네트워크프로그래밍-4주
소켓프로그래밍-2

정인환교수

4주 강의 내용

- Windows Socket 프로그래밍 환경
- Time Client / Server 상세 설명 및 응용
  - TCP Time Client/Server 응용
- 소켓프로그래밍 예2 – echo client / server
  - echo client/server 기본/응용1
  - 응용2,3 – Server가 대문자/소문자 변환
- 과제
  - echo client/server 응용
    - Client 에서 대/소문자 변환 Menu 사용
    - Applicatin Protocol 만들기
  - Login 기능 추가하기
    - login protocol 만들기

Windows Socket 프로그래밍 환경

- Linux << 99% 그대로 사용 >> Windows
- Linux time_client.c >> Windows wtime_client.c
  - 헤더파일 필요

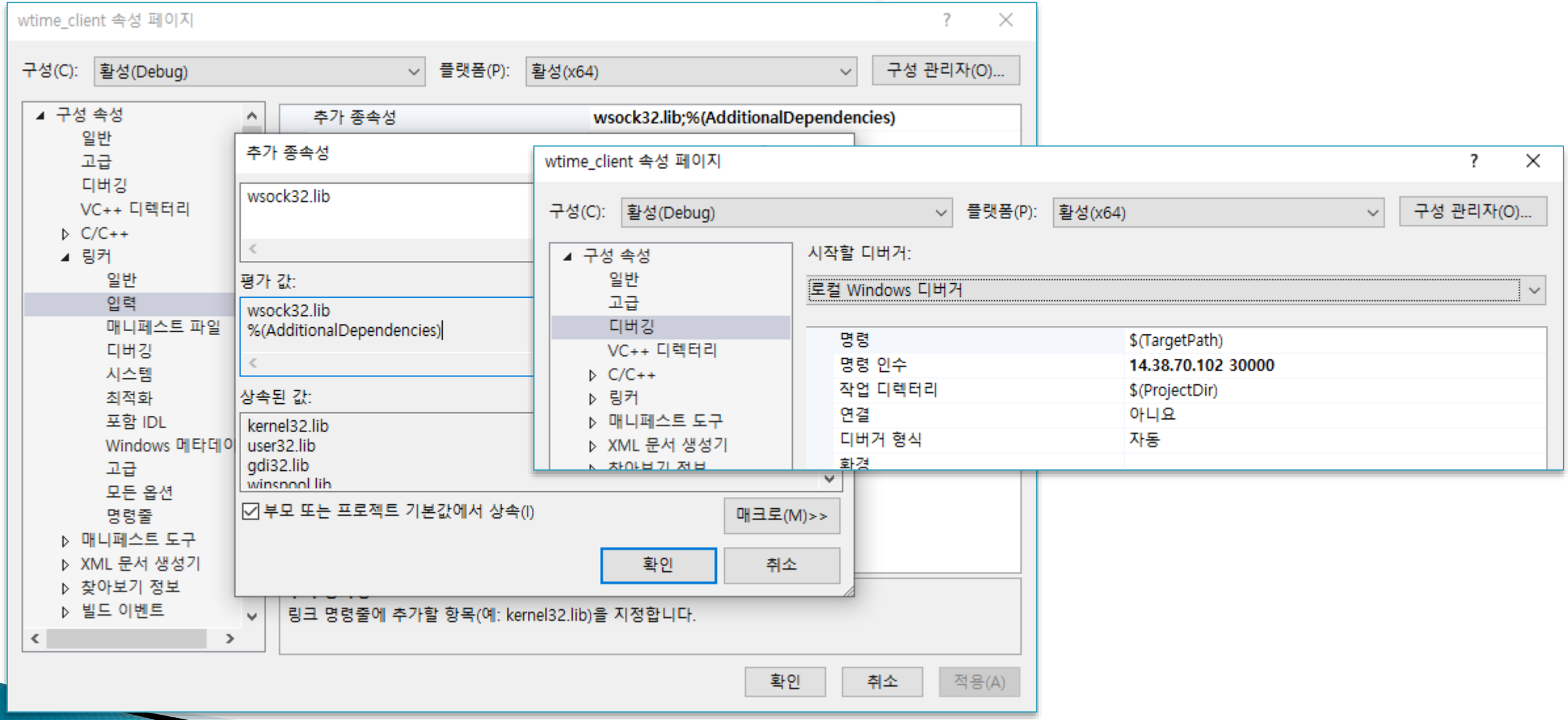
```
#include <winsock.h>
#include <signal.h>
#include <stdio.h>
#include <conio.h>
#include <stdlib.h>
```

- Library 환경 설정
  - wsock32.lib 링커에 추가
- 프로그램 순서
  - 시작시
    - WSAStartup()
      - Winsock.dll을 초기화
  - 종료시
    - 소켓닫을때
      - closesocket()
    - WSACleanup()
      - Winsock.dll의 사용 종료

```
WORD version = MAKEWORD(1,1);
WSADATA wsadata;
WSAStartup(version, &wsadata);
```

```
closesocket();
WSACleanup();
exit(0);
```

Windows Visual Studio Project 설정



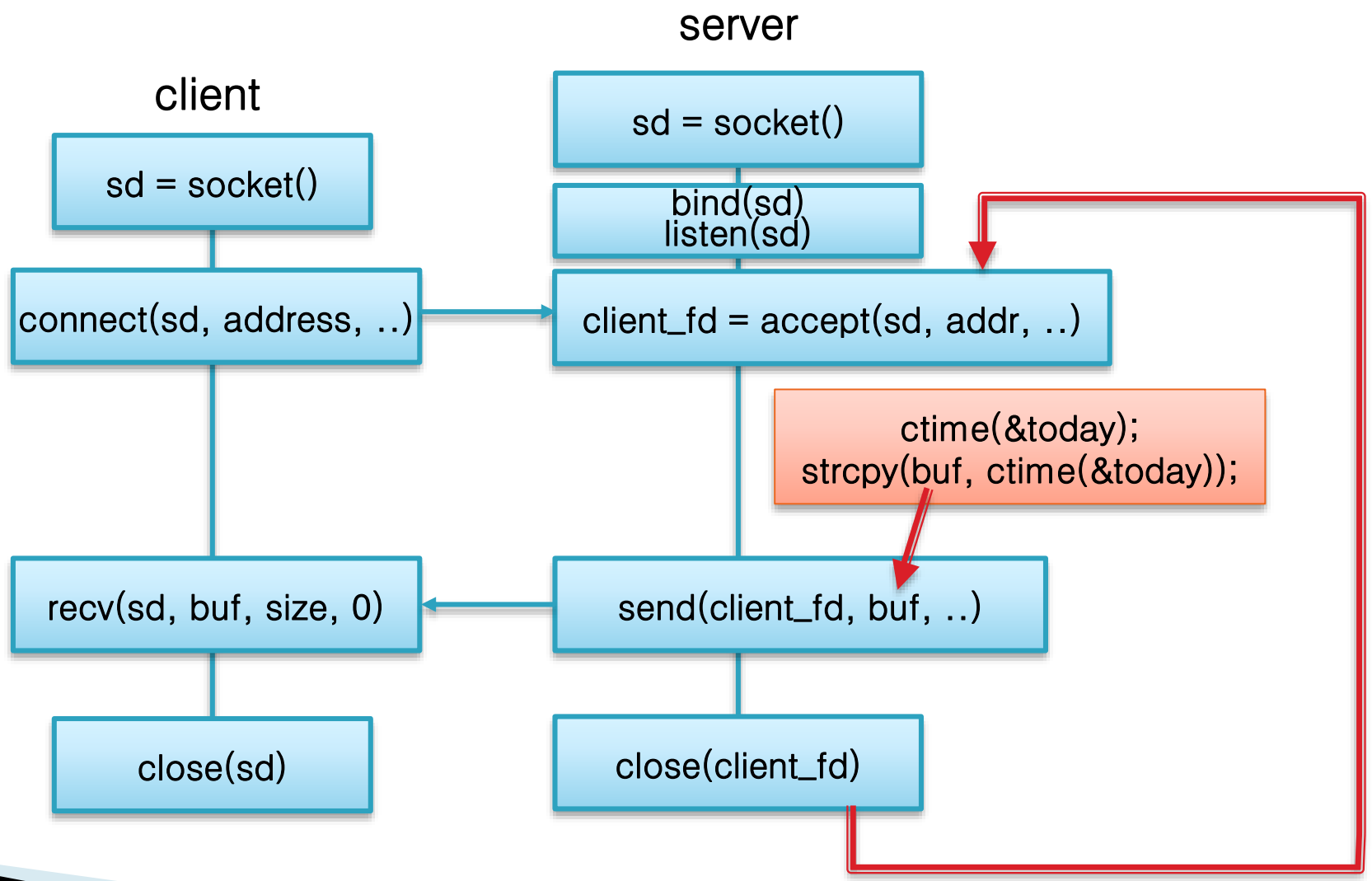
```c
/* Linux
파일명 : time_client.c
기  능 : time 서비스를 요구하는
TCP(연결형) 클라이언트
사용법 : time_client[ip][port] //
default는 127.0.0.1 30000
*/
#include <stdio.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <sys/signal.h>
#include <unistd.h>

#define BUF_LEN 128
#define TIME_SERVER "127.0.0.1"
#define TIME_PORT "30000"

void main(int argc, char *argv[]) {
        int sock;
        struct sockaddr_in server;
        char *haddr;
        char buf[BUF_LEN+1] = {0};

        sock = socket(...)

        closce(sock);
}
```

Linux time_client.c

```c
/* Windows
파일명 : wtime_client.c
기  능 : time 서비스를 요구하는 TCP(연결형)
클라이언트
사용법 : time_client[ip][port] // default는
127.0.0.1 30000
*/
#include <winsock.h>
#include <signal.h>
#include <stdio.h>
#include <conio.h>
#include <stdlib.h>

WSADATA wsadata;
int             main_socket;

void exit_callback(int sig)
{
    closesocket(main_socket);
    WSACleanup();
    exit(0);
}

void init_winsock()
{
    WORD sversion;
    u_long iMode = 1;

    // winsock 사용을 위해 필수적임
    signal(SIGINT, exit_callback);
    sversion = MAKEWORD(1, 1);
    WSAStartup(sversion, &wsadata);
}
```

