Assignment 1
Of
Network & Distributed System Lab (CS2051)

Masters of Technology in Computer Science And Engineering

submitted to
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1. Write simple TCP and UDP program using socket API which will transfer simple text messages, and check TCP and UDP packets using Wireshark.

   Answer.

   The following code is the implementation for **TCP client side programming**.

```
/* tcpclient.c */

#include <sys/socket.h>
#include <sys/types.h>
#include <netinet/in.h>
#include <netdb.h>
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
#include <unistd.h>
#include <errno.h>


int main()
{

        int sock, bytes_recieved;
        char send_data[1024],recv_data[1024];
        struct hostent *host;
        struct sockaddr_in server_addr;

        host = gethostbyname("127.0.0.1");

        if ((sock = socket(AF_INET, SOCK_STREAM, 0)) == -1) {
            perror("Socket");
            exit(1);
        }

        server_addr.sin_family = AF_INET;
        server_addr.sin_port = htons(5000);
        server_addr.sin_addr = *((struct in_addr *)host->h_addr);
        bzero(&(server_addr.sin_zero),8);

        if (connect(sock, (struct sockaddr *)&server_addr,
                    sizeof(struct sockaddr)) == -1)
        {
```

```
            perror("Connect");
            exit(1);
        }

        while(1)
        {

          bytes_recieved=recv(sock,recv_data,1024,0);
          recv_data[bytes_recieved] = '\0';

          if (strcmp(recv_data , "q") == 0 || strcmp(recv_data , "Q") == 0)
          {
           close(sock);
           break;
          }

          else
           printf("\nRecieved data = %s " , recv_data);

           printf("\nSEND (q or Q to quit) : ");
           gets(send_data);

          if (strcmp(send_data , "q") != 0 && strcmp(send_data , "Q") != 0)
           send(sock,send_data,strlen(send_data), 0);

          else
          {
           send(sock,send_data,strlen(send_data), 0);
           close(sock);
           break;
          }

        }
return 0;
}
```

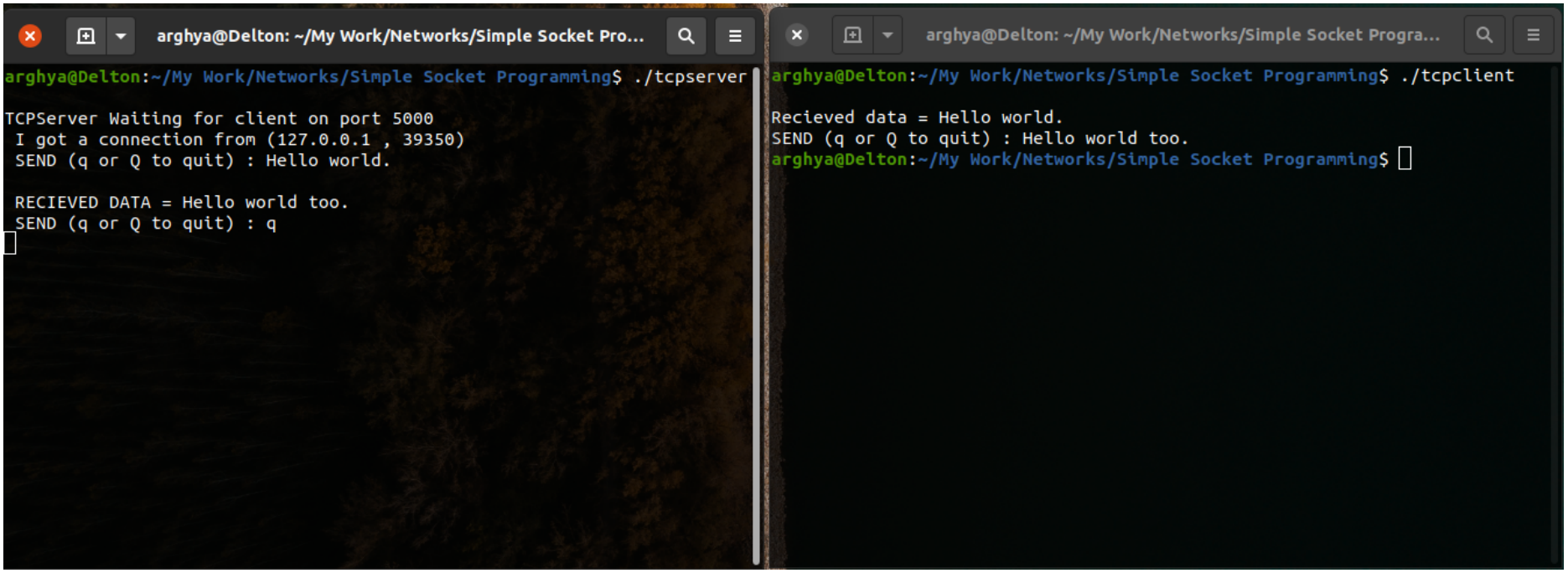
The following code is the implementation for **TCP Server side programming**.

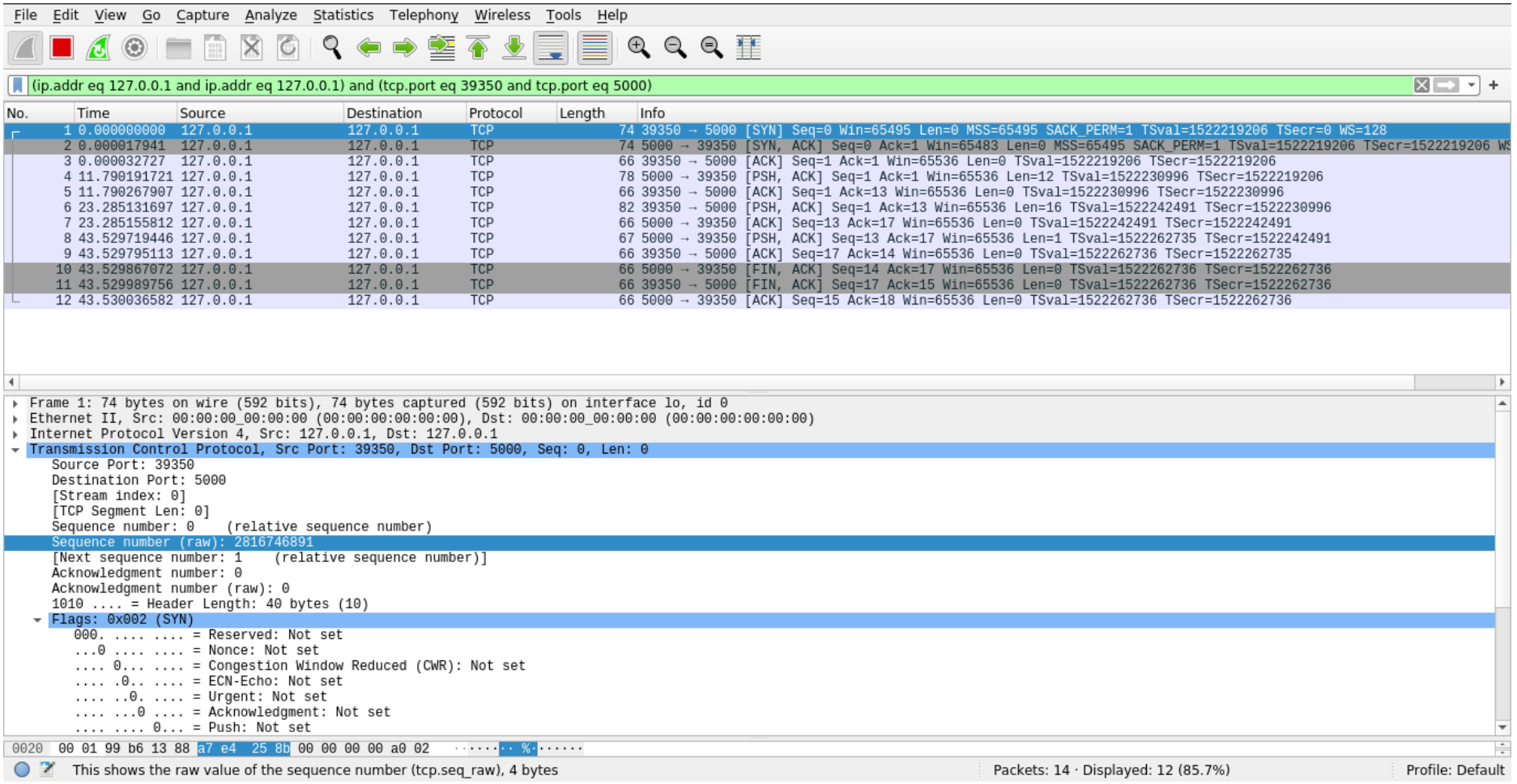
```
/* tcpserver.c */

#include <sys/types.h>
#include <sys/socket.h>
```

```
#include <netinet/in.h>
#include <arpa/inet.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <errno.h>
#include <string.h>


int main()
{
        int sock, connected, bytes_recieved , true = 1;
        char send_data [1024] , recv_data[1024];

        struct sockaddr_in server_addr,client_addr;
        int sin_size;

        if ((sock = socket(AF_INET, SOCK_STREAM, 0)) == -1) {
            perror("Socket");
            exit(1);
        }

        if (setsockopt(sock,SOL_SOCKET,SO_REUSEADDR,&true,sizeof(int)) == -1) {
            perror("Setsockopt");
            exit(1);
        }

        server_addr.sin_family = AF_INET;
        server_addr.sin_port = htons(5000);
        server_addr.sin_addr.s_addr = INADDR_ANY;
        bzero(&(server_addr.sin_zero),8);

        if (bind(sock, (struct sockaddr *)&server_addr, sizeof(struct sockaddr))
                                                                    == -1) {
            perror("Unable to bind");
            exit(1);
        }

        if (listen(sock, 5) == -1) {
            perror("Listen");
            exit(1);
        }
```

```
printf("\nTCPServer Waiting for client on port 5000");
fflush(stdout);


while(1)
{

    sin_size = sizeof(struct sockaddr_in);

    connected = accept(sock, (struct sockaddr *)&client_addr,&sin_size);

    printf("\n I got a connection from (%s , %d)",
           inet_ntoa(client_addr.sin_addr),ntohs(client_addr.sin_port));

    while (1)
    {
      printf("\n SEND (q or Q to quit) : ");
      gets(send_data);

      if (strcmp(send_data , "q") == 0 || strcmp(send_data , "Q") == 0)
      {
        send(connected, send_data,strlen(send_data), 0);
        close(connected);
        break;
      }

      else
         send(connected, send_data,strlen(send_data), 0);

      bytes_recieved = recv(connected,recv_data,1024,0);

      recv_data[bytes_recieved] = '\0';

      if (strcmp(recv_data , "q") == 0 || strcmp(recv_data , "Q") == 0)
      {
        close(connected);
        break;
      }

      else
      printf("\n RECIEVED DATA = %s " , recv_data);
```

```
            fflush(stdout);
        }
    }

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




File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
(ip.addr eq 127.0.0.1 and ip.addr eq 127.0.0.1) and (tcp.port eq 39350 and tcp.port eq 5000)
No. Time Source Destination Protocol Length Info
1 0.000000000 127.0.0.1 127.0.0.1 TCP 74 39350 → 5000 [SYN] Seq=0 Win=65495 Len=0 MSS=65495 SACK_PERM=1 TSval=1522219206 TSecr=0 WS=128
2 0.000017941 127.0.0.1 127.0.0.1 TCP 74 5000 → 39350 [SYN, ACK] Seq=0 Ack=1 Win=65483 Len=0 MSS=65495 SACK_PERM=1 TSval=1522219206 TSecr=1522219206 WS
3 0.000032727 127.0.0.1 127.0.0.1 TCP 66 39350 → 5000 [ACK] Seq=1 Ack=1 Win=65536 Len=0 TSval=1522219206 TSecr=1522219206
4 11.790191721 127.0.0.1 127.0.0.1 TCP 78 5000 → 39350 [PSH, ACK] Seq=1 Ack=1 Win=65536 Len=12 TSval=1522230996 TSecr=1522219206
5 11.790267907 127.0.0.1 127.0.0.1 TCP 66 39350 → 5000 [ACK] Seq=1 Ack=13 Win=65536 Len=0 TSval=1522230996 TSecr=1522230996
6 23.285131697 127.0.0.1 127.0.0.1 TCP 82 39350 → 5000 [PSH, ACK] Seq=1 Ack=13 Win=65536 Len=16 TSval=1522242491 TSecr=1522230996
7 23.285155812 127.0.0.1 127.0.0.1 TCP 66 5000 → 39350 [ACK] Seq=13 Ack=17 Win=65536 Len=0 TSval=1522242491 TSecr=1522242491
8 43.529719446 127.0.0.1 127.0.0.1 TCP 67 5000 → 39350 [PSH, ACK] Seq=13 Ack=17 Win=65536 Len=1 TSval=1522262735 TSecr=1522242491
9 43.529795113 127.0.0.1 127.0.0.1 TCP 66 39350 → 5000 [ACK] Seq=17 Ack=14 Win=65536 Len=0 TSval=1522262736 TSecr=1522262735
10 43.529867072 127.0.0.1 127.0.0.1 TCP 66 5000 → 39350 [FIN, ACK] Seq=14 Ack=17 Win=65536 Len=0 TSval=1522262736 TSecr=1522262736
11 43.529989756 127.0.0.1 127.0.0.1 TCP 66 39350 → 5000 [FIN, ACK] Seq=17 Ack=15 Win=65536 Len=0 TSval=1522262736 TSecr=1522262736
12 43.530036582 127.0.0.1 127.0.0.1 TCP 66 5000 → 39350 [ACK] Seq=15 Ack=18 Win=65536 Len=0 TSval=1522262736 TSecr=1522262736
Frame 1: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface lo, id 0
Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 00:00:00_00:00:00 (00:00:00:00:00:00)
Internet Protocol Version 4, Src: 127.0.0.1, Dst: 127.0.0.1
Transmission Control Protocol, Src Port: 39350, Dst Port: 5000, Seq: 0, Len: 0
Source Port: 39350
Destination Port: 5000
[Stream index: 0]
[TCP Segment Len: 0]
Sequence number: 0 (relative sequence number)
Sequence number (raw): 2816746891
[Next sequence number: 1 (relative sequence number)]
Acknowledgment number: 0
Acknowledgment number (raw): 0
1010 .... = Header Length: 40 bytes (10)
Flags: 0x002 (SYN)
000. .... = Reserved: Not set
...0 .... = Nonce: Not set
.... 0... .... = Congestion Window Reduced (CWR): Not set
.... .0.. .... = ECN-Echo: Not set
.... ..0. .... = Urgent: Not set
....0 .... = Acknowledgment: Not set
.... 0... = Push: Not set
0020 00 01 99 b6 13 88 a7 e4 25 8b 00 00 00 00 a0 02
This shows the raw value of the sequence number (tcp.seq_raw), 4 bytes
Packets: 14 · Displayed: 12 (85.7%)
Profile: Default

The following code is the implementation for **UDP Client side programming**.

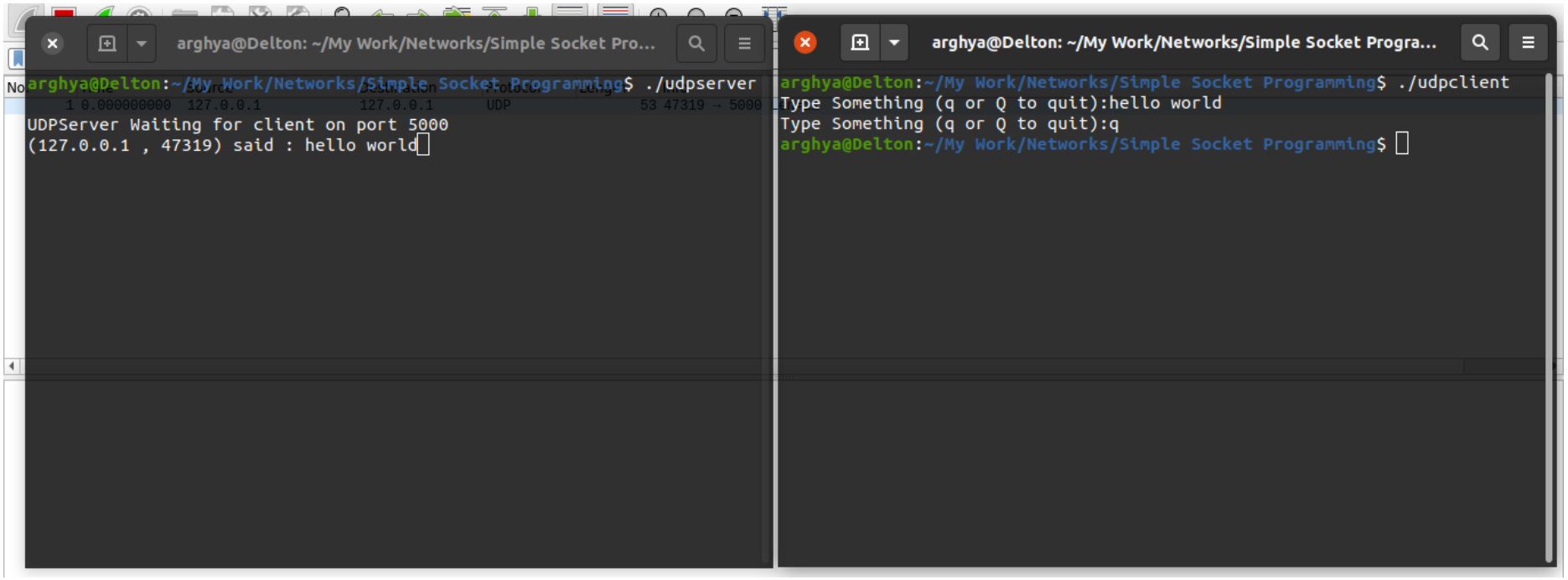
```
/* udpclient.c */

