습니다.



2계층(Data Link Layer) 이더넷 패킷 헤더 분석하기

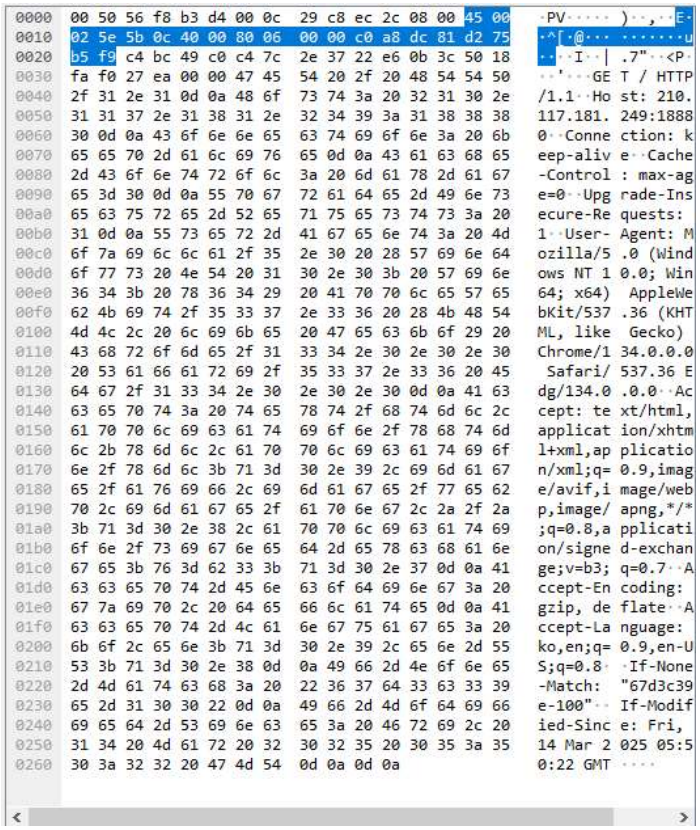
0000 00 50 56 f8 b3 d4 00 0c 29 c8 ec 2c 08 00 45 00 ·PV·····)··,··E·
0010 02 5e 5b 0c 40 00 80 06 00 00 c0 a8 dc 81 d2 75 ·^[·@··· ·······u
0020 b5 f9 c4 bc 49 c0 c4 7c 2e 37 22 e6 0b 3c 50 18 ····I··| .7"··<P·
0030 fa f0 27 ea 00 00 47 45 54 20 2f 20 48 54 54 50 ··'···GE T / HTTP
0040 2f 31 2e 31 0d 0a 48 6f 73 74 3a 20 32 31 30 2e /1.1··Ho st: 210.
0050 31 31 37 2e 31 38 31 2e 32 34 39 3a 31 38 38 38 117.181. 249:1888
0060 30 0d 0a 43 6f 6e 6e 65 63 74 69 6f 6e 3a 20 6b 0··Conne ction: k
0070 65 65 70 2d 61 6c 69 76 65 0d 0a 43 61 63 68 65 eep-aliv e··Cache
0080 2d 43 6f 6e 74 72 6f 6c 3a 20 6d 61 78 2d 61 67 -Control : max-ag
0090 65 3d 30 0d 0a 55 70 67 72 61 64 65 2d 49 6e 73 e=0··Upg rade-Ins
00a0 65 63 75 72 65 2d 52 65 71 75 65 73 74 73 3a 20 ecure-Re quests:
00b0 31 0d 0a 55 73 65 72 2d 41 67 65 6e 74 3a 20 4d 1··User- Agent: M
00c0 6f 7a 69 6c 6c 61 2f 35 2e 30 20 28 57 69 6e 64 ozilla/5 .0 (Wind
00d0 6f 77 73 20 4e 54 20 31 30 2e 30 3b 20 57 69 6e ows NT 1 0.0; Win
00e0 36 34 3b 20 78 36 34 29 20 41 70 70 6c 65 57 65 64; x64) AppleWe
00f0 62 4b 69 74 2f 35 33 37 2e 33 36 20 28 4b 48 54 bKit/537 .36 (KHT
0100 4d 4c 2c 20 6c 69 6b 65 20 47 65 63 6b 6f 29 20 ML, like Gecko)
0110 43 68 72 6f 6d 65 2f 31 33 34 2e 30 2e 30 2e 30 Chrome/1 34.0.0.0
0120 20 53 61 66 61 72 69 2f 35 33 37 2e 33 36 20 45 Safari/ 537.36 E
0130 64 67 2f 31 33 34 2e 30 2e 30 2e 30 0d 0a 41 63 dg/134.0 .0.0··Ac
0140 63 65 70 74 3a 20 74 65 78 74 2f 68 74 6d 6c 2c cept: te xt/html,
0150 61 70 70 6c 69 63 61 74 69 6f 6e 2f 78 68 74 6d applicat ion/xhtm
0160 6c 2b 78 6d 6c 2c 61 70 70 6c 69 63 61 74 69 6f l+xml,ap plicatio
0170 6e 2f 78 6d 6c 3b 71 3d 30 2e 39 2c 69 6d 61 67 n/xml;q= 0.9,imag
0180 65 2f 61 76 69 66 2c 69 6d 61 67 65 2f 77 65 62 e/avif,i mage/web
0190 70 2c 69 6d 61 67 65 2f 61 70 6e 67 2c 2a 2f 2a p,image/ apng,*/*
01a0 3b 71 3d 30 2e 38 2c 61 70 70 6c 69 63 61 74 69 ;q=0.8,a pplicati
01b0 6f 6e 2f 73 69 67 6e 65 64 2d 65 78 63 68 61 6e on/signe d-exchan
01c0 67 65 3b 76 3d 62 33 3b 71 3d 30 2e 37 0d 0a 41 ge;v=b3; q=0.7··A
01d0 63 63 65 70 74 2d 45 6e 63 6f 64 69 6e 67 3a 20 ccept-En coding:
01e0 67 7a 69 70 2c 20 64 65 66 6c 61 74 65 0d 0a 41 gzip, de flate··A
01f0 63 63 65 70 74 2d 4c 61 6e 67 75 61 67 65 3a 20 ccept-La nguage:
0200 6b 6f 2c 65 6e 3b 71 3d 30 2e 39 2c 65 6e 2d 55 ko,en;q= 0.9,en-U
0210 53 3b 71 3d 30 2e 38 0d 0a 49 66 2d 4e 6f 6e 65 S;q=0.8· ·If-None
0220 2d 4d 61 74 63 68 3a 20 22 36 37 64 33 63 33 39 -Match: "67d3c39
0230 65 2d 31 30 30 22 0d 0a 49 66 2d 4d 6f 64 69 66 e-100"·· If-Modif
0240 69 65 64 2d 53 69 6e 63 65 3a 20 46 72 69 2c 20 ied-Sinc e: Fri,
0250 31 34 20 4d 61 72 20 32 30 32 35 20 30 35 3a 35 14 Mar 2 025 05:5
0260 30 3a 32 32 20 47 4d 54 0d 0a 0d 0a 0:22 GMT····