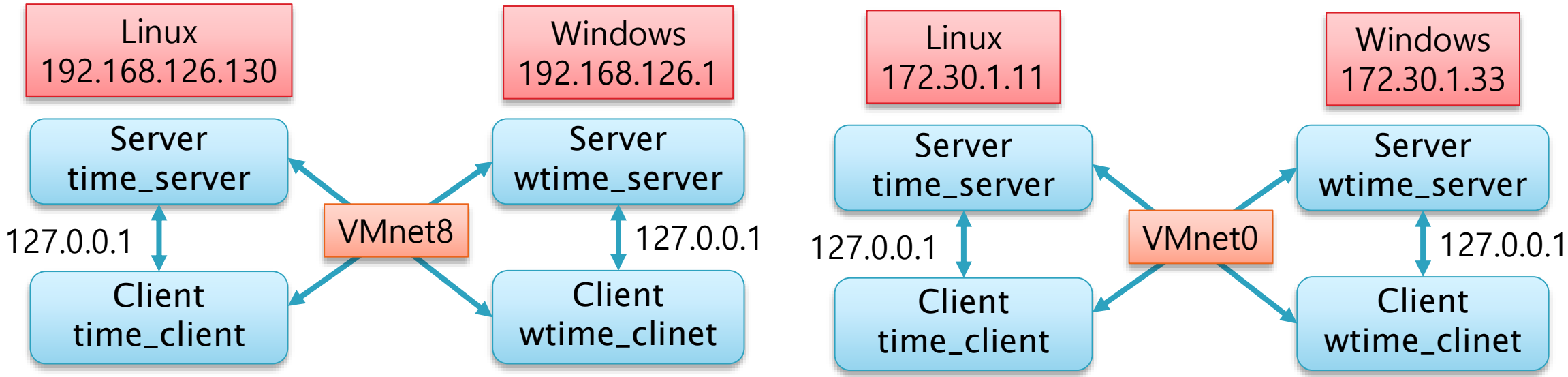
```c
#define BUF_LEN 128
#define TIME_SERVER "127.0.0.1"
#define TIME_PORT "30000"

void main(int argc, char* argv[]) {
    int sock;
    struct sockaddr_in server;
    char* haddr;
    char buf[BUF_LEN + 1] = { 0 };
    char* ip_addr = TIME_SERVER, * port_no = TIME_PORT;

    init_winsock();

    if (argc == 3) {
        ip_addr = argv[1];
        port_no = argv[2];
    }
    if ((sock = socket(AF_INET, SOCK_STREAM, 0)) < 0) {
        printf("can't create socket₩n");
        exit(0);
    }
    main_socket = sock; // 추가

    // 생략


    printf("Time information from server is %s", buf);

    closesocket(sock);
    return(0);
}
```

소켓프로그래밍 예1-1 – TCP time client/server



소켓프로그래밍 예1 – TCP/UDP time client/server

- Linux Client / Linux Server
- Windows Client / Windows Server
- Windows Client / Linux Server
- Linux Client / Windows Server



소켓프로그래밍 예1 – TCP time client/server

- time_server.c

```
# define TIME_PORT     "30000"
main (int argc, char *argv[])
{
    int sock, sock2;
    struct sockaddr_in server, client;
    int len;
    char buf [256];
    time_t today;

    sock = socket (AF_INET, SOCK_STREAM, 0);
    server.sin_family = AF_INET;
    server.sin_addr.s_addr = htonl (INADDR_ANY);
    server.sin_port = htons (atoi(TIME_PORT));
    bind (sock, (struct sockaddr *)&server, sizeof (server));
    listen (sock, 5);
    while (1) {
        sock2 = accept (sock, (struct sockaddr *)&client, &len);
        time (&today);
        strcpy (buf, ctime (&today));
        send (sock2, buf, strlen (buf) + 1, 0);
        close (sock2);
    }
}
```

TCP SOCK_STREAM
UDP SOCK_DGRAM

INADDR_ANY = 0.0.0.0
모든 연결에서 대기한다.

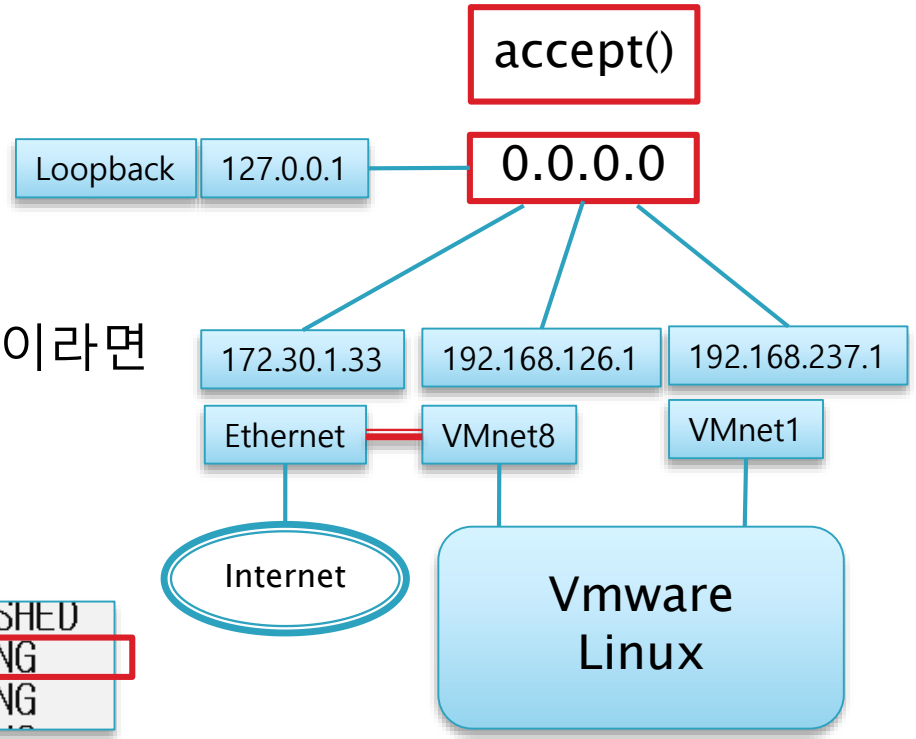
bind(), accept() 함수에서 기다리는 IP 주소 결정

- Network Interface가 2개 이상인 경우
  - ipconfig 로 확인 가능
  - 이더넷(172.30.1.33), VMnet1(192.168.237.1), VMnet8(192.168.126.1), Loopback(127.0.0.1)
- server.sin_addr.s_addr = htonl(INADDR_ANY); // “0.0.0.0”
  - 모든 Network Interface에서 accept() 기다린다.
  - Netstat –na 로 확인
  - client 는 위의 4가지 주소 모두 접속 가능

```
TCP    0.0.0.0:21300          0.0.0.0:0              LISTENING
TCP    0.0.0.0:30000          0.0.0.0:0              LISTENING
TCP    0.0.0.0:49152          0.0.0.0:0              LISTENING
```

- INADDR_ANY 아닌 실제 IP 주소
  - #define TIME_SERVER “0.0.0.0” 대신 “172.30.1.33” 이라면
  - ip_addr = TIME_SERVER
  - server.sin_addr.s_addr = inet_addr(ip_addr);
  - client는 172.30.1.33 30000 만 접속 가능

```
TCP    172.30.1.33:10182      157.240.215.63:443     ESTABLISHED
TCP    172.30.1.33:30000      0.0.0.0:0              LISTENING
TCP    192.168.126.1:139      0.0.0.0:0              LISTENING
```