#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <netdb.h>
#include <stdio.h>
#include <unistd.h>
#include <errno.h>
#include <string.h>
#include <stdlib.h>

int main()
{
        int sock;
        struct sockaddr_in server_addr;
        struct hostent *host;
        char send_data[1024];

        host= (struct hostent *) gethostbyname((char *)"127.0.0.1");


if ((sock = socket(AF_INET, SOCK_DGRAM, 0)) == -1)
{
        perror("socket");
        exit(1);
}

        server_addr.sin_family = AF_INET;
        server_addr.sin_port = htons(5000);
        server_addr.sin_addr = *((struct in_addr *)host->h_addr);
        bzero(&(server_addr.sin_zero),8);

   while (1)
   {

            printf("Type Something (q or Q to quit):");
            gets(send_data);
```

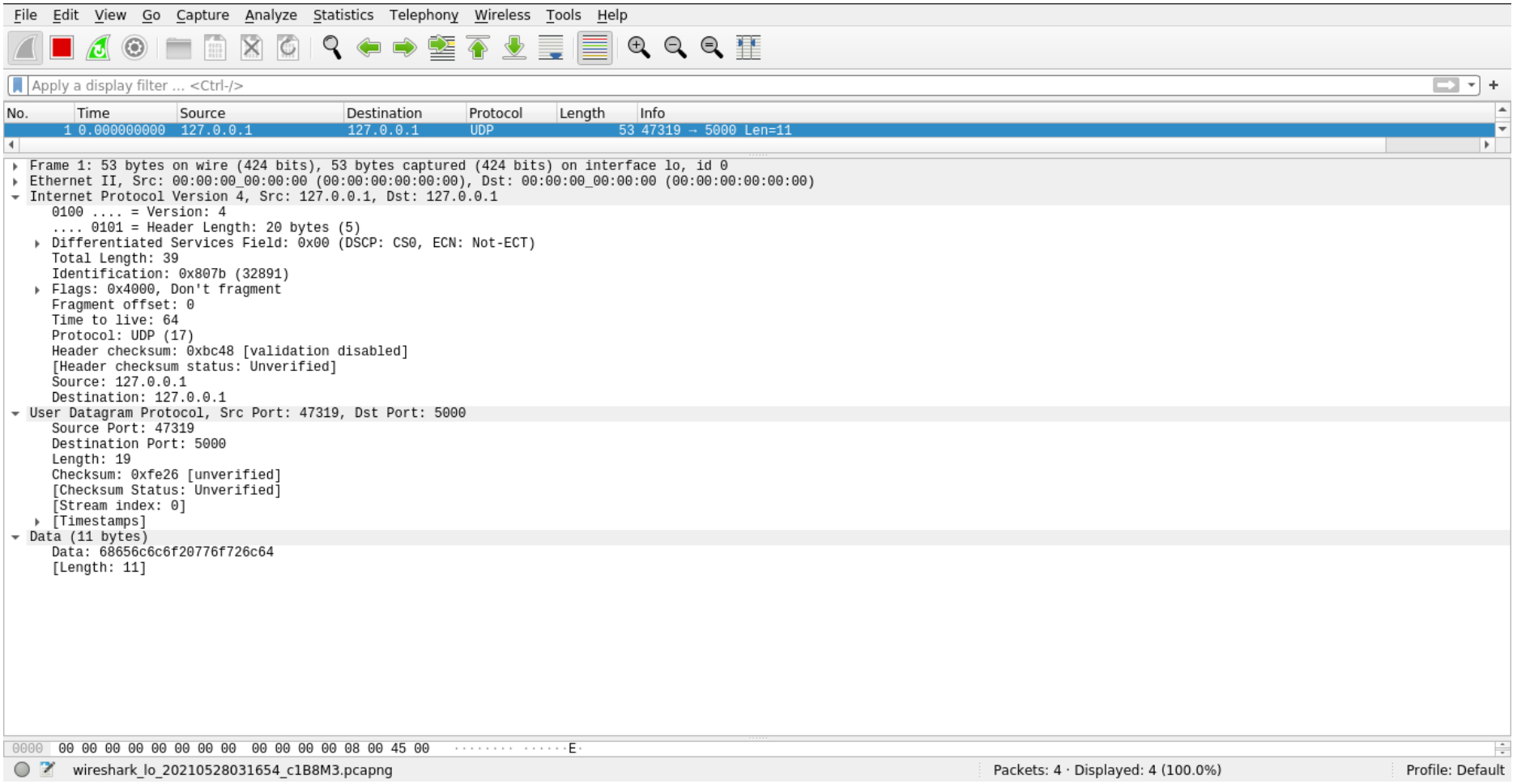
```
            if ((strcmp(send_data , "q") == 0) || strcmp(send_data , "Q") == 0)
            break;

        else
                sendto(sock, send_data, strlen(send_data), 0,
                (struct sockaddr *)&server_addr, sizeof(struct sockaddr));

    }

}
```

The following code is the implementation for **UDP Server side programming**.