구분	HEX	Binary
2계층	00 50 56 f8 b3 d4 00 0c 29 c8 ec 2c 08 00	00000000 01010000 01010110 11111000 10110011 11010100 00000000 00001100 00101001 11001000 11101100 00101100 00001000 00000000

Destination MAC Address
00000000 01010000 01010110 11111000 10110011 11010100
Source MAC Address
00000000 00001100 00101001 11001000 11101100 00101100

Type	
00001000 00000000	

3계층(Network Layer) IPv4

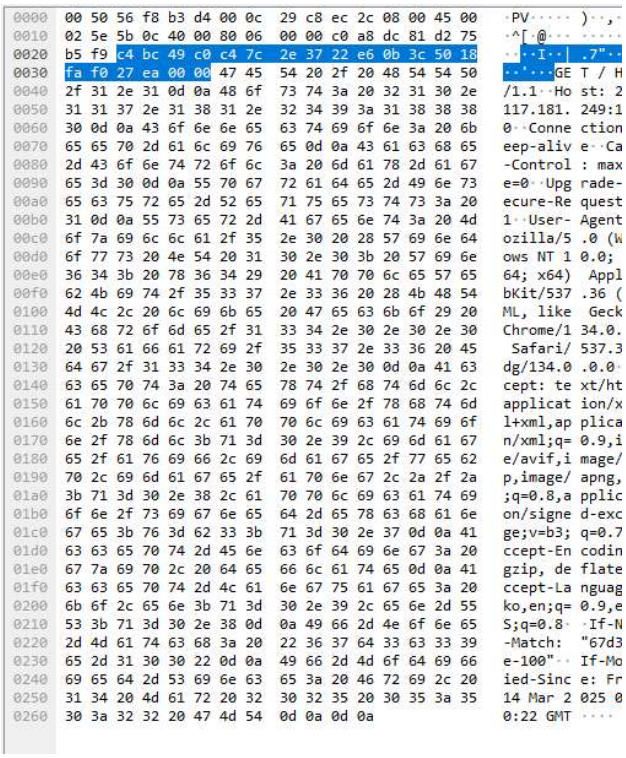


```
0000  00 50 56 f8 b3 d4 00 0c  29 c8 ec 2c 08 00 45 00   ·PV····· )··,··E·
0010  02 5e 5b 0c 40 00 80 06  00 00 c0 a8 dc 81 d2 75   ·^[·@··· ·······u
0020  b5 f9 c4 bc 49 c0 c4 7c  2e 37 22 e6 0b 3c 50 18   ····I··| .7"··<P·
0030  fa f0 27 ea 00 00 47 45  54 20 2f 20 48 54 54 50   ··'···GE T / HTTP
0040  2f 31 2e 31 0d 0a 48 6f  73 74 3a 20 32 31 30 2e   /1.1··Ho st: 210.
0050  31 31 37 2e 31 38 31 2e  32 34 39 3a 31 38 38 38   117.181. 249:1888
0060  30 0d 0a 43 6f 6e 6e 65  63 74 69 6f 6e 3a 20 6b   0··Conne ction: k
0070  65 65 70 2d 61 6c 69 76  65 0d 0a 43 61 63 68 65   eep-aliv e··Cache
0080  2d 43 6f 6e 74 72 6f 6c  3a 20 6d 61 78 2d 61 67   -Control : max-ag
0090  65 3d 30 0d 0a 55 70 67  72 61 64 65 2d 49 6e 73   e=0··Upg rade-Ins
00a0  65 63 75 72 65 2d 52 65  71 75 65 73 74 73 3a 20   ecure-Re quests:
00b0  31 0d 0a 55 73 65 72 2d  41 67 65 6e 74 3a 20 4d   1··User- Agent: M
00c0  6f 7a 69 6c 6c 61 2f 35  2e 30 20 28 57 69 6e 64   ozilla/5 .0 (Wind
00d0  6f 77 73 20 4e 54 20 31  30 2e 30 3b 20 57 69 6e   ows NT 1 0.0; Win
00e0  36 34 3b 20 78 36 34 29  20 41 70 70 6c 65 57 65   64; x64)  AppleWe
00f0  62 4b 69 74 2f 35 33 37  2e 33 36 20 28 4b 48 54   bKit/537 .36 (KHT
0100  4d 4c 2c 20 6c 69 6b 65  20 47 65 63 6b 6f 29 20   ML, like  Gecko)
0110  43 68 72 6f 6d 65 2f 31  33 34 2e 30 2e 30 2e 30   Chrome/1 34.0.0.0
0120  20 53 61 66 61 72 69 2f  35 33 37 2e 33 36 20 45    Safari/ 537.36 E
0130  64 67 2f 31 33 34 2e 30  2e 30 2e 30 0d 0a 41 63   dg/134.0 .0.0··Ac
0140  63 65 70 74 3a 20 74 65  78 74 2f 68 74 6d 6c 2c   cept: te xt/html,
0150  61 70 70 6c 69 63 61 74  69 6f 6e 2f 78 68 74 6d   applicat ion/xhtm
0160  6c 2b 78 6d 6c 2c 61 70  70 6c 69 63 61 74 69 6f   l+xml,ap plicatio
0170  6e 2f 78 6d 6c 3b 71 3d  30 2e 39 2c 69 6d 61 67   n/xml;q= 0.9,imag
0180  65 2f 61 76 69 66 2c 69  6d 61 67 65 2f 77 65 62   e/avif,i mage/web
0190  70 2c 69 6d 61 67 65 2f  61 70 6e 67 2c 2a 2f 2a   p,image/ apng,*/*
01a0  3b 71 3d 30 2e 38 2c 61  70 70 6c 69 63 61 74 69   ;q=0.8,a pplicati
01b0  6f 6e 2f 73 69 67 6e 65  64 2d 65 78 63 68 61 6e   on/signe d-exchan
01c0  67 65 3b 76 3d 62 33 3b  71 3d 30 2e 37 0d 0a 41   ge;v=b3; q=0.7··A
01d0  63 63 65 70 74 2d 45 6e  63 6f 64 69 6e 67 3a 20   ccept-En coding:
01e0  67 7a 69 70 2c 20 64 65  66 6c 61 74 65 0d 0a 41   gzip, de flate··A
01f0  63 63 65 70 74 2d 4c 61  6e 67 75 61 67 65 3a 20   ccept-La nguage:
0200  6b 6f 2c 65 6e 3b 71 3d  30 2e 39 2c 65 6e 2d 55   ko,en;q= 0.9,en-U
0210  53 3b 71 3d 30 2e 38 0d  0a 49 66 2d 4e 6f 6e 65   S;q=0.8·  ·If-None
0220  2d 4d 61 74 63 68 3a 20  22 36 37 64 33 63 33 39   -Match:  "67d3c39
0230  65 2d 31 30 30 22 0d 0a  49 66 2d 4d 6f 64 69 66   e-100"·· If-Modif
0240  69 65 64 2d 53 69 6e 63  65 3a 20 46 72 69 2c 20   ied-Sinc e: Fri,
0250  31 34 20 4d 61 72 20 32  30 32 35 20 30 35 3a 35   14 Mar 2 025 05:5
0260  30 3a 32 32 20 47 4d 54  0d 0a 0d 0a               0:22 GMT ····
```

구분	HEX	Binary
3계층	45 00 02 5e 5b 0c 40 00 80 06 00 00 c0 a8 dc 81 d2 75 b5 f9	01000101 00000000 01011110 01011011 00001100 01000000 00000000 10000000 00000110 00000000 00000000 11000000 10101000 11011100 10000001 11010010 01110101 00000000 11111001 11000100

Version	IHL	Type Of Service	Total Length
0100	0101	0000 0000	0000 0010 0101 1110
Identification		Flag	Fragment Offset
0101 1011 0000 1100		010	0 0000 0000 0000
Time To Live	Protocol	Header Checksum	
1000 0000	0000 0110	0000 0000 0000 0000	
Source Address			
1100 0000 1010 1000 1101 1100 1000 0001			
Destination Address			
1101 0010 0111 0101 1011 0101 1111 1001			