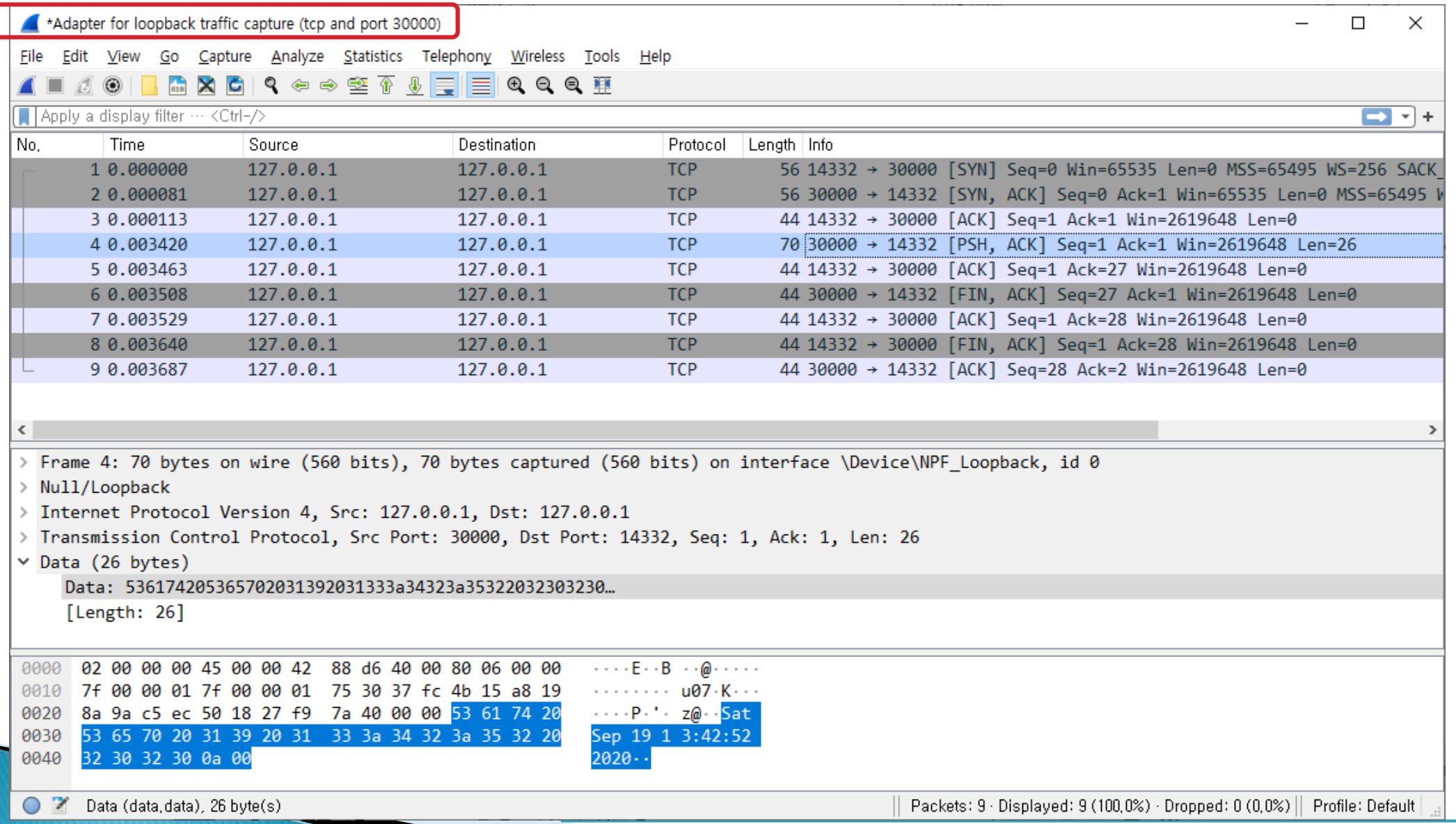


소켓프로그래밍 예1-1 – TCP time client/server

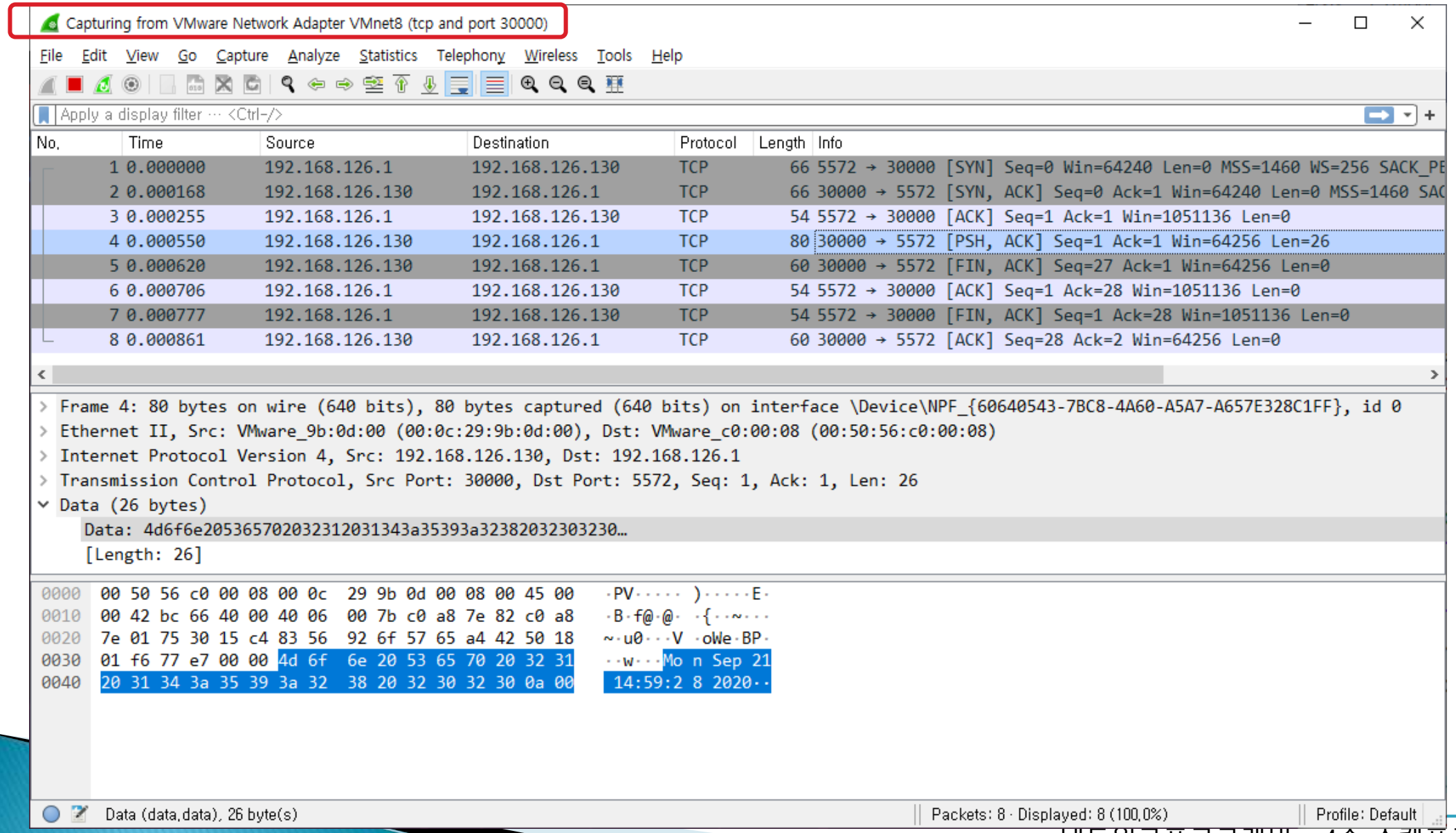
- time_client.c

```
#define TIME_SERVER     "127.0.0.1"
#define TIME_PORT        30000

void main(int argc, char *argv[]) {
   int sock;
   struct sockaddr_in server;
   char buf[BUF_LEN+1] = {0};
   char *ip_addr = TIME_SERVER, *port_no = TIME_PORT;
   if (argc == 3) {
        ip_addr = argv[1];
        port_no = argv[2];
  }
  sock = socket(AF_INET, SOCK_STREAM, 0);

  server.sin_family = AF_INET;
  server.sin_addr.s_addr = inet_addr (ip_addr); // "127.0.0.1" → 0x7f000001
  server.sin_port = htons(atoi(port_no));

  connect(sock, (struct sockaddr *)&server, sizeof(server));

  if (recv(sock, buf, sizeof (buf), 0) == -1)
      exit (1);
  printf ("Time information from server is %s", buf);
  close (sock);
}
```

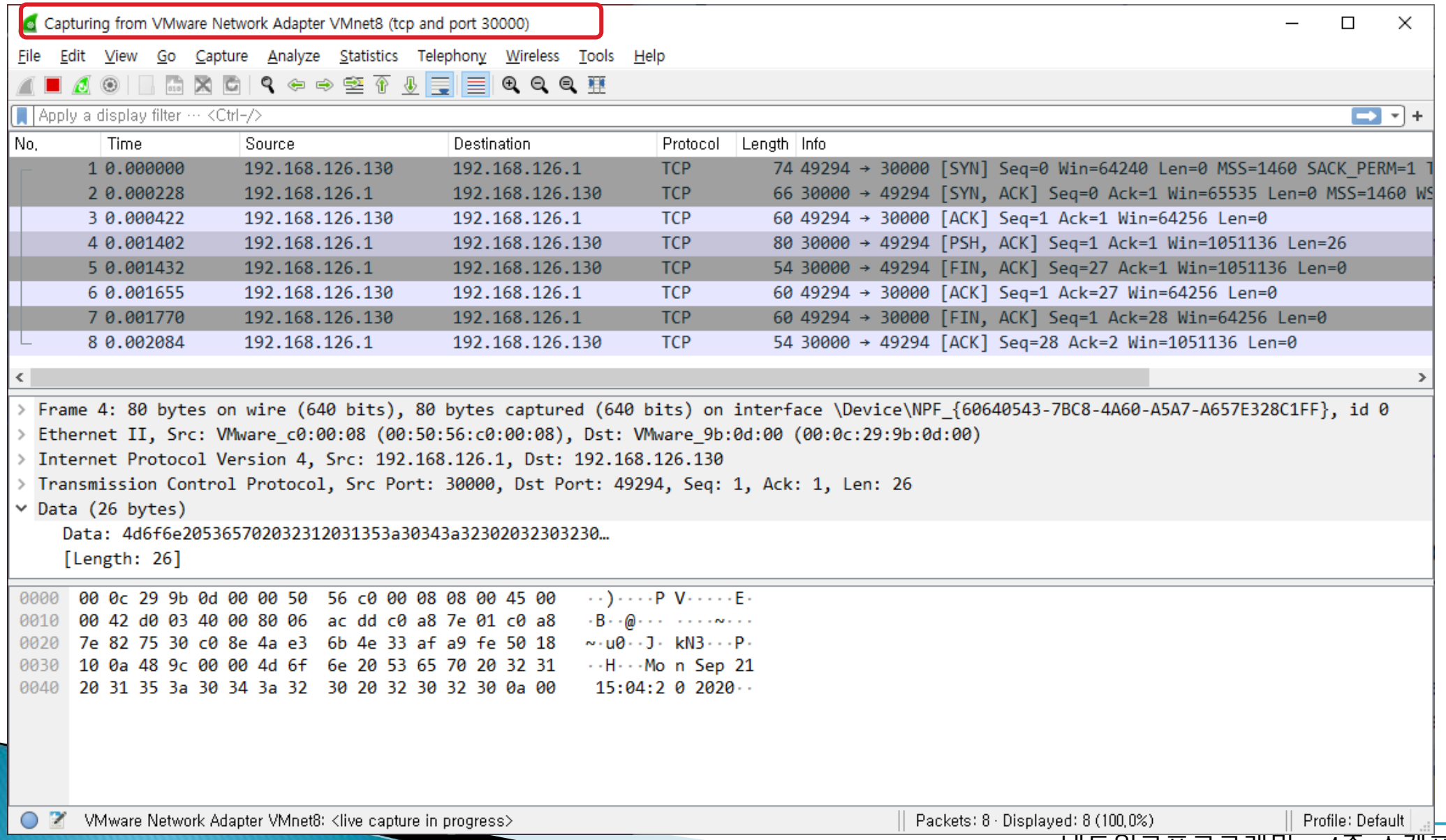
Windows time_client <127.0.0.1> time_server



Windows time_client(192.168.126.1) <VMnet8> Linux time_server(192.168.126.130)

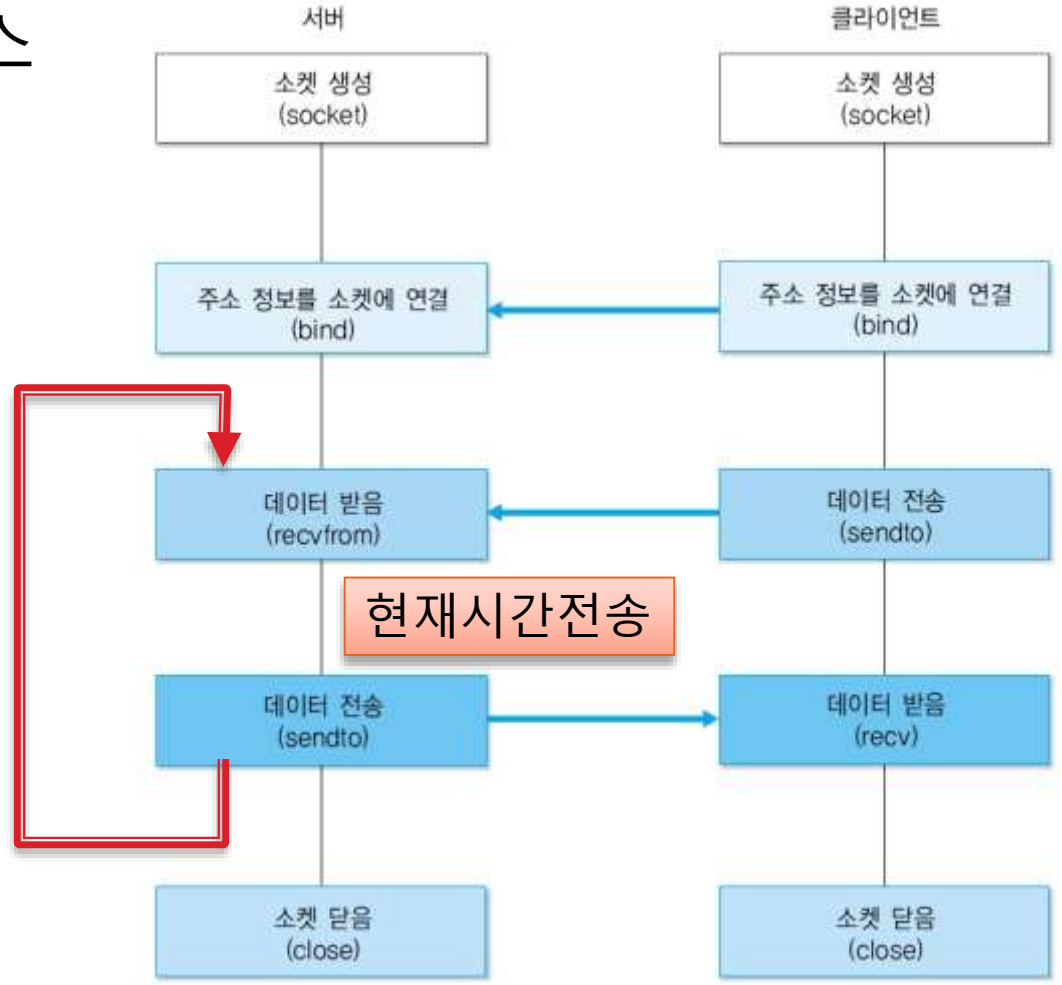


Linux time_client(192.168.126.128) <VMnet8> Widows time_server(192.168.126.1)