```
/* udpserver.c */

#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <stdio.h>
#include <unistd.h>
#include <errno.h>
#include <string.h>
#include <stdlib.h>

int main()
{
        int sock;
        int addr_len, bytes_read;
        char recv_data[1024];
        struct sockaddr_in server_addr , client_addr;


        if ((sock = socket(AF_INET, SOCK_DGRAM, 0)) == -1) {
            perror("Socket");
            exit(1);
        }

        server_addr.sin_family = AF_INET;
        server_addr.sin_port = htons(5000);
        server_addr.sin_addr.s_addr = INADDR_ANY;
        bzero(&(server_addr.sin_zero),8);
```

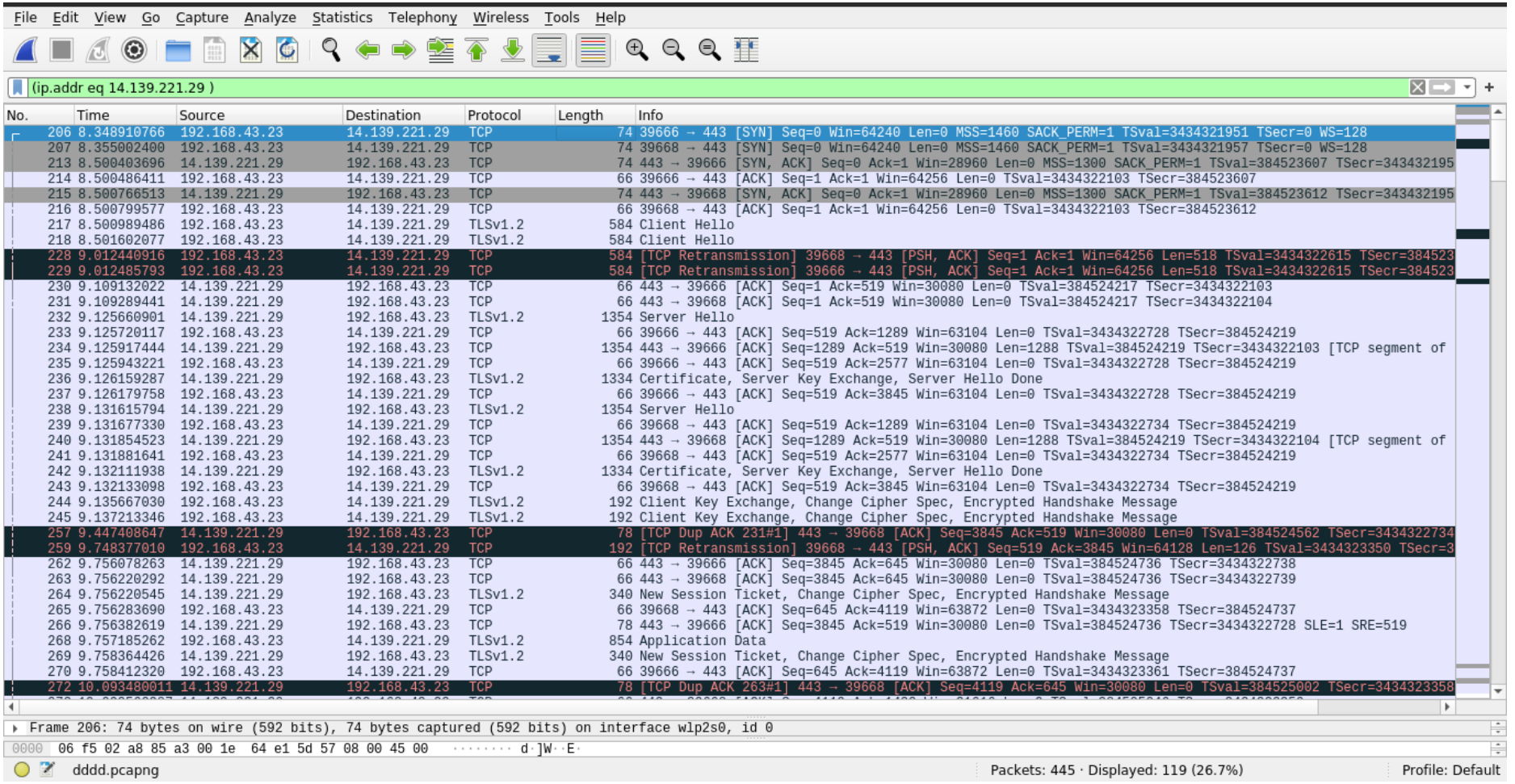
```
        if (bind(sock,(struct sockaddr *)&server_addr,
            sizeof(struct sockaddr)) == -1)
        {
            perror("Bind");
            exit(1);
        }

        addr_len = sizeof(struct sockaddr);

        printf("\nUDPServer Waiting for client on port 5000");
        fflush(stdout);

        while (1)
        {

          bytes_read = recvfrom(sock,recv_data,1024,0,
                           (struct sockaddr *)&client_addr, &addr_len);


          recv_data[bytes_read] = '\0';

          printf("\n(%s , %d) said : ",inet_ntoa(client_addr.sin_addr),
                                       ntohs(client_addr.sin_port));
          printf("%s", recv_data);
          fflush(stdout);