4계층(Transport Layer) TCP

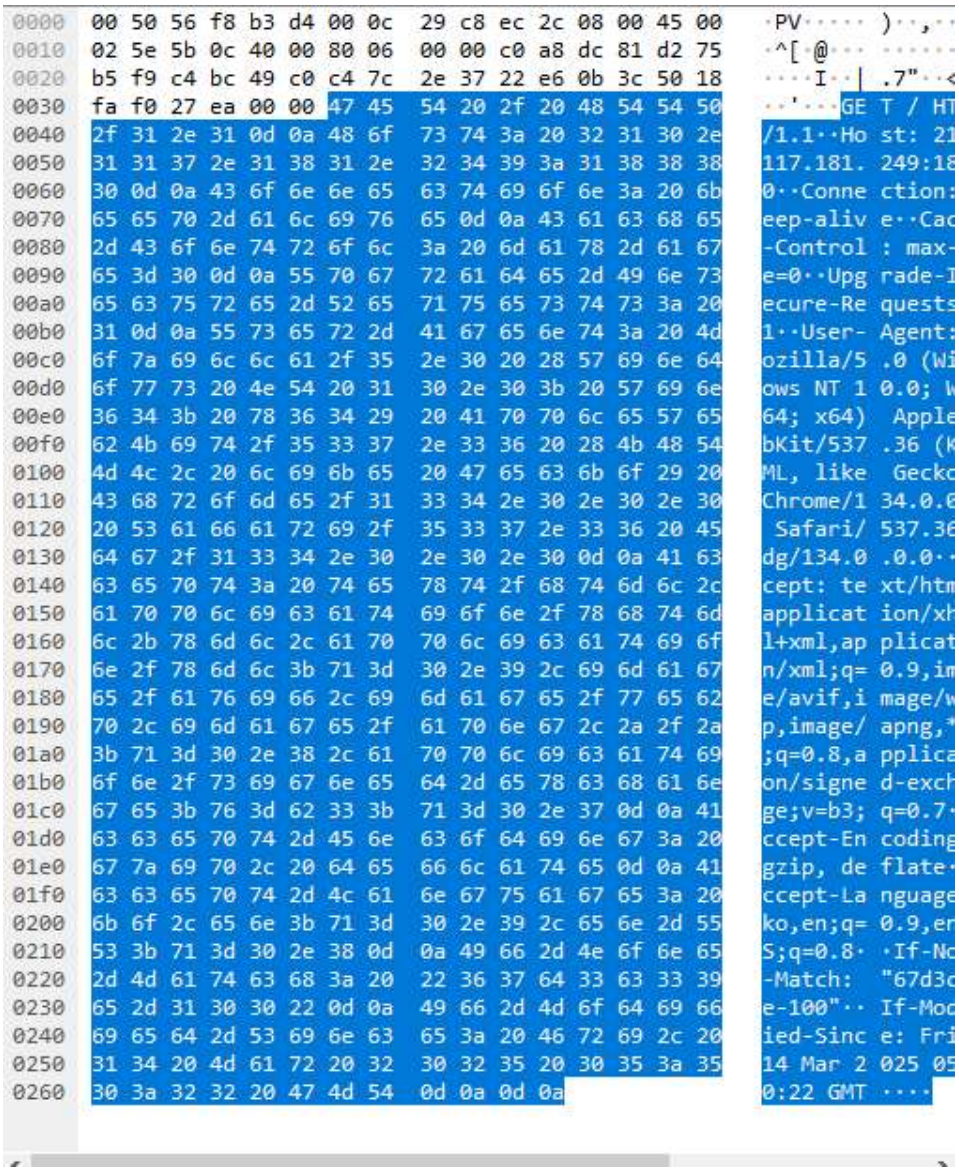


```
0000  00 50 56 f8 b3 d4 00 0c  29 c8 ec 2c 08 00 45 00   ·PV····· )··,··E·
0010  02 5e 5b 0c 40 00 80 06  00 00 c0 a8 dc 81 d2 75   ·^[·@··· ·····Ò·u
0020  b5 f9 c4 bc 49 c0 c4 7c  2e 37 22 e6 0b 3c 50 18   ····I··| .7"··<P·
0030  fa f0 27 ea 00 00 47 45  54 20 2f 20 48 54 54 50   ··'···GE T / HTTP
0040  2f 31 2e 31 0d 0a 48 6f  73 74 3a 20 32 31 30 2e   /1.1··Ho st: 210.
0050  31 31 37 2e 31 38 31 2e  32 34 39 3a 31 38 38 38   117.181. 249:1888
0060  30 0d 0a 43 6f 6e 6e 65  63 74 69 6f 6e 3a 20 6b   0··Conne ction: k
0070  65 65 70 2d 61 6c 69 76  65 0d 0a 43 61 63 68 65   eep-aliv e··Cache
0080  2d 43 6f 6e 74 72 6f 6c  3a 20 6d 61 78 2d 61 67   -Control : max-ag
0090  65 3d 30 0d 0a 55 70 67  72 61 64 65 2d 49 6e 73   e=0··Upg rade-Ins
00a0  65 63 75 72 65 2d 52 65  71 75 65 73 74 73 3a 20   ecure-Re quests:
00b0  31 0d 0a 55 73 65 72 2d  41 67 65 6e 74 3a 20 4d   1··User- Agent: M
00c0  6f 7a 69 6c 6c 61 2f 35  2e 30 20 28 57 69 6e 64   ozilla/5 .0 (Wind
00d0  6f 77 73 20 4e 54 20 31  30 2e 30 3b 20 57 69 6e   ows NT 1 0.0; Win
00e0  36 34 3b 20 78 36 34 29  20 41 70 70 6c 65 57 65   64; x64)  AppleWe
00f0  62 4b 69 74 2f 35 33 37  2e 33 36 20 28 4b 48 54   bKit/537 .36 (KHT
0100  4d 4c 2c 20 6c 69 6b 65  20 47 65 63 6b 6f 29 20   ML, like  Gecko)
0110  43 68 72 6f 6d 65 2f 31  33 34 2e 30 2e 30 2e 30   Chrome/1 34.0.0.0
0120  20 53 61 66 61 72 69 2f  35 33 37 2e 33 36 20 45    Safari/ 537.36 E