소켓프로그램 예1-2 – UDP time client/server

- 비연결형 서비스



[그림 12-2] UDP를 이용한 통신 절차

소켓프로그램 예1-2 – UDP time client/server

- udp_time_server.c

```
main (int argc, char *argv[])
{
   time_t today;
   char *port_no = TIME_PORT;
    if (argc==2) port_no = argv[1];
   sock = socket (AF_INET, SOCK_DGRAM, 0);
   server.sin_family = AF_INET;
   server.sin_addr.s_addr = htonl (INADDR_ANY);
   server.sin_port = htons (atoi(port_no));
   bind (sock, (struct sockaddr *)&server, sizeof (server));

   while (1) {
      client_len = sizeof(client);
      buf_len = recvfrom (sock, buf, 256, 0, (struct sockaddr *)&client, &client_len);
      if (buf_len < 0)
         exit (1);
      printf("Server : A client data recvfrom msg = %s.\n", buf);
      time (&today);
      strcpy (buf, ctime (&today));
       printf("Server time=%s", buf);
      sendto (sock, buf, strlen (buf) + 1, 0, (struct sockaddr *)&client, client_len);
   }
}
```

TCP SOCK_STREAM
UDP SOCK_DGRAM

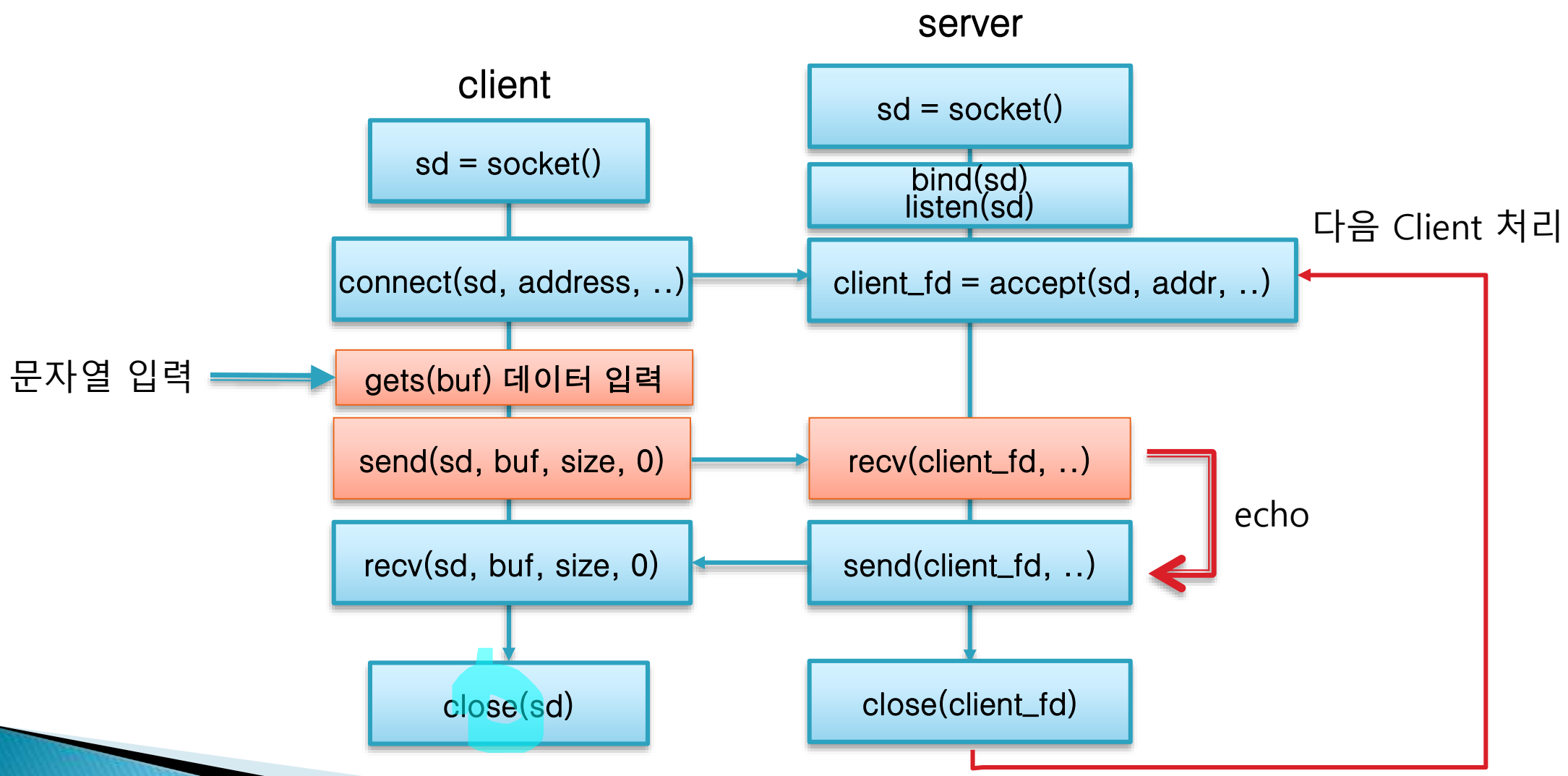
INADDR_ANY = 0.0.0.0
모든 연결에서 대기한다.

소켓프로그램 예1-2 – UDP time client/server

- udp_time_client.c

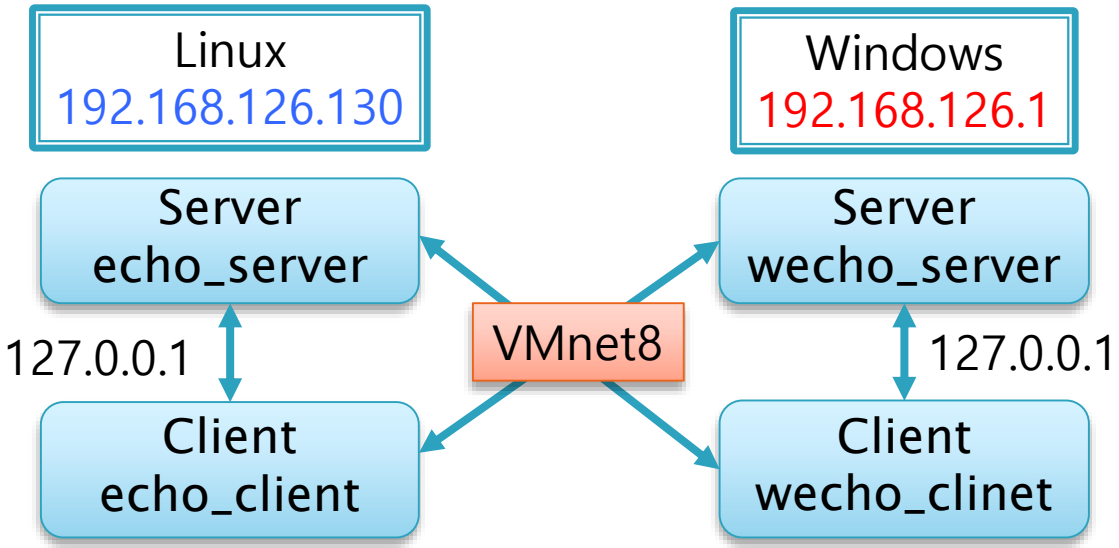
```
main ()
{
  sock = socket (AF_INET, SOCK_DGRAM, 0);
  server.sin_family = AF_INET;
  server.sin_addr.s_addr = htonl (inet_addr (TIME_SERVER));
  server.sin_port = htons (TIME_PORT);
  buf[0] = '?'; buf[1] = '\0';
  server_len = sizeof(server);
  buf_len = sendto (sock, buf, strlen(buf) + 1, 0, (struct sockaddr *)&server,
    server_len);
  if (buf_len < 0) exit (1);
    buf_len = recvfrom(sock, buf, 256, 0, (struct  sockaddr*)&server,
     &server_len);
  if (buf_len < 0) exit (1);
  printf ("Time information from server is %s", buf);
}
```