        }
        return 0;
}
```

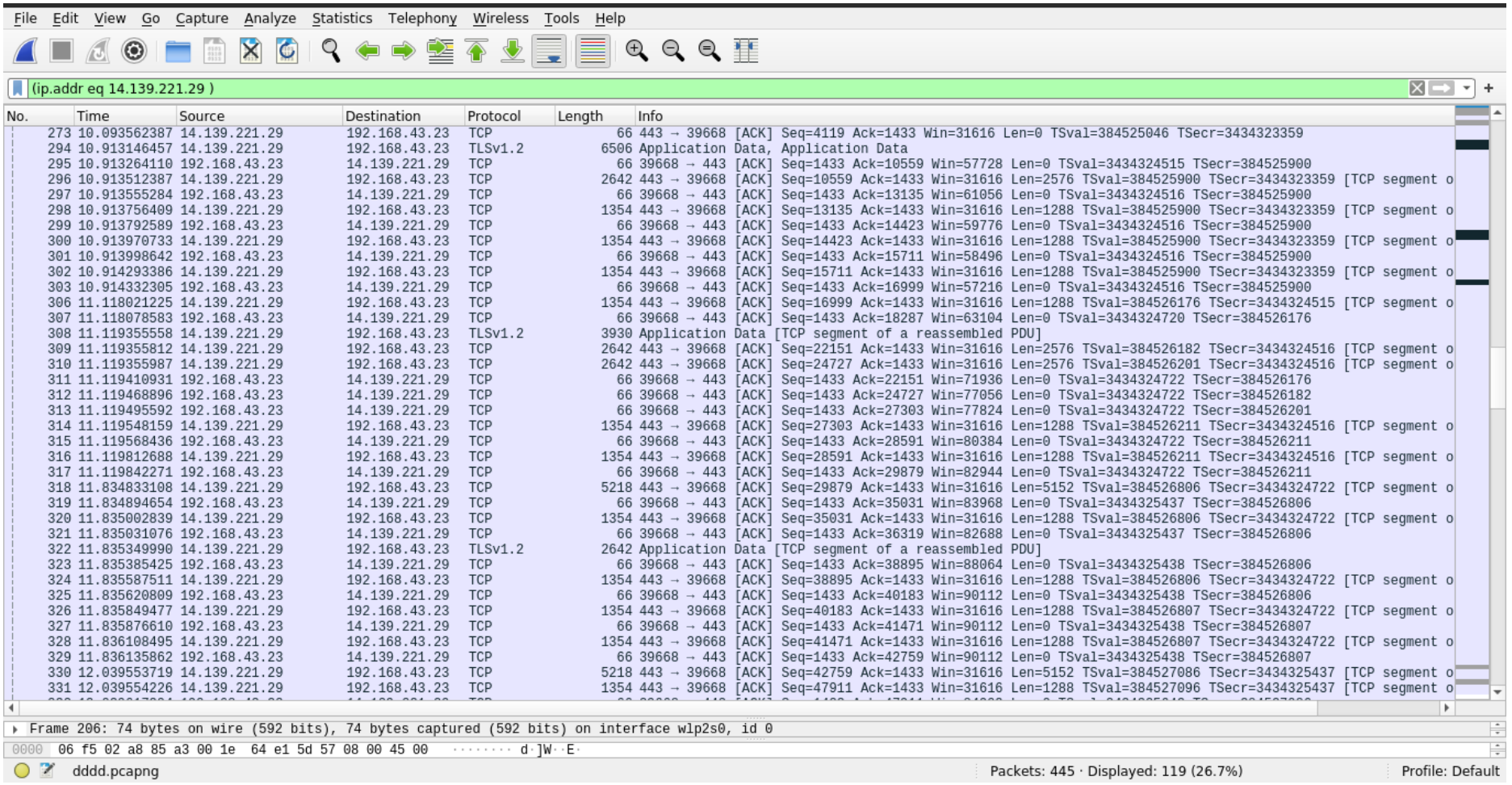

arghya@Delton: ~/My Work/Networks/Simple Socket Pro...
arghya@Delton:~/My Work/Networks/Simple Socket Programming$ ./udpserver
UDPServer Waiting for client on port 5000
(127.0.0.1 , 47319) said : hello world
arghya@Delton: ~/My Work/Networks/Simple Socket Progra...
arghya@Delton:~/My Work/Networks/Simple Socket Programming$ ./udpclient
Type Something (q or Q to quit):hello world
Type Something (q or Q to quit):q
arghya@Delton:~/My Work/Networks/Simple Socket Programming$

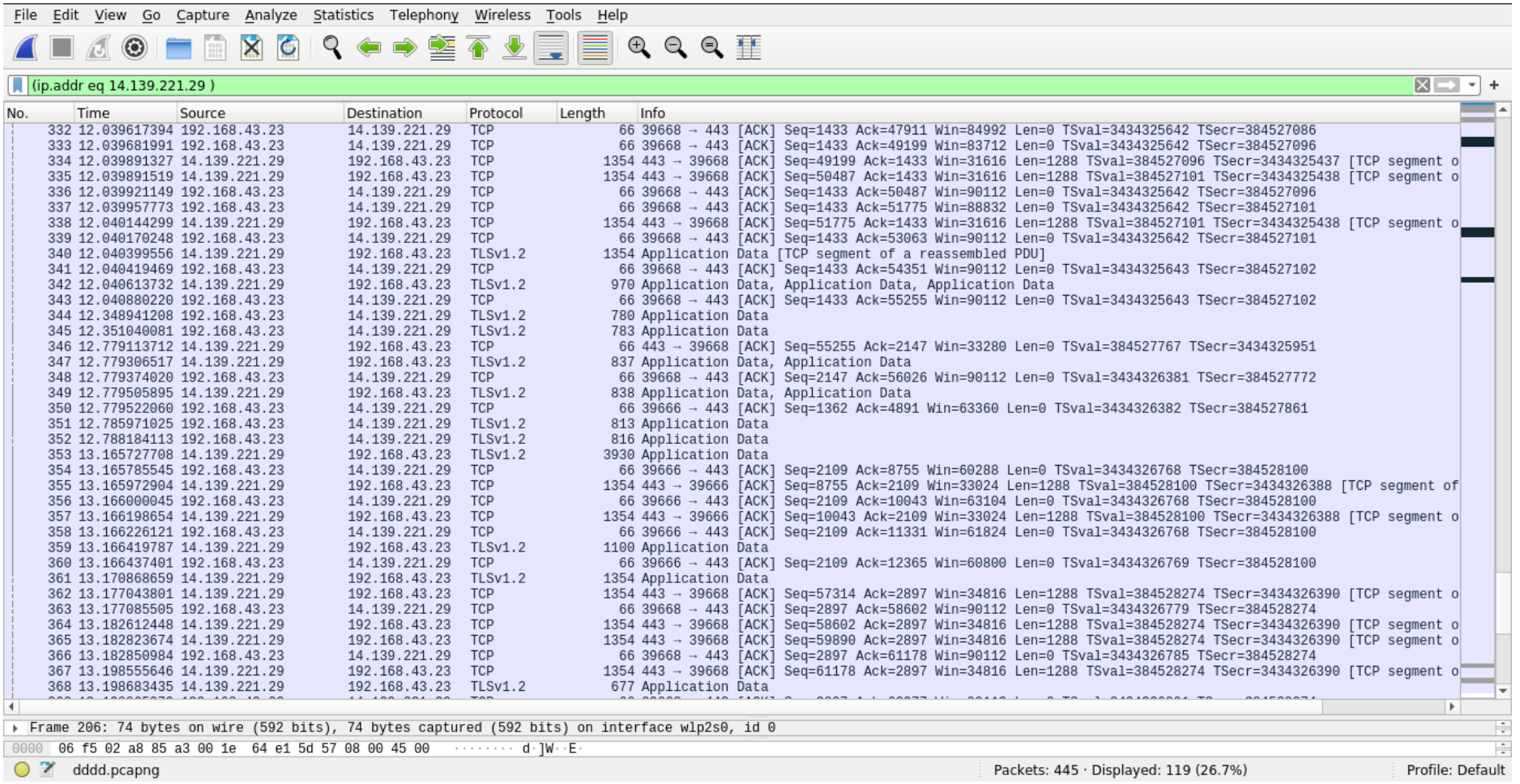

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter ... <Ctrl-/>
No. Time Source Destination Protocol Length Info
1 0.000000000 127.0.0.1 127.0.0.1 UDP 53 47319 → 5000 Len=11
Frame 1: 53 bytes on wire (424 bits), 53 bytes captured (424 bits) on interface lo, id 0
Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 00:00:00_00:00:00 (00:00:00:00:00:00)
Internet Protocol Version 4, Src: 127.0.0.1, Dst: 127.0.0.1
0100 .... = Version: 4
.... 0101 = Header Length: 20 bytes (5)
Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
Total Length: 39
Identification: 0x807b (32891)
Flags: 0x4000, Don't fragment
Fragment offset: 0
Time to live: 64
Protocol: UDP (17)
Header checksum: 0xbc48 [validation disabled]
[Header checksum status: Unverified]
Source: 127.0.0.1
Destination: 127.0.0.1
User Datagram Protocol, Src Port: 47319, Dst Port: 5000
Source Port: 47319
Destination Port: 5000
Length: 19
Checksum: 0xfe26 [unverified]
[Checksum Status: Unverified]
[Stream index: 0]
[Timestamps]
Data (11 bytes)
Data: 68656c6c6f20776f726c64
[Length: 11]
0000 00 00 00 00 00 00 00 00 00 00 00 00 08 00 45 00 ....E·
wireshark_lo_20210528031654_c1B8M3.pcapng
Packets: 4 · Displayed: 4 (100.0%)
Profile: Default

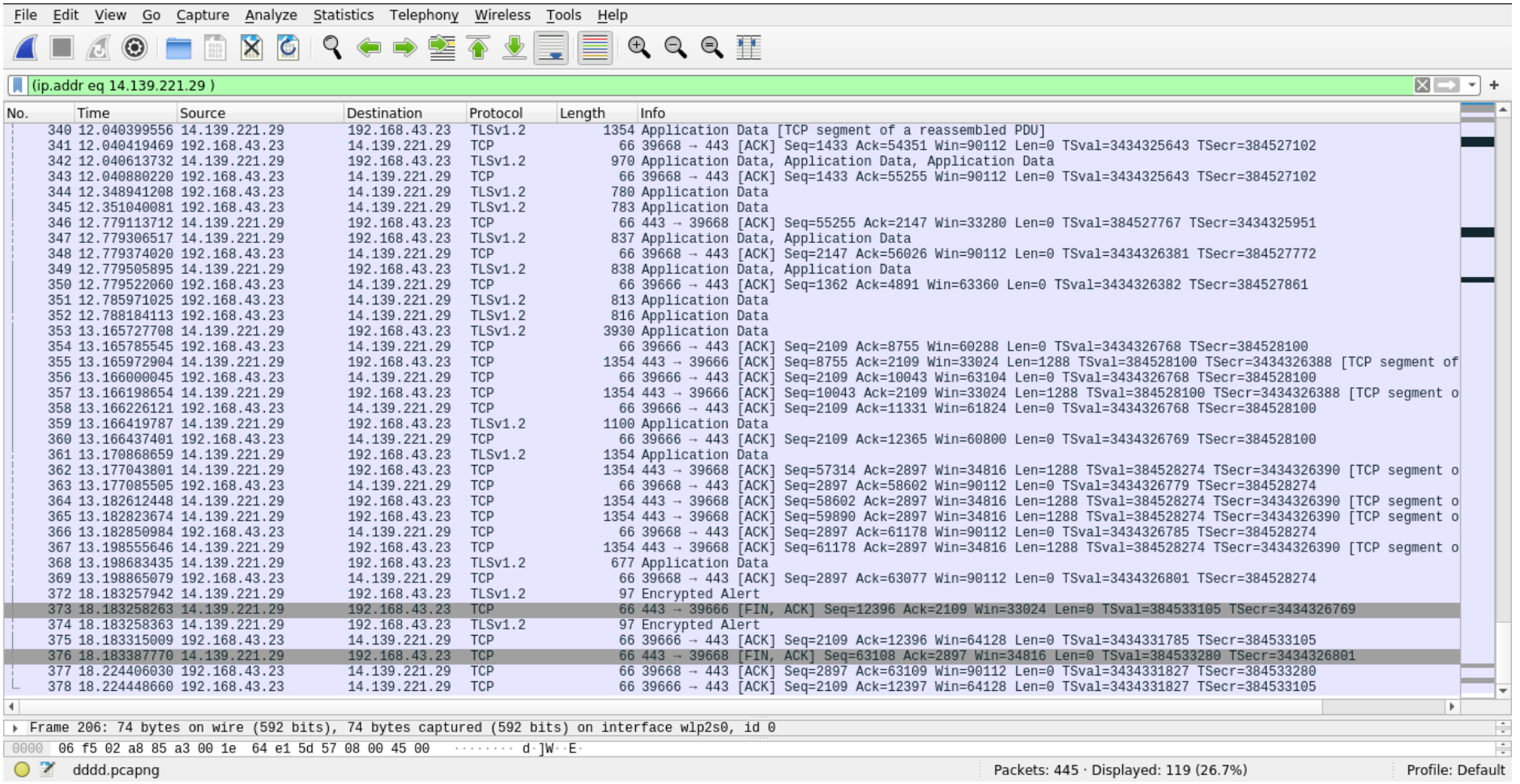
2. Using wireshark, capture the TCP headers while connecting your computer to the server of nit.dgp.ac.in.

Answer.




File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
(ip.addr eq 14.139.221.29)
No. Time Source Destination Protocol Length Info
273 10.093562387 14.139.221.29 192.168.43.23 TCP 66 443 → 39668 [ACK] Seq=4119 Ack=1433 Win=31616 Len=0 TSval=384525046 TSecr=3434323359
294 10.913146457 14.139.221.29 192.168.43.23 TLSv1.2 6506 Application Data, Application Data
295 10.913264110 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=10559 Win=57728 Len=0 TSval=3434324515 TSecr=384525900
296 10.913512387 14.139.221.29 192.168.43.23 TCP 2642 443 → 39668 [ACK] Seq=10559 Ack=1433 Win=31616 Len=2576 TSval=384525900 TSecr=3434323359 [TCP segment o
297 10.913555284 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=13135 Win=61056 Len=0 TSval=3434324516 TSecr=384525900
298 10.913756409 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=13135 Ack=1433 Win=31616 Len=1288 TSval=384525900 TSecr=3434323359 [TCP segment o
299 10.913792589 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=14423 Win=59776 Len=0 TSval=3434324516 TSecr=384525900
300 10.913970733 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=14423 Ack=1433 Win=31616 Len=1288 TSval=384525900 TSecr=3434323359 [TCP segment o
301 10.913998642 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=15711 Win=58496 Len=0 TSval=3434324516 TSecr=384525900
302 10.914293386 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=15711 Ack=1433 Win=31616 Len=1288 TSval=384525900 TSecr=3434323359 [TCP segment o
303 10.914332305 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=16999 Win=57216 Len=0 TSval=3434324516 TSecr=384525900
306 11.118021225 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=16999 Ack=1433 Win=31616 Len=1288 TSval=384526176 TSecr=3434324515 [TCP segment o
307 11.118078583 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=18287 Win=63104 Len=0 TSval=3434324720 TSecr=384526176
308 11.119355558 14.139.221.29 192.168.43.23 TLSv1.2 3930 Application Data [TCP segment of a reassembled PDU]
309 11.119355812 14.139.221.29 192.168.43.23 TCP 2642 443 → 39668 [ACK] Seq=22151 Ack=1433 Win=31616 Len=2576 TSval=384526182 TSecr=3434324516 [TCP segment o