0130  64 67 2f 31 33 34 2e 30  2e 30 2e 30 0d 0a 41 63   dg/134.0 .0.0··Ac
0140  63 65 70 74 3a 20 74 65  78 74 2f 68 74 6d 6c 2c   cept: te xt/html,
0150  61 70 70 6c 69 63 61 74  69 6f 6e 2f 78 68 74 6d   applicat ion/xhtm
0160  6c 2b 78 6d 6c 2c 61 70  70 6c 69 63 61 74 69 6f   l+xml,ap plicatio
0170  6e 2f 78 6d 6c 3b 71 3d  30 2e 39 2c 69 6d 61 67   n/xml;q= 0.9,imag
0180  65 2f 61 76 69 66 2c 69  6d 61 67 65 2f 77 65 62   e/avif,i mage/web
0190  70 2c 69 6d 61 67 65 2f  61 70 6e 67 2c 2a 2f 2a   p,image/ apng,*/*
01a0  3b 71 3d 30 2e 38 2c 61  70 70 6c 69 63 61 74 69   ;q=0.8,a pplicati
01b0  6f 6e 2f 73 69 67 6e 65  64 2d 65 78 63 68 61 6e   on/signe d-exchan
01c0  67 65 3b 76 3d 62 33 3b  71 3d 30 2e 37 0d 0a 41   ge;v=b3; q=0.7··A
01d0  63 63 65 70 74 2d 45 6e  63 6f 64 69 6e 67 3a 20   ccept-En coding:
01e0  67 7a 69 70 2c 20 64 65  66 6c 61 74 65 0d 0a 41   gzip, de flate··A
01f0  63 63 65 70 74 2d 4c 61  6e 67 75 61 67 65 3a 20   ccept-La nguage:
0200  6b 6f 2c 65 6e 3b 71 3d  30 2e 39 2c 65 6e 2d 55   ko,en;q= 0.9,en-U
0210  53 3b 71 3d 30 2e 38 0d  0a 49 66 2d 4e 6f 6e 65   S;q=0.8·  ·If-None
0220  2d 4d 61 74 63 68 3a 20  22 36 37 64 33 63 33 39   -Match:  "67d3c39
0230  65 2d 31 30 30 22 0d 0a  49 66 2d 4d 6f 64 69 66   e-100"·· If-Modif
0240  69 65 64 2d 53 69 6e 63  65 3a 20 46 72 69 2c 20   ied-Sinc e: Fri,
0250  31 34 20 4d 61 72 20 32  30 32 35 20 30 35 3a 35   14 Mar 2 025 05:5
0260  30 3a 32 32 20 47 4d 54  0d 0a 0d 0a               0:22 GMT ····
```