소켓프로그램 예제 2 – Echo Client/Server

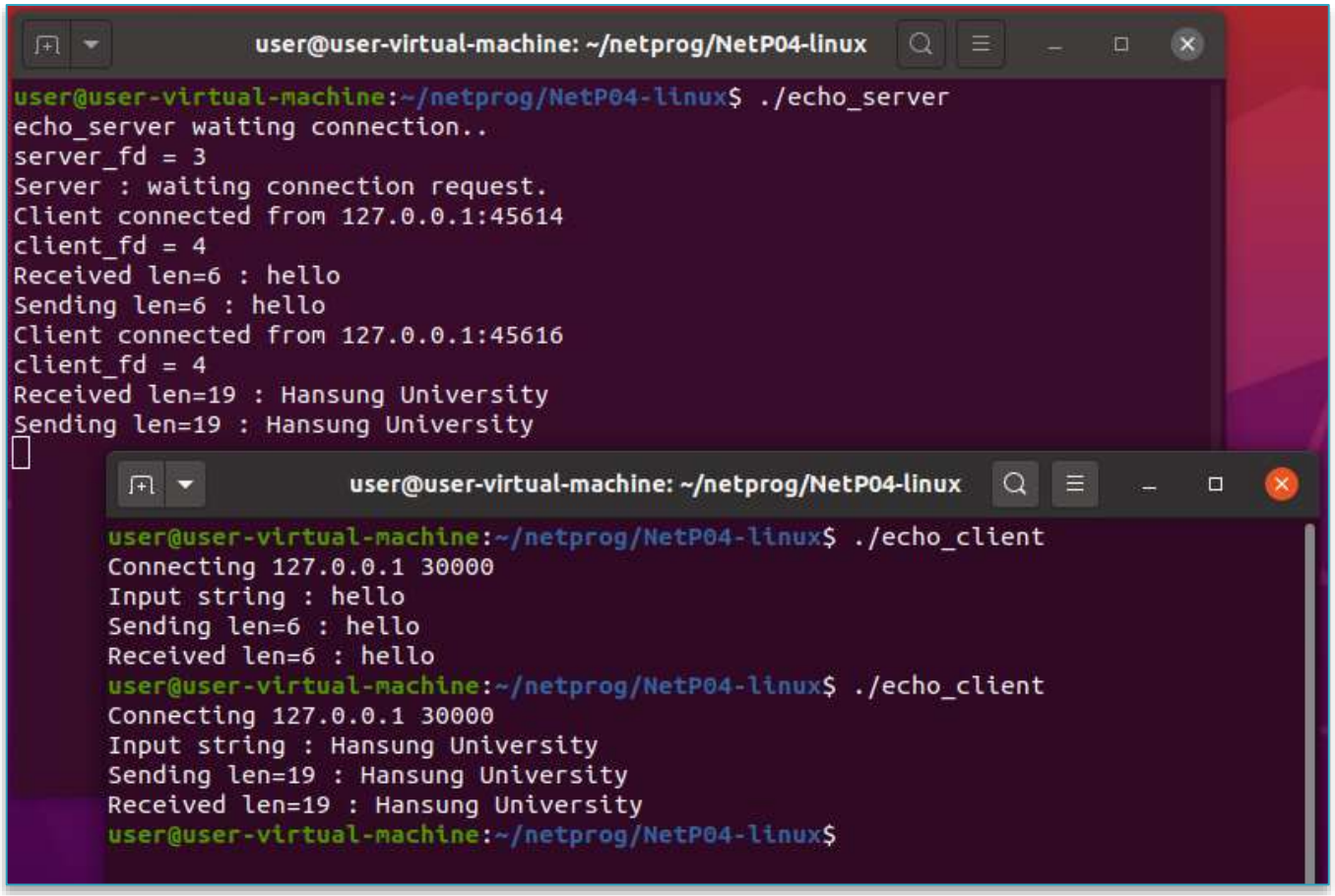


소켓프로그래밍 예제 2 - echo client server

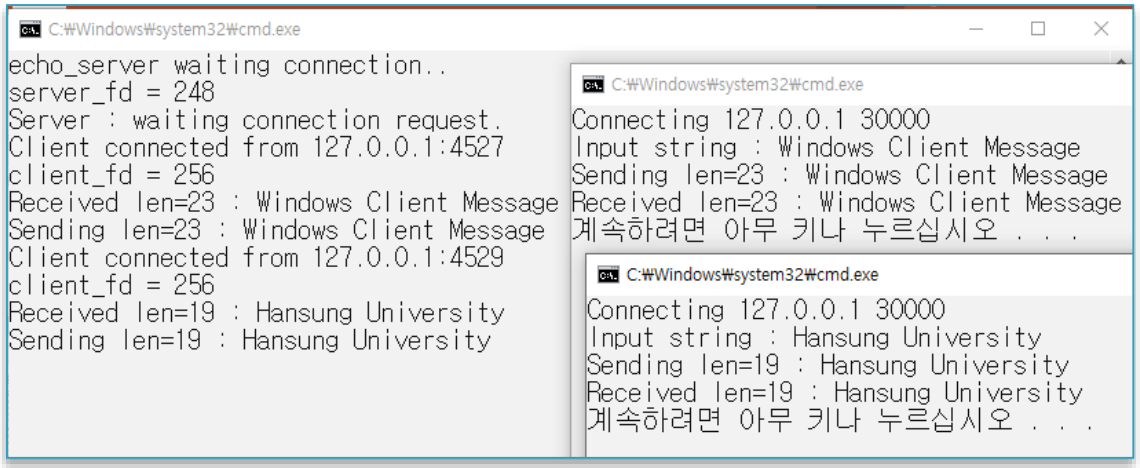
- Linux(Vmware)와 Windows IP 확인
  - Linux : ip a 또는 ifconfig
    - 192.168.126.128 이라고 가정
  - Windows : ipconfig 로 확인
    - 192.168.126.1 라고 가정
- Linux <-> Linux
  - ./echo_server [30000]
  - ./echo_client [127.0.0.1] [30000]
- Windows <-> Windows
  - wecho_server [30000]
  - wecho_client [127.0.0.1] [30000]
- Linux <-> Window
  - Linux server / Windows client
    - Linux : echo_server [30000]
    - Window : wecho_client 192.168.126.130 30000
  - Windows server / Linux client
    - Window : wecho_server [30000]
    - Linux : ./echo_client 192.168.126.1 30000



echo client/server 실행 화면 (127.0.0.1 Loopback)



Linux echo_client/server



Windows wecho_client/server

echo client/server 실행 화면 (Linux <> Windows)

Linux Client

```
user@user-virtual-machine: ~/netprog/NetP04-linux
user@user-virtual-machine:~/netprog/NetP04-linux$ ./echo_client
Connecting 127.0.0.1 30000
Input string : hello
Sending len=6 : hello
Received len=6 : hello
user@user-virtual-machine:~/netprog/NetP04-linux$ ./echo_client 192.168.126.1 30
00
Connecting 192.168.126.1 3000
^C
user@user-virtual-machine:~/netprog/NetP04-linux$ ./echo_client 192.168.126.1 30
000
Connecting 192.168.126.1 30000
Input string : Linux client
Sending len=13 : Linux client
Received len=13 : Linux client
user@user-virtual-machine:~/netprog/NetP04-linux$
```

Windows Server

```
C:₩Windows₩system32₩cmd.exe
echo_server waiting connection..
server_fd = 244
Server : waiting connection request.
Client connected from 192.168.126.130:49330
client_fd = 248
Received len=13 : Linux client
Sending len=13 : Linux client
```

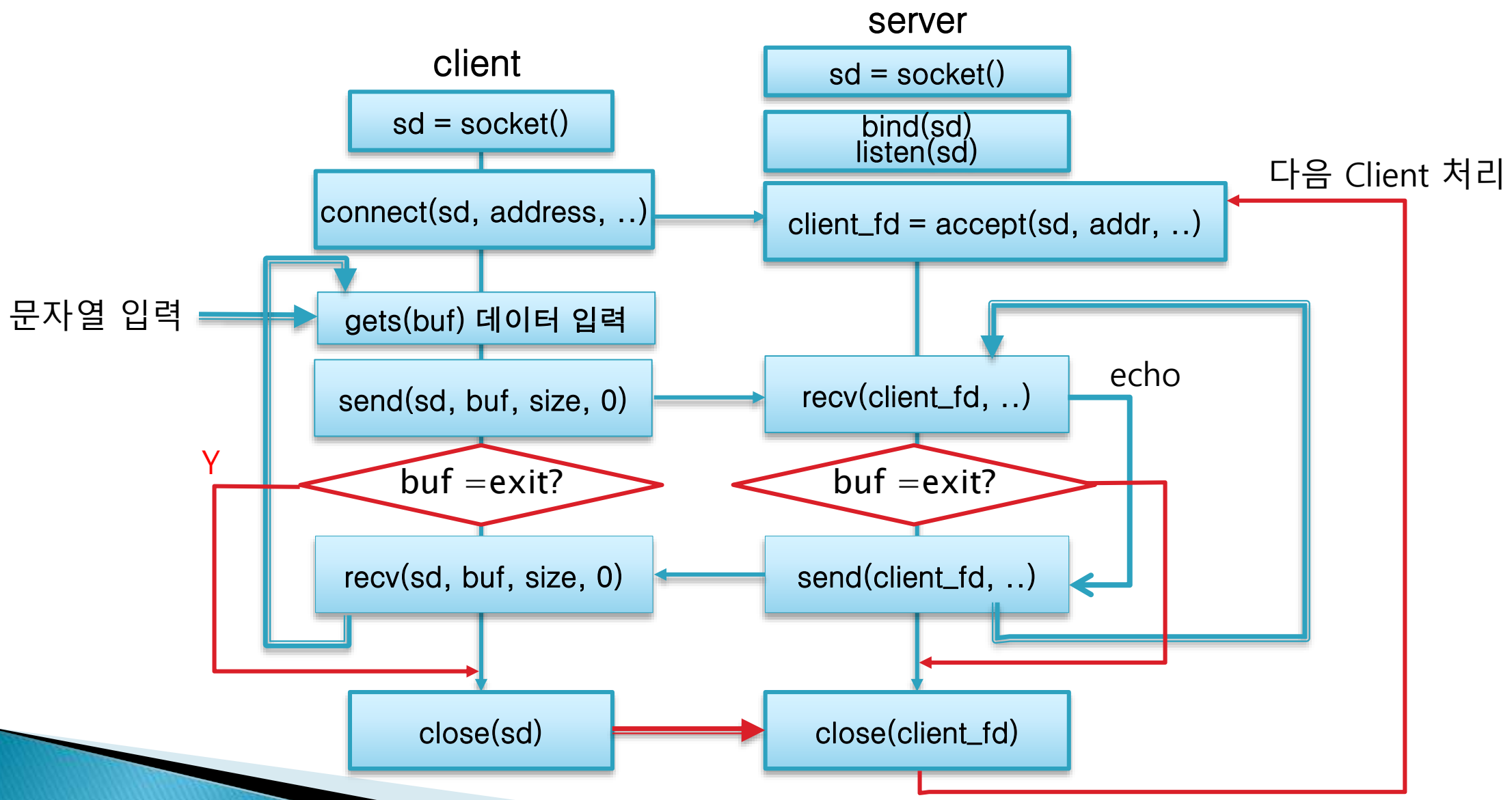
Linux Server

```
user@user-virtual-machine: ~/netprog/NetP04-linux
user@user-virtual-machine:~/netprog/NetP04-linux$ ./echo_server
echo_server waiting connection..
server_fd = 3
Server : waiting connection request.
Client connected from 127.0.0.1:55162
client_fd = 4
Received len=6 : hello
Sending len=6 : hello
Client connected from 192.168.126.1:1136
client_fd = 4
Received len=15 : Windwos client
Sending len=15 : Windwos client
```