310 11.119355987 14.139.221.29 192.168.43.23 TCP 2642 443 → 39668 [ACK] Seq=24727 Ack=1433 Win=31616 Len=2576 TSval=384526201 TSecr=3434324516 [TCP segment o
311 11.119410931 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=22151 Win=71936 Len=0 TSval=3434324722 TSecr=384526176
312 11.119468896 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=24727 Win=77056 Len=0 TSval=3434324722 TSecr=384526182
313 11.119495592 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=27303 Win=77824 Len=0 TSval=3434324722 TSecr=384526201
314 11.119548159 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=27303 Ack=1433 Win=31616 Len=1288 TSval=384526211 TSecr=3434324516 [TCP segment o
315 11.119568436 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=28591 Win=80384 Len=0 TSval=3434324722 TSecr=384526211
316 11.119812688 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=28591 Ack=1433 Win=31616 Len=1288 TSval=384526211 TSecr=3434324516 [TCP segment o
317 11.119842271 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=29879 Win=82944 Len=0 TSval=3434324722 TSecr=384526211
318 11.834833108 14.139.221.29 192.168.43.23 TCP 5218 443 → 39668 [ACK] Seq=29879 Ack=1433 Win=31616 Len=5152 TSval=384526806 TSecr=3434324722 [TCP segment o
319 11.834894654 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=35031 Win=83968 Len=0 TSval=3434325437 TSecr=384526806
320 11.835002839 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=35031 Ack=1433 Win=31616 Len=1288 TSval=384526806 TSecr=3434324722 [TCP segment o
321 11.835031076 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=36319 Win=82688 Len=0 TSval=3434325437 TSecr=384526806
322 11.835349990 14.139.221.29 192.168.43.23 TLSv1.2 2642 Application Data [TCP segment of a reassembled PDU]
323 11.835385425 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=38895 Win=88064 Len=0 TSval=3434325438 TSecr=384526806
324 11.835587511 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=38895 Ack=1433 Win=31616 Len=1288 TSval=384526806 TSecr=3434324722 [TCP segment o
325 11.835620809 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=40183 Win=90112 Len=0 TSval=3434325438 TSecr=384526806
326 11.835849477 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=40183 Ack=1433 Win=31616 Len=1288 TSval=384526807 TSecr=3434324722 [TCP segment o
327 11.835876610 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=41471 Win=90112 Len=0 TSval=3434325438 TSecr=384526807
328 11.836108495 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=41471 Ack=1433 Win=31616 Len=1288 TSval=384526807 TSecr=3434324722 [TCP segment o
329 11.836135862 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=42759 Win=90112 Len=0 TSval=3434325438 TSecr=384526807
330 12.039553719 14.139.221.29 192.168.43.23 TCP 5218 443 → 39668 [ACK] Seq=42759 Ack=1433 Win=31616 Len=5152 TSval=384527086 TSecr=3434325437 [TCP segment o
331 12.039554226 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=47911 Ack=1433 Win=31616 Len=1288 TSval=384527096 TSecr=3434325437 [TCP segment o
Frame 206: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface wlp2s0, id 0
0000 06 f5 02 a8 85 a3 00 1e 64 e1 5d 57 08 00 45 00 ···· ···· d·]W··E·
dddd.pcapng
Packets: 445 · Displayed: 119 (26.7%)
Profile: Default


File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
(ip.addr eq 14.139.221.29)
No. Time Source Destination Protocol Length Info
332 12.039617394 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=47911 Win=84992 Len=0 TSval=3434325642 TSecr=384527086
333 12.039681991 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=49199 Win=83712 Len=0 TSval=3434325642 TSecr=384527096
334 12.039891327 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=49199 Ack=1433 Win=31616 Len=1288 TSval=384527096 TSecr=3434325437 [TCP segment o
335 12.039891519 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=50487 Ack=1433 Win=31616 Len=1288 TSval=384527101 TSecr=3434325438 [TCP segment o
336 12.039921149 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=50487 Win=90112 Len=0 TSval=3434325642 TSecr=384527096
337 12.039957773 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=51775 Win=88832 Len=0 TSval=3434325642 TSecr=384527101