구분	HEX	Binary
4계층	c4 bc 49 c0 c4 7c 2e 37 22 e6 0b 3c 50 18 fa f0 27 ea 00 00	10111100 01001001 11000000 11000100 01111100 00101110 00110111 00100010 11100110 00001011 00111100 01010000 00011000 00000000 11110000 00100111 11101010 00000000 00000000 01000111

Source Port(S.Port)		Destination Port	
1100 0100 1011 1100		0100 1001 1100 0000	
Sequence Number			
1100 0100 0111 1100 0010 1110 0011 0111			
Acknowledgment Number			
0010 0010 1110 0110 0000 1011 0011 1100			
Data Offset	Reserved	Control Bit	Window
0101	0000 00	01 1000	1111 1010 1111 0000
Checksum		Urgent Pointer	
0010 0111 1110 1010		0000 0000 0000 0000	

7계층(Application Layer)



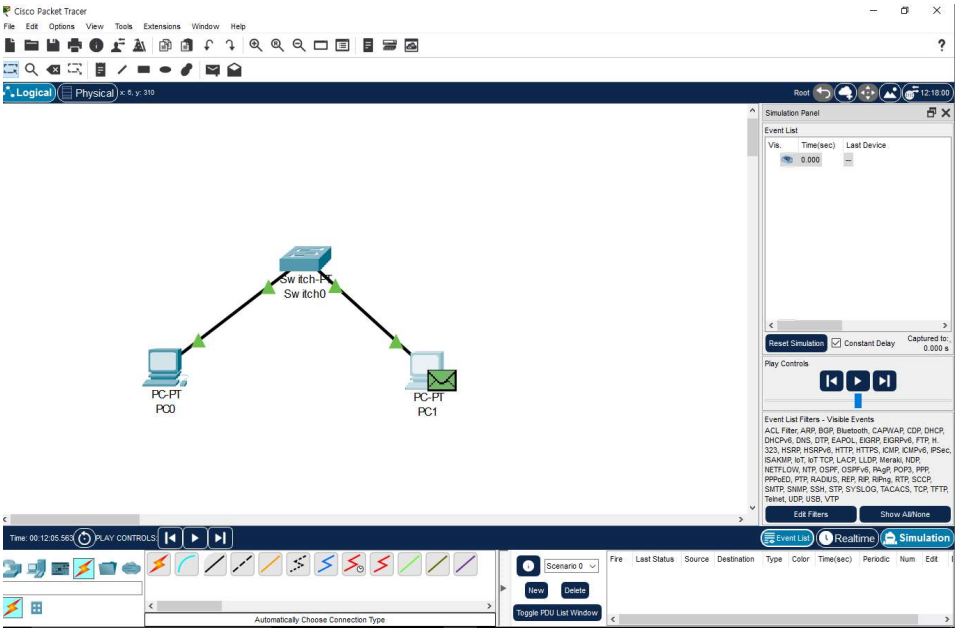
```
0000  00 50 56 f8 b3 d4 00 0c  29 c8 ec 2c 08 00 45 00   ·PV····· )··,··E·
0010  02 5e 5b 0c 40 00 80 06  00 00 c0 a8 dc 81 d2 75   ·^[·@··· ·······u
0020  b5 f9 c4 bc 49 c0 c4 7c  2e 37 22 e6 0b 3c 50 18   ····I··| .7"··<P·
0030  fa f0 27 ea 00 00 47 45  54 20 2f 20 48 54 54 50   ··'···GE T / HTTP
0040  2f 31 2e 31 0d 0a 48 6f  73 74 3a 20 32 31 30 2e   /1.1··Ho st: 210.
0050  31 31 37 2e 31 38 31 2e  32 34 39 3a 31 38 38 38   117.181. 249:1888
0060  30 0d 0a 43 6f 6e 6e 65  63 74 69 6f 6e 3a 20 6b   0··Conne ction: k
0070  65 65 70 2d 61 6c 69 76  65 0d 0a 43 61 63 68 65   eep-aliv e··Cache
0080  2d 43 6f 6e 74 72 6f 6c  3a 20 6d 61 78 2d 61 67   -Control : max-ag
0090  65 3d 30 0d 0a 55 70 67  72 61 64 65 2d 49 6e 73   e=0··Upg rade-Ins
00a0  65 63 75 72 65 2d 52 65  71 75 65 73 74 73 3a 20   ecure-Re quests:
00b0  31 0d 0a 55 73 65 72 2d  41 67 65 6e 74 3a 20 4d   1··User- Agent: M
00c0  6f 7a 69 6c 6c 61 2f 35  2e 30 20 28 57 69 6e 64   ozilla/5 .0 (Wind
00d0  6f 77 73 20 4e 54 20 31  30 2e 30 3b 20 57 69 6e   ows NT 1 0.0; Win
00e0  36 34 3b 20 78 36 34 29  20 41 70 70 6c 65 57 65   64; x64)  AppleWe
00f0  62 4b 69 74 2f 35 33 37  2e 33 36 20 28 4b 48 54   bKit/537 .36 (KHT
0100  4d 4c 2c 20 6c 69 6b 65  20 47 65 63 6b 6f 29 20   ML, like  Gecko)
0110  43 68 72 6f 6d 65 2f 31  33 34 2e 30 2e 30 2e 30   Chrome/1 34.0.0.0
0120  20 53 61 66 61 72 69 2f  35 33 37 2e 33 36 20 45    Safari/ 537.36 E