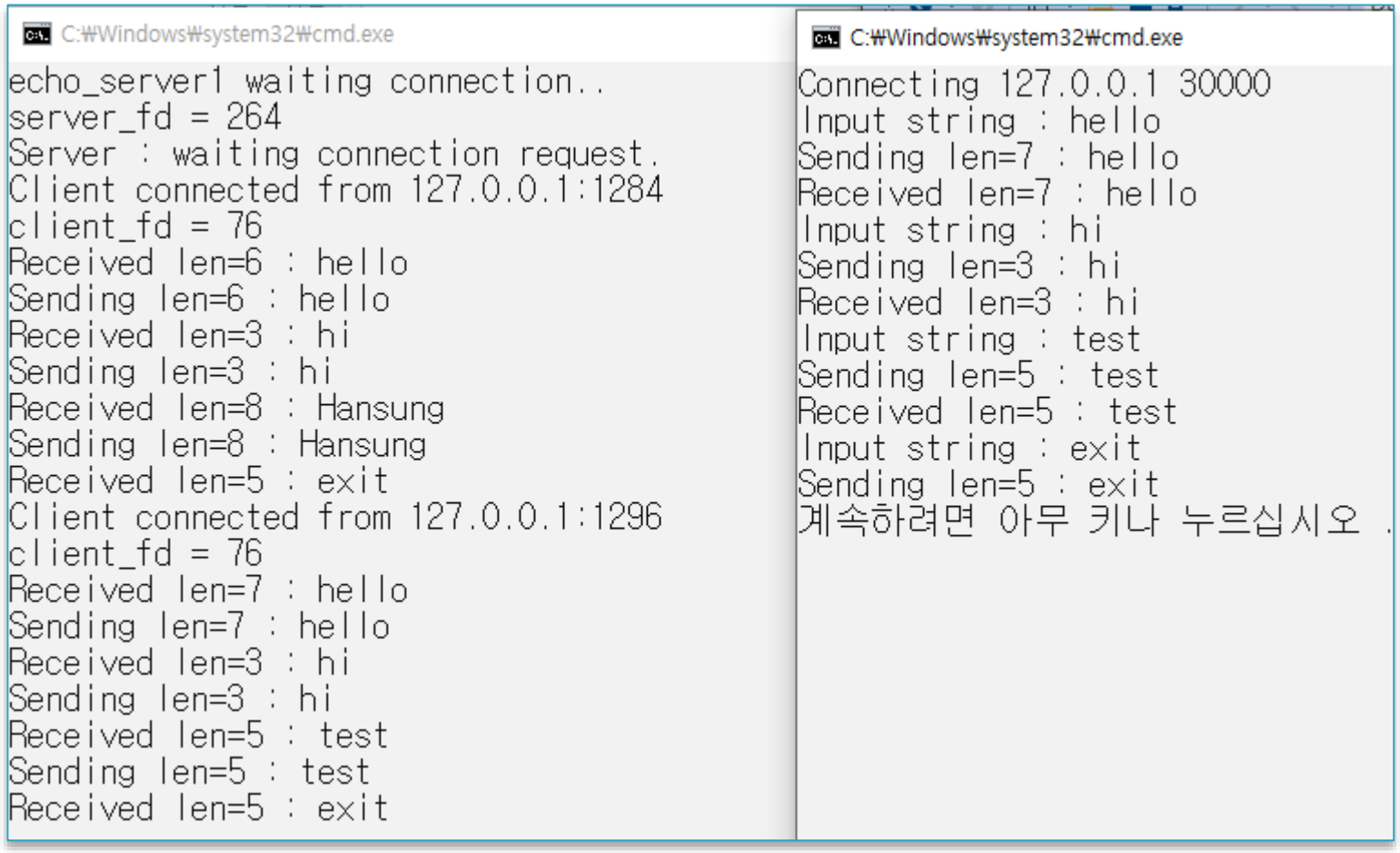
Windows Client

```
C:₩Windows₩system32₩cmd.exe
Connecting 192.168.126.130 30000
Input string : Windwos client
Sending len=15 : Windwos client
Received len=15 : Windwos client
계속하려면 아무 키나 누르십시오 . . .
```

응용1 echo client1/server1 – exit 입력 전까지 반복



응용1 echo client1/server1 "exit" 까지 반복 실행 화면



Windows >> Linux 복제하기

- Windows Visual Stutio
  - 일단, Windows 환경에서 완벽하게 구현 (127.0.0.1 사용)
  - wecho_client1.c, wecho_server1.c 에서 변경된 부분만 복사
    - connect/accept 이후 부분만 복사하면 됨
- Linux
  - cp echo_client.c echo_client1.c
  - cp echo_server.c echo_server1.c
  - Windows 에서 변경된 부분만 복사
    - connect/accept 이후 부분만 복사하면 됨
    - closesocket() >> close() 로 변경
  - Makefile 에 echo_client echo_server 추가
  - make 로 compile
  - Windwos<>Linux 상호 Test

응용2 echo client2/server2 – 대문자로 변경하기

- Client 에서 보낸 문자열을 Server 가 대문자로 변경하여 Return
- Client – echo_client.c 그대로 사용
  - Local에서 대문자 변환 대신 Server에 변환 요청

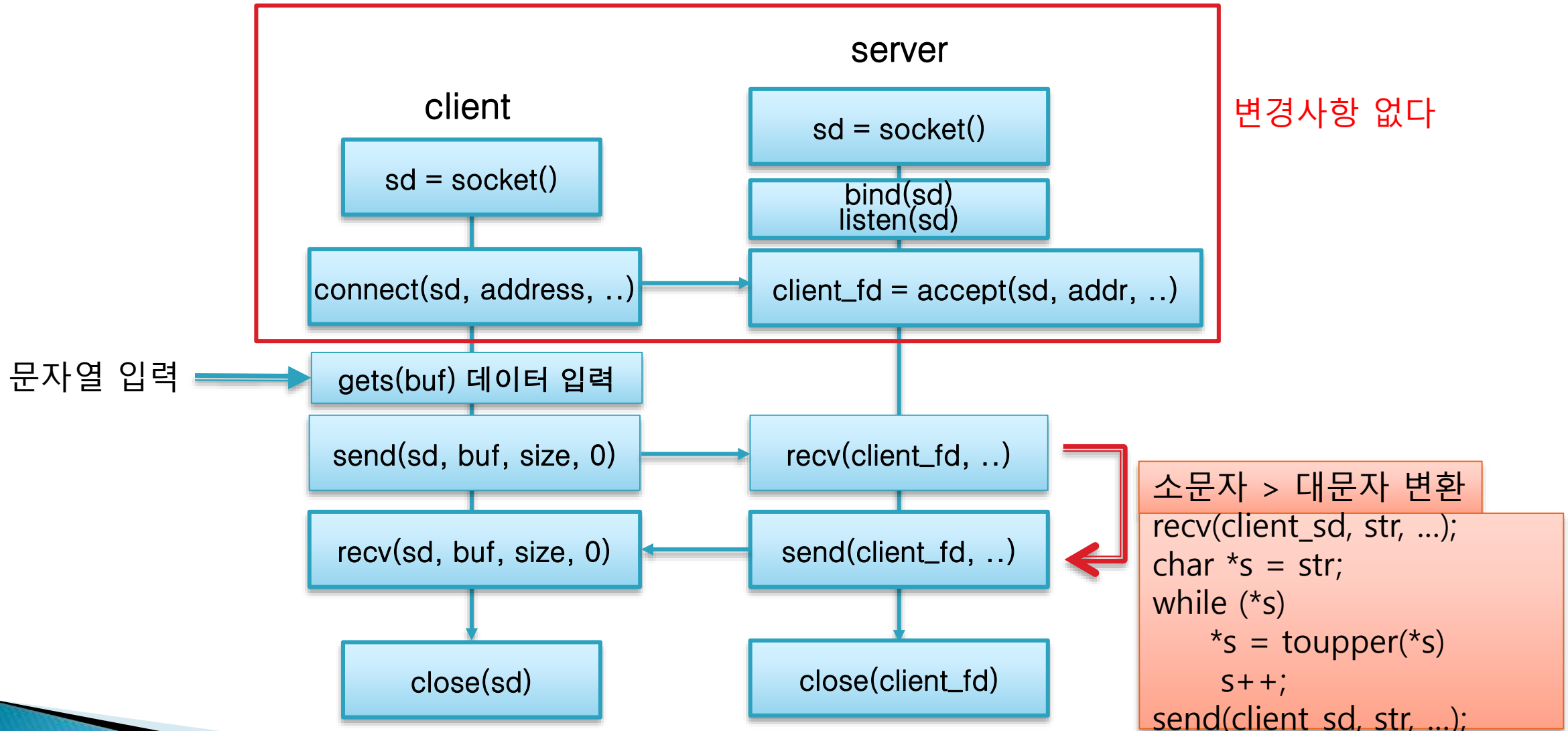
```
// Local 에서 변환
gets(str);
char *s = str;
while (*s)
      *s = toupper(*s)
```

```
// Server에게 변환 요청
// Echo client에서 수정할 것이 없다.
gets(str);
send(server_sd, str, ...);
recv(server_sd, str, ...)
```

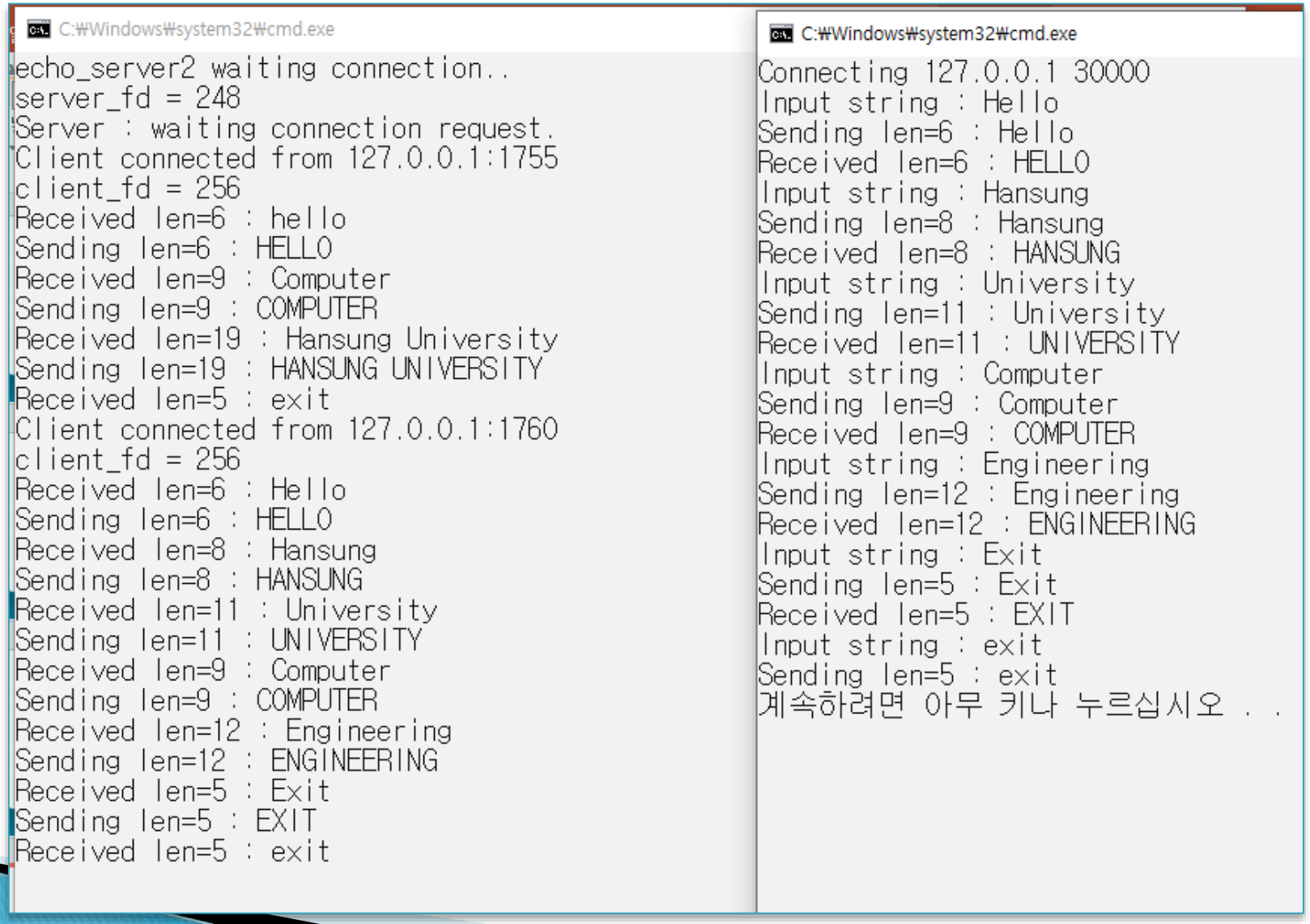
- Server – echo_server.c
- Client에서 받은 문자열을 대문자로 변환하고 송신

```
recv(client_sd, str, ...);
char *s = str;
while (*s)
      *s = toupper(*s)
send(client_sd, str, ...);
```