338 12.040144299 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=51775 Ack=1433 Win=31616 Len=1288 TSval=384527101 TSecr=3434325438 [TCP segment o
339 12.040170248 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=53063 Win=90112 Len=0 TSval=3434325642 TSecr=384527101
340 12.040399556 14.139.221.29 192.168.43.23 TLSv1.2 1354 Application Data [TCP segment of a reassembled PDU]
341 12.040419469 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=54351 Win=90112 Len=0 TSval=3434325643 TSecr=384527102
342 12.040613732 14.139.221.29 192.168.43.23 TLSv1.2 970 Application Data, Application Data, Application Data
343 12.040880220 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=1433 Ack=55255 Win=90112 Len=0 TSval=3434325643 TSecr=384527102
344 12.348941208 192.168.43.23 14.139.221.29 TLSv1.2 780 Application Data
345 12.351040081 192.168.43.23 14.139.221.29 TLSv1.2 783 Application Data
346 12.779113712 14.139.221.29 192.168.43.23 TCP 66 443 → 39668 [ACK] Seq=55255 Ack=2147 Win=33280 Len=0 TSval=384527767 TSecr=3434325951
347 12.779306517 14.139.221.29 192.168.43.23 TLSv1.2 837 Application Data, Application Data
348 12.779374020 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=2147 Ack=56026 Win=90112 Len=0 TSval=3434326381 TSecr=384527772
349 12.779505895 14.139.221.29 192.168.43.23 TLSv1.2 838 Application Data, Application Data
350 12.779522060 192.168.43.23 14.139.221.29 TCP 66 39666 → 443 [ACK] Seq=1362 Ack=4891 Win=63360 Len=0 TSval=3434326382 TSecr=384527861
351 12.785971025 192.168.43.23 14.139.221.29 TLSv1.2 813 Application Data
352 12.788184113 192.168.43.23 14.139.221.29 TLSv1.2 816 Application Data
353 13.165727708 14.139.221.29 192.168.43.23 TLSv1.2 3930 Application Data
354 13.165785545 192.168.43.23 14.139.221.29 TCP 66 39666 → 443 [ACK] Seq=2109 Ack=8755 Win=60288 Len=0 TSval=3434326768 TSecr=384528100
355 13.165972904 14.139.221.29 192.168.43.23 TCP 1354 443 → 39666 [ACK] Seq=8755 Ack=2109 Win=33024 Len=1288 TSval=384528100 TSecr=3434326388 [TCP segment of
356 13.166000045 192.168.43.23 14.139.221.29 TCP 66 39666 → 443 [ACK] Seq=2109 Ack=10043 Win=63104 Len=0 TSval=3434326768 TSecr=384528100
357 13.166198654 14.139.221.29 192.168.43.23 TCP 1354 443 → 39666 [ACK] Seq=10043 Ack=2109 Win=33024 Len=1288 TSval=384528100 TSecr=3434326388 [TCP segment o
358 13.166226121 192.168.43.23 14.139.221.29 TCP 66 39666 → 443 [ACK] Seq=2109 Ack=11331 Win=61824 Len=0 TSval=3434326768 TSecr=384528100
359 13.166419787 14.139.221.29 192.168.43.23 TLSv1.2 1100 Application Data
360 13.166437401 192.168.43.23 14.139.221.29 TCP 66 39666 → 443 [ACK] Seq=2109 Ack=12365 Win=60800 Len=0 TSval=3434326769 TSecr=384528100
361 13.170868659 14.139.221.29 192.168.43.23 TLSv1.2 1354 Application Data
362 13.177043801 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=57314 Ack=2897 Win=34816 Len=1288 TSval=384528274 TSecr=3434326390 [TCP segment o
363 13.177085505 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=2897 Ack=58602 Win=90112 Len=0 TSval=3434326779 TSecr=384528274
364 13.182612448 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=58602 Ack=2897 Win=34816 Len=1288 TSval=384528274 TSecr=3434326390 [TCP segment o
365 13.182823674 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=59890 Ack=2897 Win=34816 Len=1288 TSval=384528274 TSecr=3434326390 [TCP segment o
366 13.182850984 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=2897 Ack=61178 Win=90112 Len=0 TSval=3434326785 TSecr=384528274
367 13.198555646 14.139.221.29 192.168.43.23 TCP 1354 443 → 39668 [ACK] Seq=61178 Ack=2897 Win=34816 Len=1288 TSval=384528274 TSecr=3434326390 [TCP segment o
368 13.198683435 14.139.221.29 192.168.43.23 TLSv1.2 677 Application Data
Frame 206: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface wlp2s0, id 0
0000 06 f5 02 a8 85 a3 00 1e 64 e1 5d 57 08 00 45 00 .... d·]W··E·
dddd.pcapng
Packets: 445 · Displayed: 119 (26.7%)
Profile: Default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347 12.779306517 14.139.221.29 192.168.43.23 TLSv1.2 837 Application Data, Application Data