0130  64 67 2f 31 33 34 2e 30  2e 30 2e 30 0d 0a 41 63   dg/134.0 .0.0··Ac
0140  63 65 70 74 3a 20 74 65  78 74 2f 68 74 6d 6c 2c   cept: te xt/html,
0150  61 70 70 6c 69 63 61 74  69 6f 6e 2f 78 68 74 6d   applicat ion/xhtm
0160  6c 2b 78 6d 6c 2c 61 70  70 6c 69 63 61 74 69 6f   l+xml,ap plicatio
0170  6e 2f 78 6d 6c 3b 71 3d  30 2e 39 2c 69 6d 61 67   n/xml;q= 0.9,imag
0180  65 2f 61 76 69 66 2c 69  6d 61 67 65 2f 77 65 62   e/avif,i mage/web
0190  70 2c 69 6d 61 67 65 2f  61 70 6e 67 2c 2a 2f 2a   p,image/ apng,*/*
01a0  3b 71 3d 30 2e 38 2c 61  70 70 6c 69 63 61 74 69   ;q=0.8,a pplicati
01b0  6f 6e 2f 73 69 67 6e 65  64 2d 65 78 63 68 61 6e   on/signe d-exchan
01c0  67 65 3b 76 3d 62 33 3b  71 3d 30 2e 37 0d 0a 41   ge;v=b3; q=0.7··A
01d0  63 63 65 70 74 2d 45 6e  63 6f 64 69 6e 67 3a 20   ccept-En coding:
01e0  67 7a 69 70 2c 20 64 65  66 6c 61 74 65 0d 0a 41   gzip, de flate··A
01f0  63 63 65 70 74 2d 4c 61  6e 67 75 61 67 65 3a 20   ccept-La nguage:
0200  6b 6f 2c 65 6e 3b 71 3d  30 2e 39 2c 65 6e 2d 55   ko,en;q= 0.9,en-U
0210  53 3b 71 3d 30 2e 38 0d  0a 49 66 2d 4e 6f 6e 65   S;q=0.8· ·If-None
0220  2d 4d 61 74 63 68 3a 20  22 36 37 64 33 63 33 39   -Match:  "67d3c39
0230  65 2d 31 30 30 22 0d 0a  49 66 2d 4d 6f 64 69 66   e-100"·· If-Modif
0240  69 65 64 2d 53 69 6e 63  65 3a 20 46 72 69 2c 20   ied-Sinc e: Fri,
0250  31 34 20 4d 61 72 20 32  30 32 35 20 30 35 3a 35   14 Mar 2 025 05:5
0260  30 3a 32 32 20 47 4d 54  0d 0a 0d 0a               0:22 GMT ····
```

```
Hypertext Transfer Protocol
> GET / HTTP/1.1\r\n
  Host: 210.117.181.249:18880\r\n
  Connection: keep-alive\r\n
  Cache-Control: max-age=0\r\n
  Upgrade-Insecure-Requests: 1\r\n
  User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/134.0.0.0 Safar
  Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,applicatic
  Accept-Encoding: gzip, deflate\r\n
  Accept-Language: ko,en;q=0.9,en-US;q=0.8\r\n
  If-None-Match: "67d3c39e-100"\r\n
  If-Modified-Since: Fri, 14 Mar 2025 05:50:22 GMT\r\n
  \r\n
  [Response in frame: 72]
  [Full request URI: http://210.117.181.249:18880/]
```

1. 데이터 링크 계층에 사용되는 장치 연결

데이터 링크 계층에서 사용되는 스위치 허브와 PC 2대를 연결했습니다.