응용2 echo client2/server2 – 대문자로 변환하기



echo client2/server2 모두 대문자로 변환

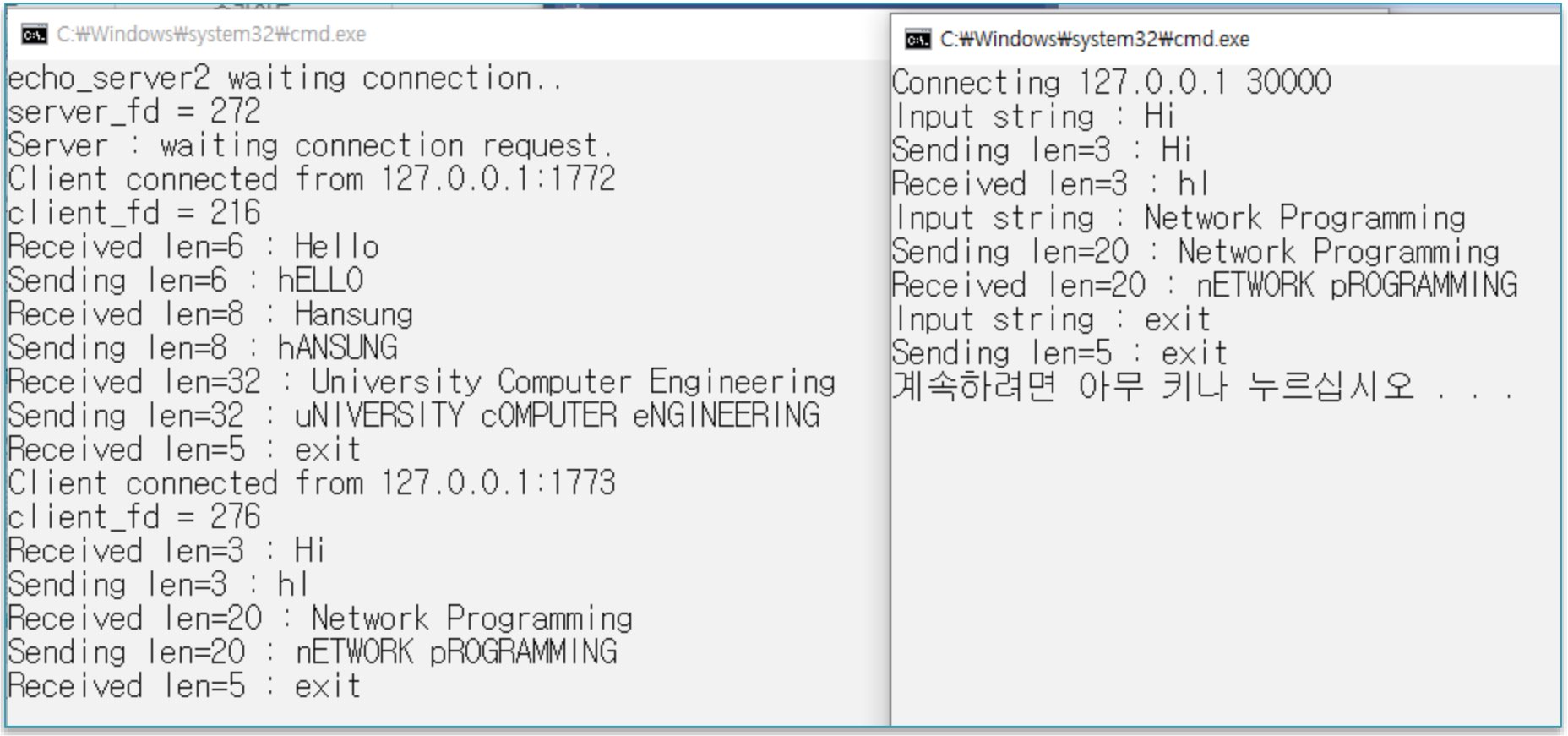


응용3 echo client3/server3 – 대/소문자 서로 변경하기

- Client 에서 보낸 문자열을 Server 가
  - 대문자는 > 소문자로
  - 소문자는 > 대문자로
- Client
  - echo_client.c 그대로 사용
- Server
  - 대/소문자 상호 변환 구현

```
mgs_size = recv(client_sd, buf, …);
buf[msg_size] = '\0';
char *s = buf;
while (*s) {
     if (islower(*s))
        *s = toupper(*s);
     else
        *s = tolower(*s);
      s++;
}
send(client_sd, buf, …);
```

echo client3/server3 대>소 소>대 변환



C:₩Windows₩system32₩cmd.exe

```
echo_server2 waiting connection..
server_fd = 272
Server : waiting connection request.
Client connected from 127.0.0.1:1772
client_fd = 216
Received len=6 : Hello
Sending len=6 : hELLO
Received len=8 : Hansung
Sending len=8 : hANSUNG
Received len=32 : University Computer Engineering
Sending len=32 : uNIVERSITY cOMPUTER eNGINEERING
Received len=5 : exit
Client connected from 127.0.0.1:1773
client_fd = 276
Received len=3 : Hi
Sending len=3 : hI
Received len=20 : Network Programming
Sending len=20 : nETWORK pROGRAMMING
Received len=5 : exit
```

C:₩Windows₩system32₩cmd.exe

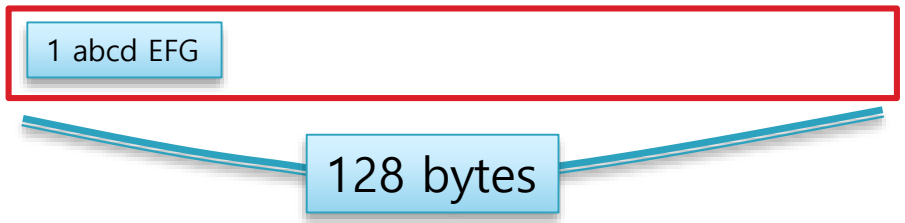
```
Connecting 127.0.0.1 30000
Input string : Hi
Sending len=3 : Hi
Received len=3 : hI
Input string : Network Programming
Sending len=20 : Network Programming
Received len=20 : nETWORK pROGRAMMING
Input string : exit
Sending len=5 : exit
계속하려면 아무 키나 누르십시오 . . .
```

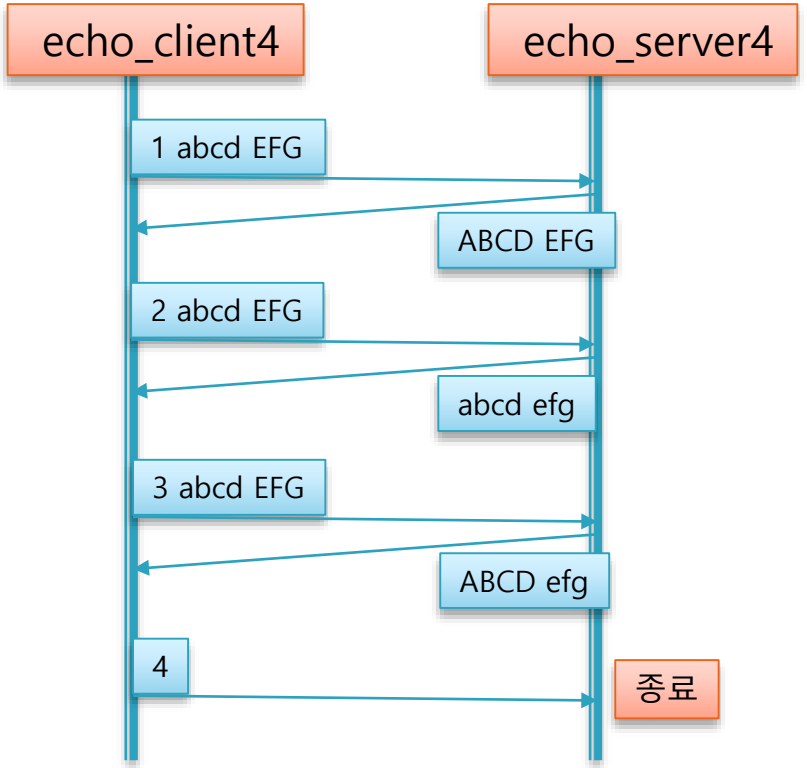
4주 과제1 Echo Client / Server 동영상 강의 내용까지 복습

1. echo client/server 기본
2. echo client1/server1 exit 입력때까지 반복하기
3. echo client2/server2 대문자로 변경하기
4. echo client3/server3 대>소 소>대문자로 변경하기

4주 과제2 Echo Client4 / Server4 대/소문자 변경 메뉴방식 구현

- Linux Server / Windows Client 로 구현
- 송/수신 data를 128 byte로 고정시켜서 전송하기
- Client 메뉴와 Application Protocol 만들기
  - 1 소문자->대문자, 2 대문자->소문자, 3 대(소)문자 → 소(대)문자
  - 송신: 1 abcd EFG → 수신: ABCD EFG
  - 송신: 2 ABCD efg → 수신: abcd efg
  - 송신: 3 abcd EFG → 수신: ABCD efg
  - 송신: 4 → 수신 session 종료