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356 13.166000045 192.168.43.23 14.139.221.29 TCP 66 39666 → 443 [ACK] Seq=2109 Ack=10043 Win=63104 Len=0 TSval=3434326768 TSecr=384528100
357 13.166198654 14.139.221.29 192.168.43.23 TCP 1354 443 → 39666 [ACK] Seq=10043 Ack=2109 Win=33024 Len=1288 TSval=384528100 TSecr=3434326388 [TCP segment o
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359 13.166419787 14.139.221.29 192.168.43.23 TLSv1.2 1100 Application Data
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366 13.182850984 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=2897 Ack=61178 Win=90112 Len=0 TSval=3434326785 TSecr=384528274
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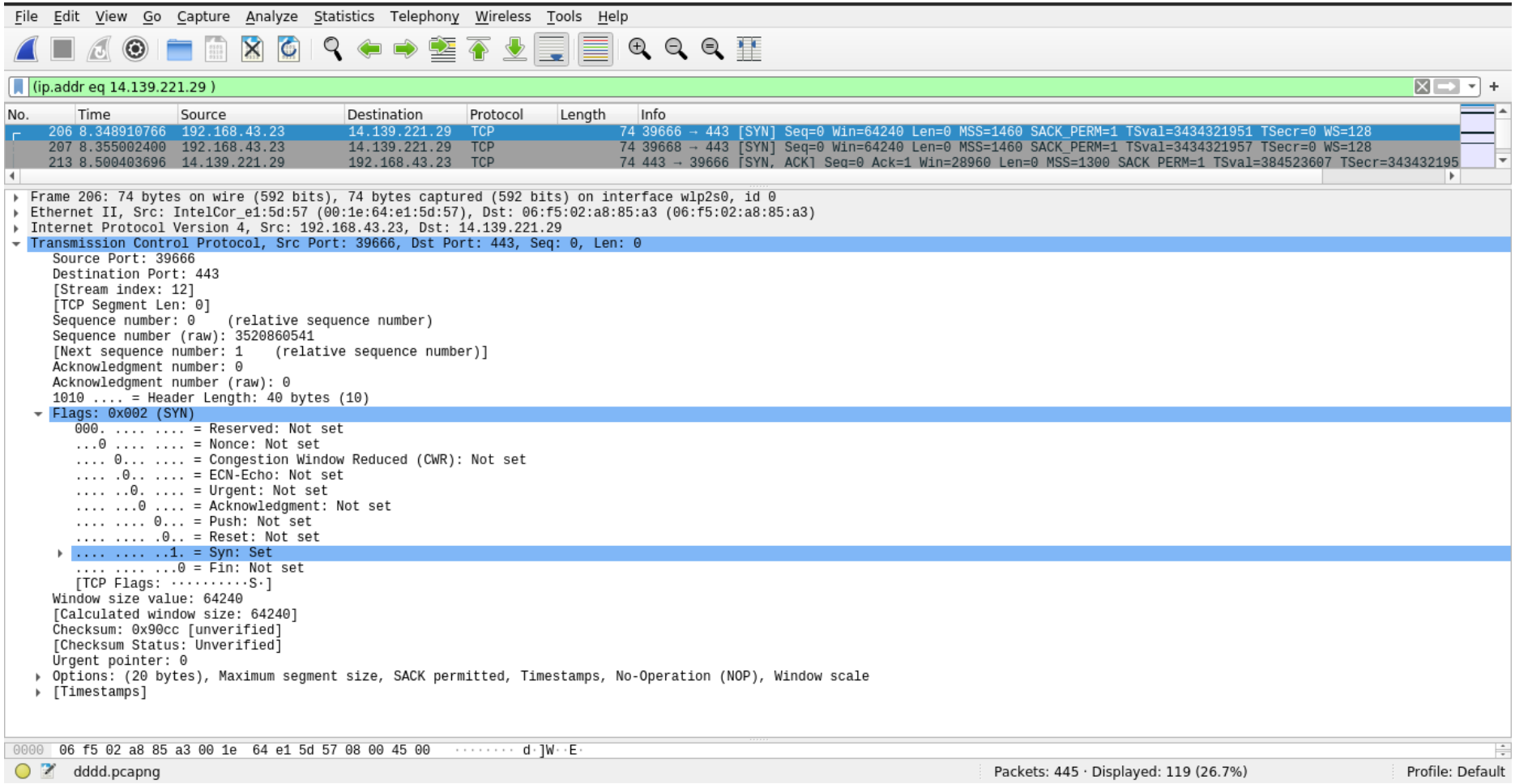
368 13.198683435 14.139.221.29 192.168.43.23 TLSv1.2 677 Application Data
369 13.198865079 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=2897 Ack=63077 Win=90112 Len=0 TSval=3434326801 TSecr=384528274
372 18.183257942 14.139.221.29 192.168.43.23 TLSv1.2 97 Encrypted Alert
373 18.183258263 14.139.221.29 192.168.43.23 TCP 66 443 → 39666 [FIN, ACK] Seq=12396 Ack=2109 Win=33024 Len=0 TSval=384533105 TSecr=3434326769
374 18.183258363 14.139.221.29 192.168.43.23 TLSv1.2 97 Encrypted Alert
375 18.183315009 192.168.43.23 14.139.221.29 TCP 66 39666 → 443 [ACK] Seq=2109 Ack=12396 Win=64128 Len=0 TSval=3434331785 TSecr=384533105
376 18.183387770 14.139.221.29 192.168.43.23 TCP 66 443 → 39668 [FIN, ACK] Seq=63108 Ack=2897 Win=34816 Len=0 TSval=384533280 TSecr=3434326801
377 18.224406030 192.168.43.23 14.139.221.29 TCP 66 39668 → 443 [ACK] Seq=2897 Ack=63109 Win=90112 Len=0 TSval=3434331827 TSecr=384533280
378 18.224448660 192.168.43.23 14.139.221.29 TCP 66 39666 → 443 [ACK] Seq=2109 Ack=12397 Win=64128 Len=0 TSval=3434331827 TSecr=384533105
Frame 206: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface wlp2s0, id 0
0000 06 f5 02 a8 85 a3 00 1e 64 e1 5d 57 08 00 45 00 ···· ···· d·]W··E·
dddd.pcapng
Packets: 445 · Displayed: 119 (26.7%)
Profile: Default

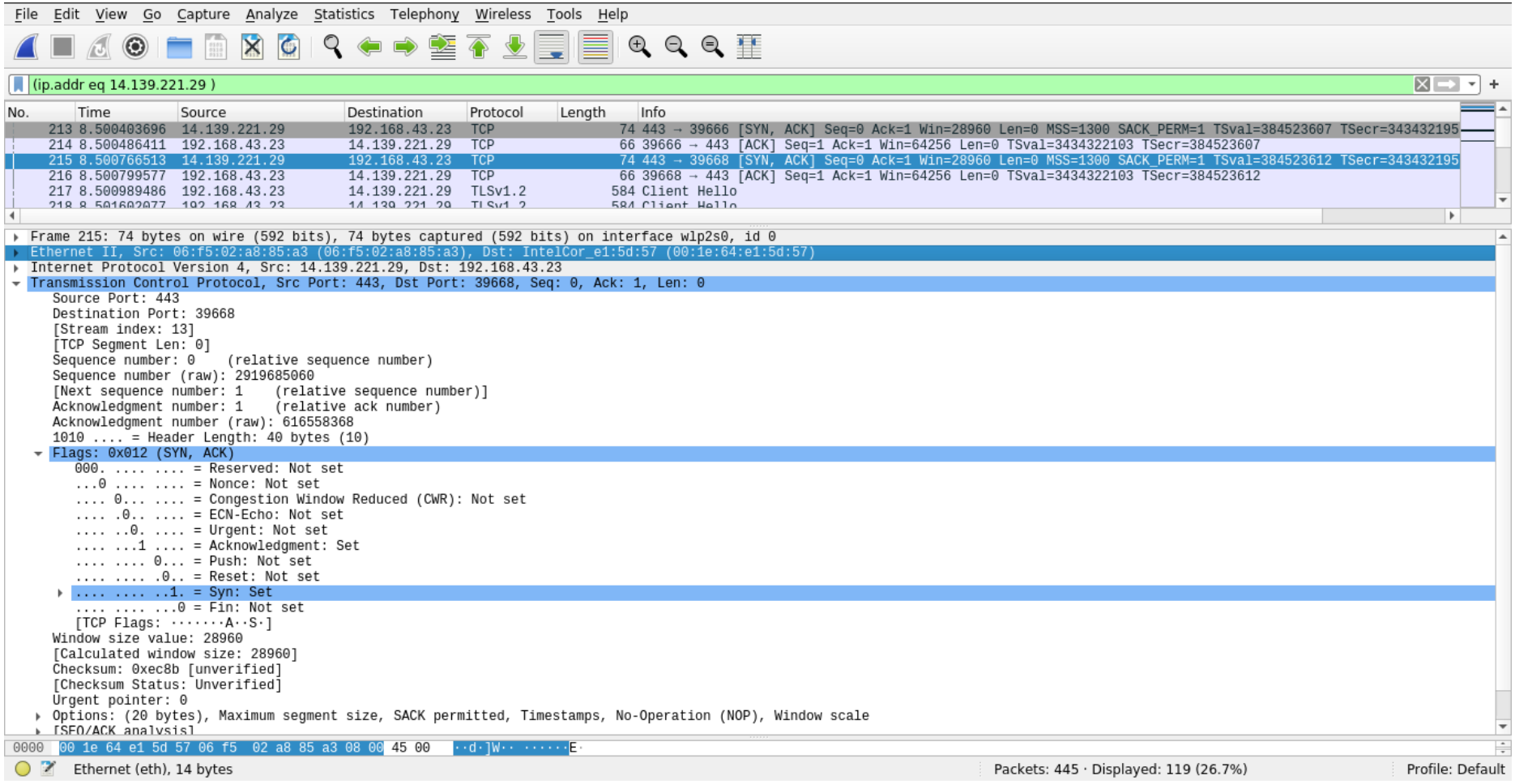
3. (a) Show how the six flags (SYN, ACK, PUSH, URGENT, RST, FIN) are working in TCP protocol

Answer.

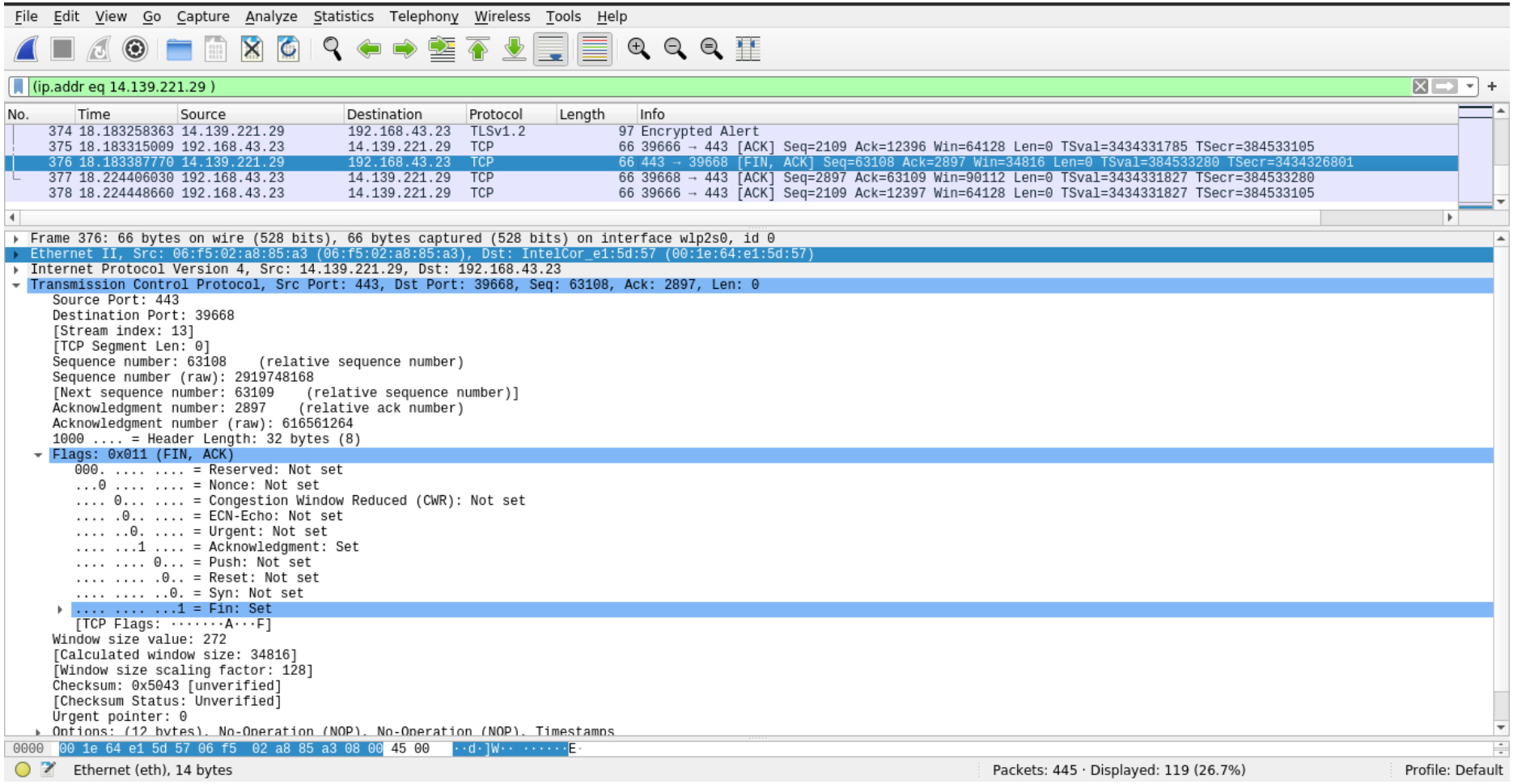
SYN – For connection establishment The synchronization flag is used as a first step in establishing a three-way handshake between two hosts. Only the first packet from both the sender and receiver should have this flag set.



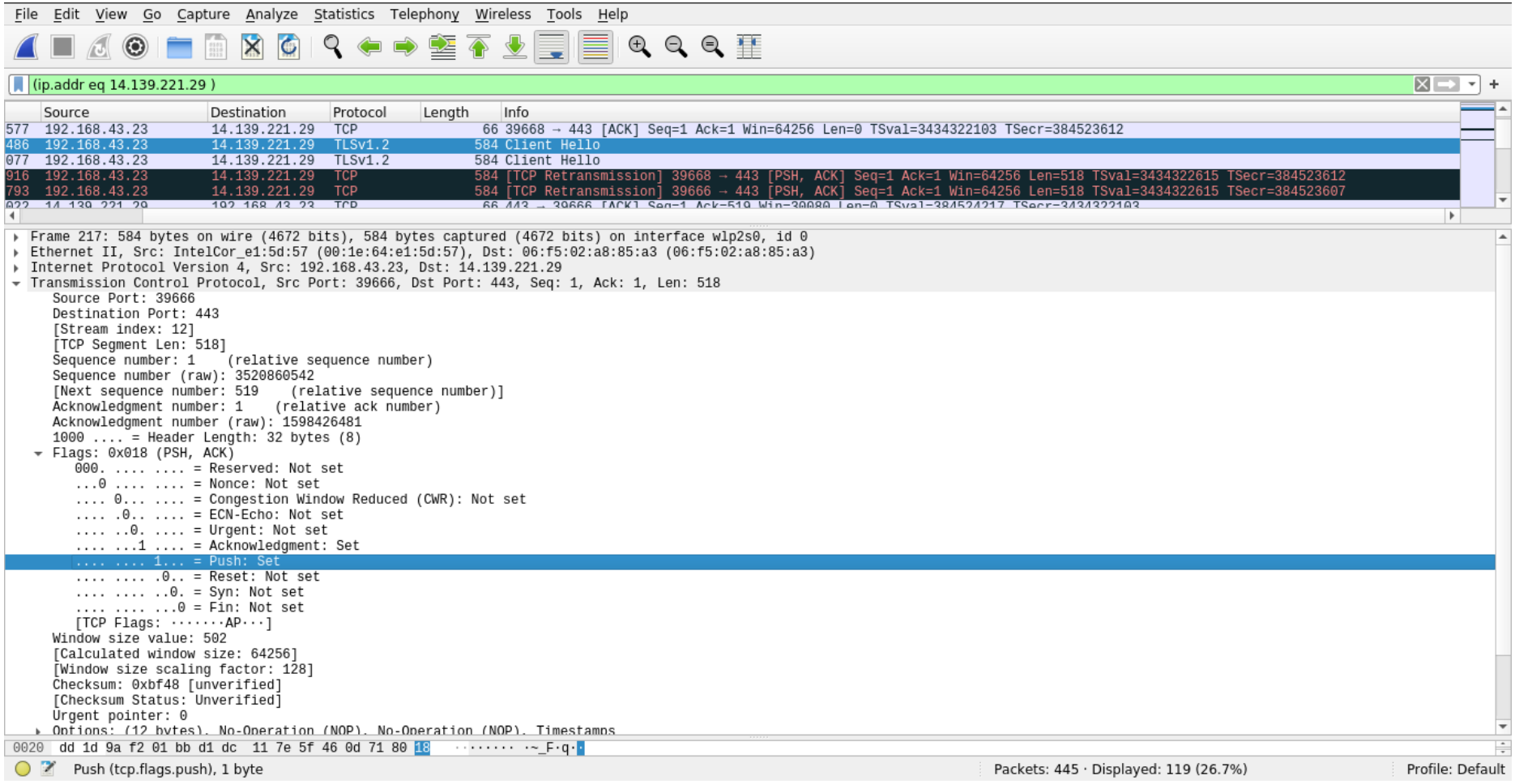
ACK – indicates that the acknowledgement number is valid The acknowledgment flag is used to acknowledge the successful receipt of a packet. the receiver sends an ACK as well as a SYN in the second step of the three way handshake process to tell the sender that it received its initial packet.



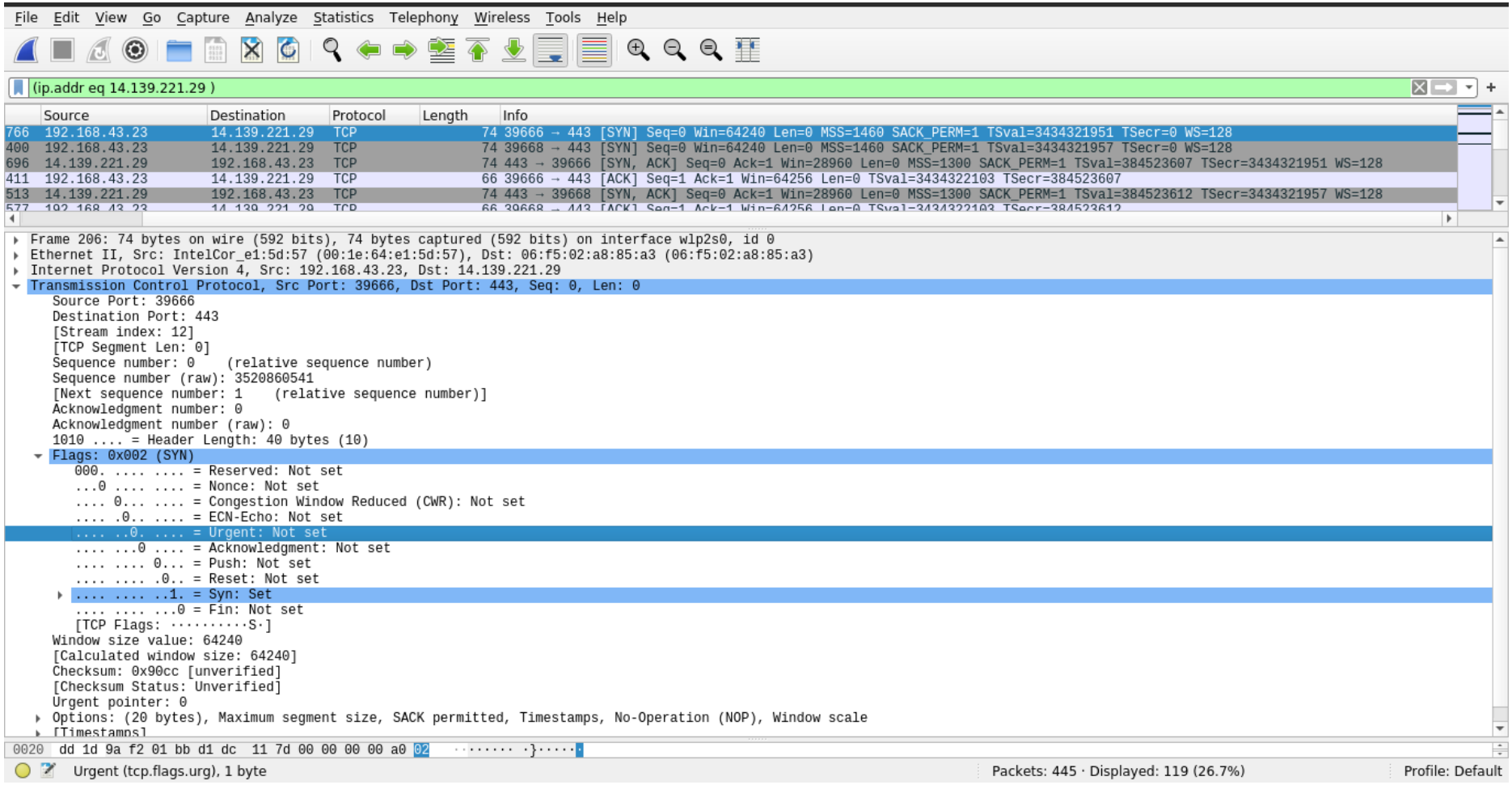
FIN – for termination of connection (I have no more data to send) The finished flag means there is no more data from the sender. Therefore, it is used in the last packet sent from the sender.



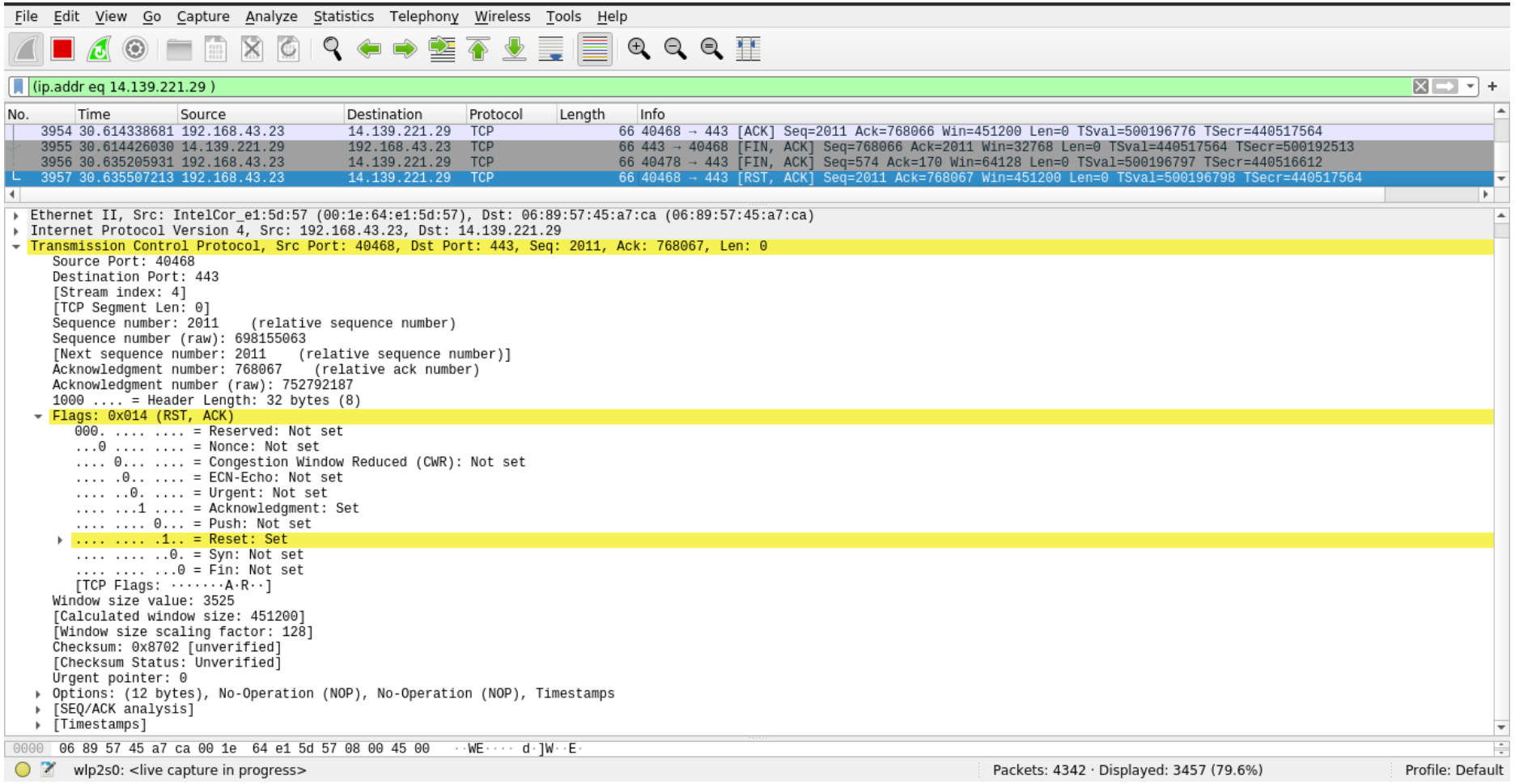
PSH – do not buffer – push the packet to the application The push flag is somewhat similar to the URG flag and tells the receiver to process these packets as they are received instead of buffering them.



URG – urgent byte in packet at location indicated in the “urgent” field The urgent flag is used to notify the receiver to process the urgent packets before processing all other packets. The receiver will be notified when all known urgent data has been received.

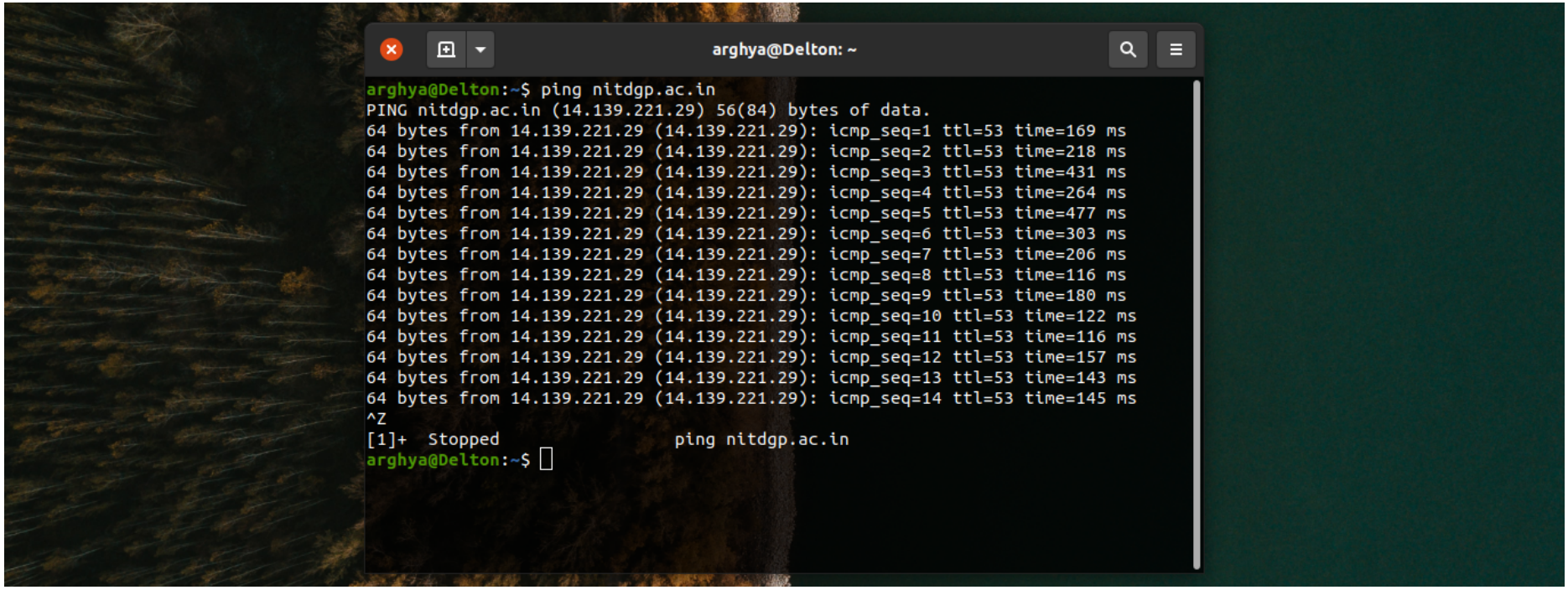


RST – rejection of TCP packet (denoted red in wireshark) The reset flag gets sent from the receiver to the sender when a packet is sent to a particular host that was not expecting it.



(b) What is the IP address of nitdgp.ac.in? On what port number is it sending and receiving TCP segments for this connection?

Answer. The IP address of nitdgp.ac.in is **14.139.221.29** and the tcp port number for sending and receiving TCP segments for the connections are **443** respectively.



(c) Write a small socket program for the URGENT pointer and urgent flag?

Answer.

The following code is the header file for **Binding server and connection of clients**.