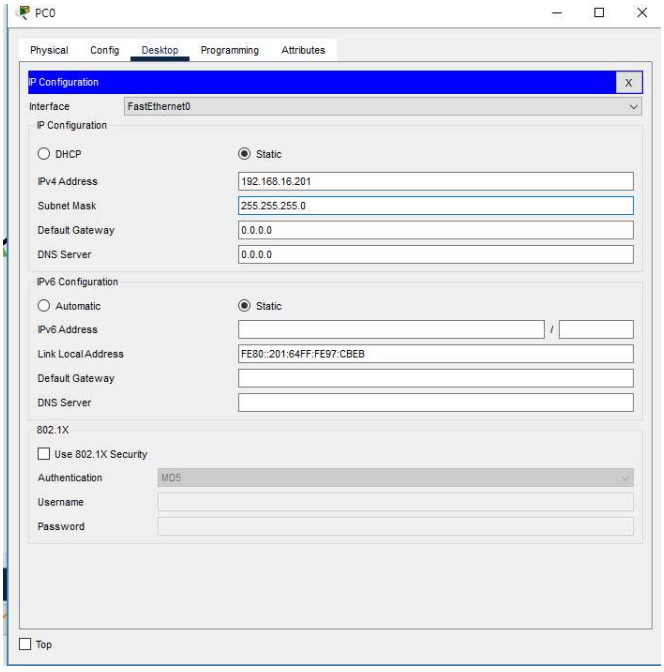
파란불이 들어오며 연결된 걸 확인할 수 있습니다.

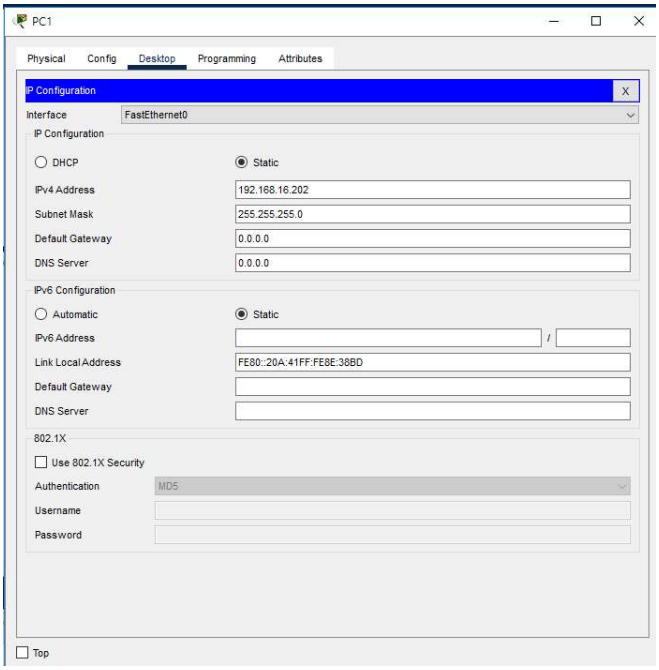


2. IP 주소 설정

PC0의 IP주소를 192.168.16.201로

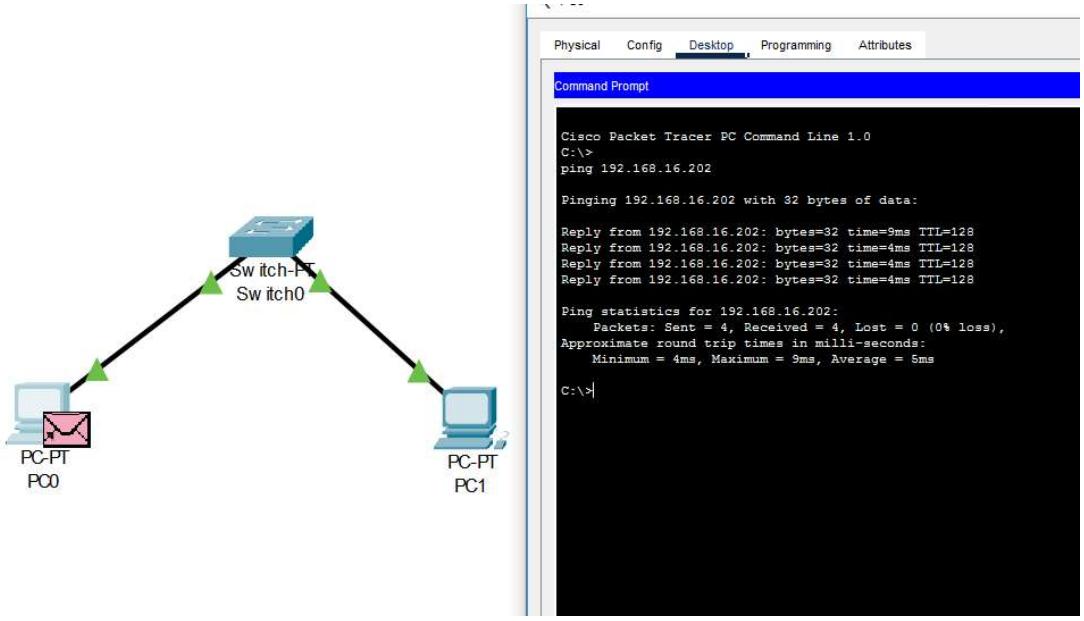
PC1의 IP주소를 192.168.16.202로 설정했습니다.