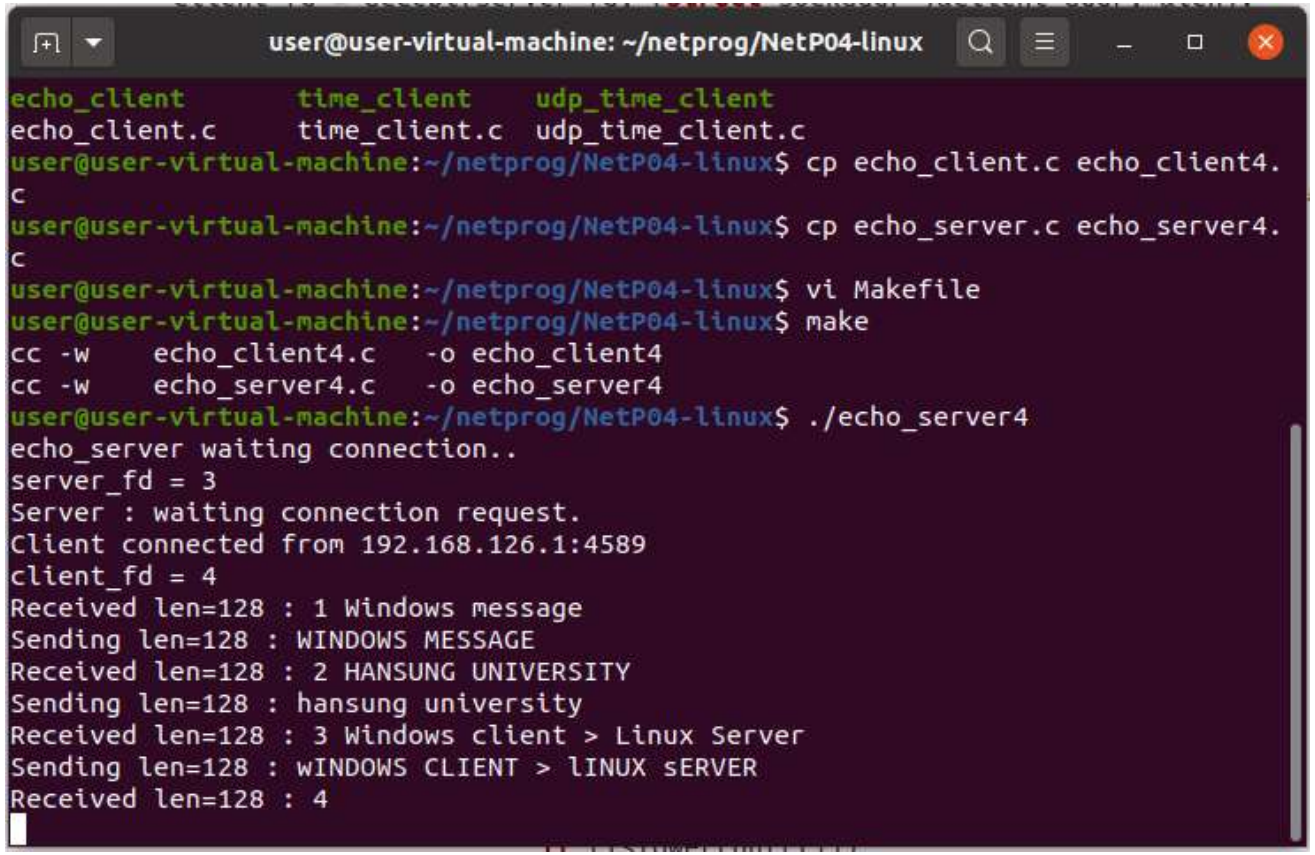



C:₩Windows₩system32₩cmd.exe
Connecting 127.0.0.1 30000
*** 대/소문자 변환 메뉴입니다. ***
(1) 모두 대문자 변환
(2) 모두 소문자 변환
(3) 대>소 소>대 변환
(4) 종료
선택하세요 : 1
Input string : Hansung University
Received 128 bytes : HANSUNG UNIVERSITY
*** 대/소문자 변환 메뉴입니다. ***
(1) 모두 대문자 변환
(2) 모두 소문자 변환
(3) 대>소 소>대 변환
(4) 종료
선택하세요 : 2
Input string : COMPUTER Engineering
Received 128 bytes : computer engineering
*** 대/소문자 변환 메뉴입니다. ***
(1) 모두 대문자 변환
(2) 모두 소문자 변환
(3) 대>소 소>대 변환
(4) 종료
선택하세요 : 3
Input string : Network Programming
Received 128 bytes : nETWORK pROGRAMMING
*** 대/소문자 변환 메뉴입니다. ***
(1) 모두 대문자 변환
(2) 모두 소문자 변환
(3) 대>소 소>대 변환
(4) 종료
선택하세요 : 4
계속하려면 아무 키나 누르십시오 . . .


C:₩Windows₩system32₩cmd.exe
Connecting 127.0.0.1 30000
*** 대/소문자 변환 메뉴입니다. ***
(1) 모두 대문자 변환
(2) 모두 소문자 변환
(3) 대>소 소>대 변환
(4) 종료
선택하세요 : 1
Input string : Computer Engineering
Received 128 bytes : COMPUTER ENGINEERING
*** 대/소문자 변환 메뉴입니다. ***
(1) 모두 대문자 변환
(2) 모두 소문자 변환
(3) 대>소 소>대 변환
(4) 종료
선택하세요 : 2
Input string : Network Programming
Received 128 bytes : network programming
*** 대/소문자 변환 메뉴입니다. ***
(1) 모두 대문자 변환
(2) 모두 소문자 변환
(3) 대>소 소>대 변환
(4) 종료
선택하세요 : 3
Input string : Socket Programming
Received 128 bytes : sOCKET pROGRAMMING
*** 대/소문자 변환 메뉴입니다. ***
(1) 모두 대문자 변환
(2) 모두 소문자 변환
(3) 대>소 소>대 변환
(4) 종료
선택하세요 : 4
계속하려면 아무 키나 누르십시오 . . .

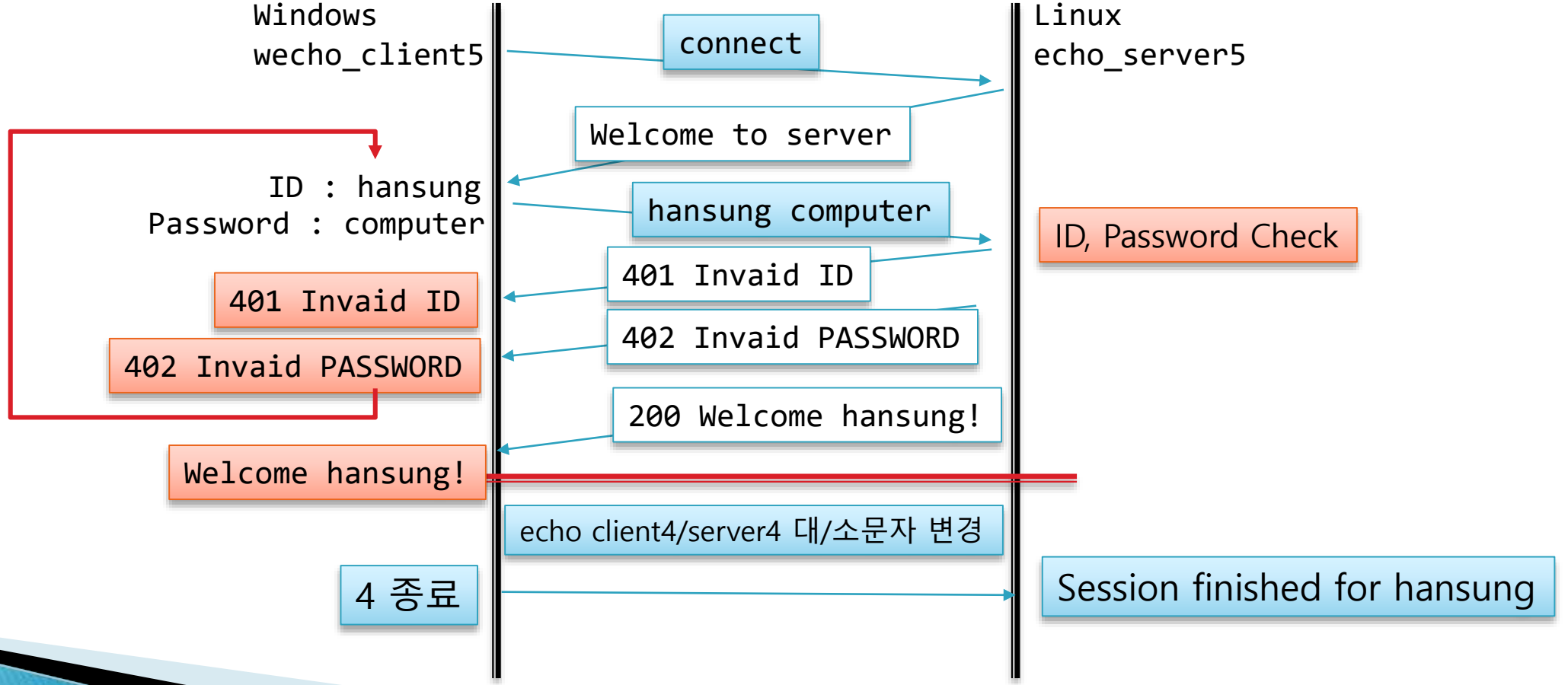

C:₩Windows₩system32₩cmd.exe
echo_server waiting connection..
server_fd = 252
Server : waiting connection request.
Client connected from 127.0.0.1:4862
client_fd = 248
Received len=128 : 1 Hansung University
Sending len=128 : HANSUNG UNIVERSITY
Received len=128 : 2 COMPUTER Engineering
Sending len=128 : computer engineering
Received len=128 : 3 Network Programming
Sending len=128 : nETWORK pROGRAMMING
Received len=128 : 4
Client connected from 127.0.0.1:5229
client_fd = 256
Received len=128 : 1 Computer Engineering
Sending len=128 : COMPUTER ENGINEERING
Received len=128 : 2 Network Programming
Sending len=128 : network programming
Received len=128 : 3 Socket Programming
Sending len=128 : sOCKET pROGRAMMING
Received len=128 : 4

Windows Client > Linux Server



4주 과제3 Login 기능 추가하기

- echo_client4/server4 활용 >> echo_client5/server5
- Windows Client / Linux Server 로 구현
- Login protocol 만들기



echo_client5/server5 실행 화면