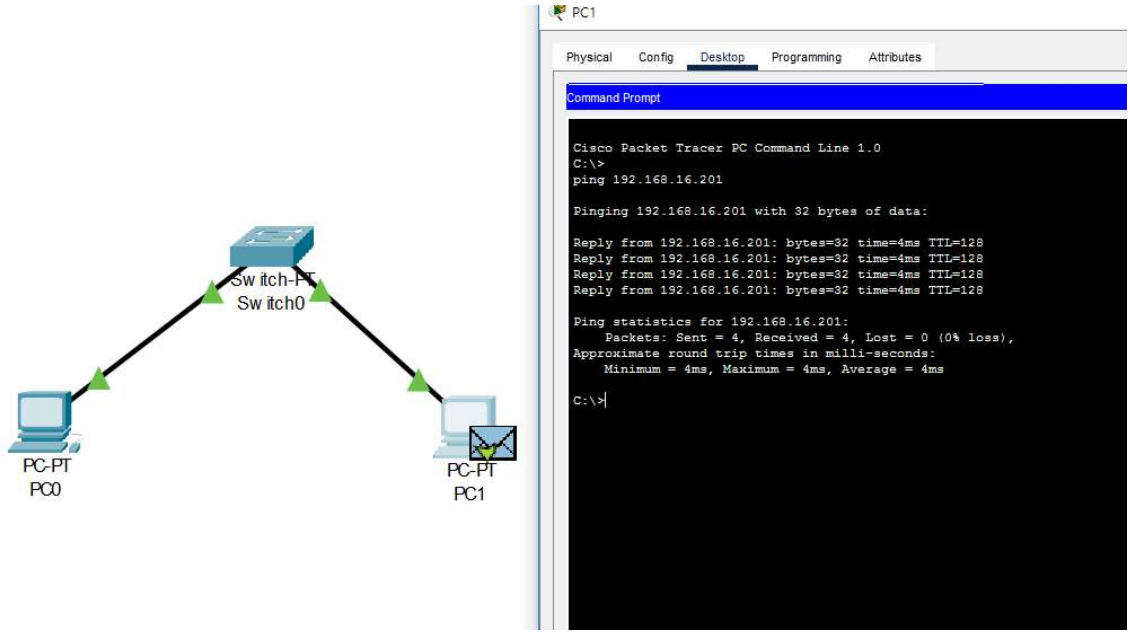


3. 연결 확인

PC0 -> PC1 Ping명령어를 실행해 Reply가 성공적으로 온걸 확인했습니다.

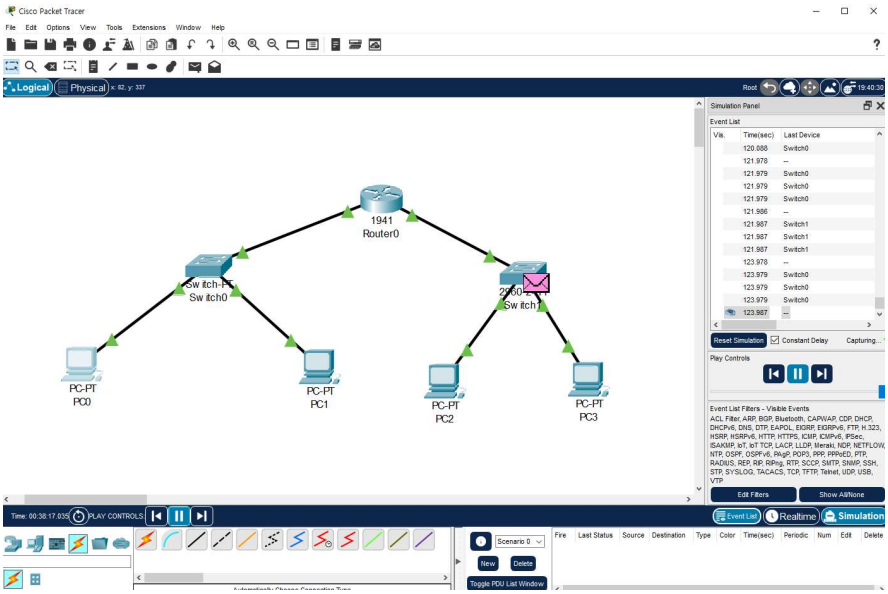


마찬가지로 PC1 -> PC0 도 Reply를 확인했습니다.



결과적으로 스위치와 연결된 PC0 <-> PC1의 연결이 정상적으로 이루어짐을 확인했습니다.

1. 네트워크 장치 연결



구분	장치	IP Address	Default Gateway IP Address
네트워크 1	PC0	192.168.16.201	192.168.16.200
	PC1	192.168.16.202	192.168.16.200
네트워크 2	PC2	192.168.15.201	192.168.15.200
	PC3	192.168.15.202	192.168.15.200

위와 같이 세팅했습니다.

2. 연결 확인하기

tracert 명령어를 통해 PC0 -> Router -> PC3으로 흘러가는지 확인해보겠습니다.

```
C:\>tracert 192.168.15.202

Tracing route to 192.168.15.202 over a maximum of 30 hops:

  1    8 ms      4 ms      4 ms      192.168.16.200
  2    *         8 ms      8 ms      192.168.15.202

Trace complete.
```

tracert 명령어가 정상적으로 실행되었으며, PC0에서 Router를 거쳐 PC3으로 패킷이 전달됨을 확인할 수 있습니다