```
/* bindacpt.h */

#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <errno.h>
#include <string.h>
#include <signal.h>
#include <fcntl.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <netdb.h>
```

```
#include <ctype.h>

int confd;
int mkaddr(void *addr,
               int *addrlen,
               char *str_addr,
               char *protocol) {

        char *inp_addr = strdup(str_addr);
        char *host_part = strtok(inp_addr, ":" );
        char *port_part = strtok(NULL, "\n" );
        struct sockaddr_in *ap =
                (struct sockaddr_in *) addr;
        struct hostent *hp = NULL;
        struct servent *sp = NULL;
        char *cp;
        long lv;

        /*
         * Set input defaults:
         */
        if ( !host_part ) {
                host_part = "*" ;
        }
        if ( !port_part ) {
                port_part = "*" ;
        }
        if ( !protocol ) {
                protocol = "tcp" ;
        }

        /*
         * Initialize the address structure:
         */
        memset(ap,0,*addrlen);
        ap->sin_family = AF_INET;
        ap->sin_port = 0;
        ap->sin_addr.s_addr = INADDR_ANY;

        /*
         * Fill in the host address:
         */
```

```
if ( strcmp(host_part, "*" ) == 0 ) {
        ; /* Leave as INADDR_ANY */
}
else if ( isdigit(*host_part) ) {
        /*
         * Numeric IP address:
         */
        ap->sin_addr.s_addr =
                inet_addr(host_part);
        // if ( ap->sin_addr.s_addr == INADDR_NONE ) {
        if ( !inet_aton(host_part,&ap->sin_addr) ) {
                return -1;
        }
}
        else {
                /*
                 * Assume a hostname:
                 */
                hp = gethostbyname(host_part);
                if ( !hp ) {
                        return -1;
                }
                if ( hp->h_addrtype != AF_INET ) {
                        return -1;
                }
                ap->sin_addr = * (struct in_addr *)
                        hp->h_addr_list[0];
        }

        /*
         * Process an optional port #:
         */
        if ( !strcmp(port_part, "*" ) ) {
                /* Leave as wild (zero) */
        }
        else if ( isdigit(*port_part) ) {
                /*
                 * Process numeric port #:
                 */
                lv = strtol(port_part,&cp,10);
                if ( cp != NULL && *cp ) {
                        return -2;
```

```
                        }
                        if ( lv < 0L || lv >= 32768 ) {
                                return -2;
                        }
                        ap->sin_port = htons( (short)lv);
                }
                else {
                        /*
                         * Lookup the service:
                         */
                        sp = getservbyname( port_part, protocol);
                        if ( !sp ) {
                                return -2;
                        }
                        ap->sin_port = (short) sp->s_port;
                }

                /*
                 * Return address length
                 */
                *addrlen = sizeof *ap;

                free(inp_addr);
                return 0;
        }

void sigurg(int signo)
{
        char buf[256];
        int     n;
        printf("SIGURG received \n");
        n = recv(confd, buf, sizeof(buf)-1, MSG_OOB);
        buf[n] = 0;
        fprintf(stdout, "read %d OOB bytes :%s\n", n, buf);
}

void  bail(const char *on_what) {
      if ( errno != 0 ) {
          fputs(strerror(errno),stderr);
          fputs(": ",stderr);
      }
      fputs(on_what,stderr);
```

```
        fputc('\n',stderr);
        exit(1);
    }

int   BindAccept(char *addr) {
        int z;
        int s;
        struct sockaddr_in adr_srvr;
        struct sockaddr_in adr_clnt;
        int len_inet;

        /*
        * Create a TCP/IP socket to use:
         */
        s = socket(PF_INET,SOCK_STREAM,0);
        if ( s == -1 )
            bail("socket()");

        /*
         * Bind the server address:
         */
        len_inet = sizeof adr_srvr;
        z = mkaddr(&adr_srvr,&len_inet,
        addr,"tcp");

        if ( z != 0 ) {
            puts("Bad address/port");
            exit(1);
        }

        /*
         * Bind server address:
         */
        z = bind(s,(struct sockaddr *)&adr_srvr,
                len_inet);
        if ( z == -1 )
            bail("bind(2)");

        /*
         * Set listen mode:
         */
        if ( listen(s,10) == -1 )
```

```
        bail("listen(2)");

    /*
     * Wait for a connect:
     */
    len_inet = sizeof adr_clnt;

    z = accept(s,
        (struct sockaddr *)&adr_clnt,
        &len_inet);

    if ( z == -1 )
            bail("accept(2)");

    close(s);    /* No longer needed */
    return z;    /* Connected socket */
}
int Connect(char *addr) {
    int z;
    int s;
    struct sockaddr_in adr_srvr;
    int len_inet;
    /*
     * Create a TDP/IP socket to use:
     */
    s = socket(PF_INET,SOCK_STREAM,0);
    if ( s == -1 )
        bail("socket()");

    /*
     * Bind the server address:
     */
    len_inet = sizeof adr_srvr;
    z = mkaddr(&adr_srvr,&len_inet,
        addr,"tcp");

    if ( z != 0 ) {
       puts("Bad address/port");
        exit(1);
    }

    /*
```

```
     * Connect to server:
     */
    len_inet = sizeof adr_srvr;

    z = connect(s,
        (struct sockaddr *)&adr_srvr,
        len_inet);

    if ( z == -1 )
            bail("connect(2)");

    return s;    /* Connected socket */
}
```

The following code is the implementation for **TCP client side programming**.

```
/* tcpclient01.c */

#include "bindacpt.h"
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <errno.h>
#include <string.h>
#include <signal.h>
#include <fcntl.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <netdb.h>
#include <ctype.h>

static void iband(int s,char *str) {
      int z;

      z = send(s,str,strlen(str),0);
      if ( z == -1 )
          bail("send(2)");

      printf("ib: '%s' (%d)\n",str,z);
  }
```

```
/*
 * Send out-of-band data:
 */
static void
oband(int s,char *str) {
    int z;

    z = send(s,str,strlen(str),MSG_OOB);
    if ( z == -1 )
        bail("send(2)");

   printf("OOB '%s' (%d)\n",str,z);
}

int
main(int argc,char **argv) {
    int s = -1;       /* Socket */

    s = Connect(argc >= 2
        ? argv[1]
        : "127.0.0.1:9011");

    iband(s,"In the beginning");
    sleep(1);
    iband(s,"Linus begat Linux,");
    sleep(1);

    iband(s,"and the Penguins");
    sleep(1);

    oband(s,"rejoiced");
    sleep(1);

    iband(s,"exceedingly.");
    close(s);

    return 0;
}
```

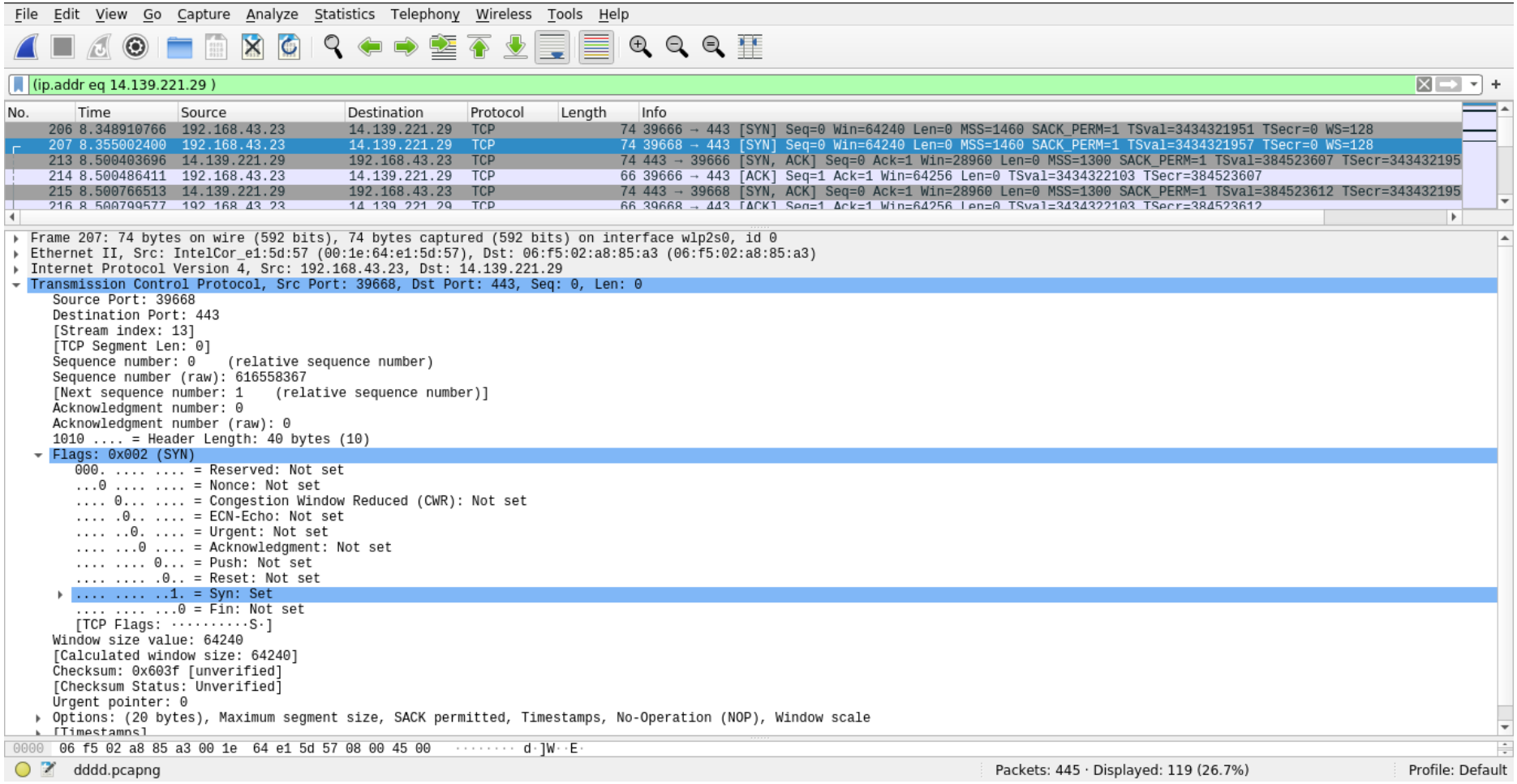
The following code is the implementation for **TCP Server side programming**.

```
/* tcpserver01.c */
```

```
#include "bindacpt.h"
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <errno.h>
#include <string.h>
#include <signal.h>
#include <fcntl.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <netdb.h>
#include <ctype.h>

int listenfd;

int     main(int argc, char **argv)
{
        int     n;
        int z;
        char buf[256];
        listenfd = BindAccept(argc >= 2? argv[1]: "127.0.0.1:9011");
        z = fcntl(listenfd,F_SETOWN,getpid());
        if ( z == -1 ) bail("fcntl(2)");
        signal(SIGURG,sigurg);
        for (;;) {
          z = recv(listenfd,buf,sizeof buf,0);
          if ( z == -1 )
              bail("recv(2)");
          if ( z == 0 )
              break;
          buf[z] = 0;

          printf("rcv '%s' (%d)\n",
              buf, z);
     }
          close(listenfd);
          return 0;
        exit(0);
}
```

(d) What is the sequence number of the TCP SYN segment that is used to initiate the TCP connection between the client computer and nitdgp.ac.in?

Answer. Relative sequence number is 0. And actual sequence number is **3520860541**. The sequence number of the TCP SYN segment is 0 since it is used to initate the TCP connection between the client computer and nitdgp.ac.in.

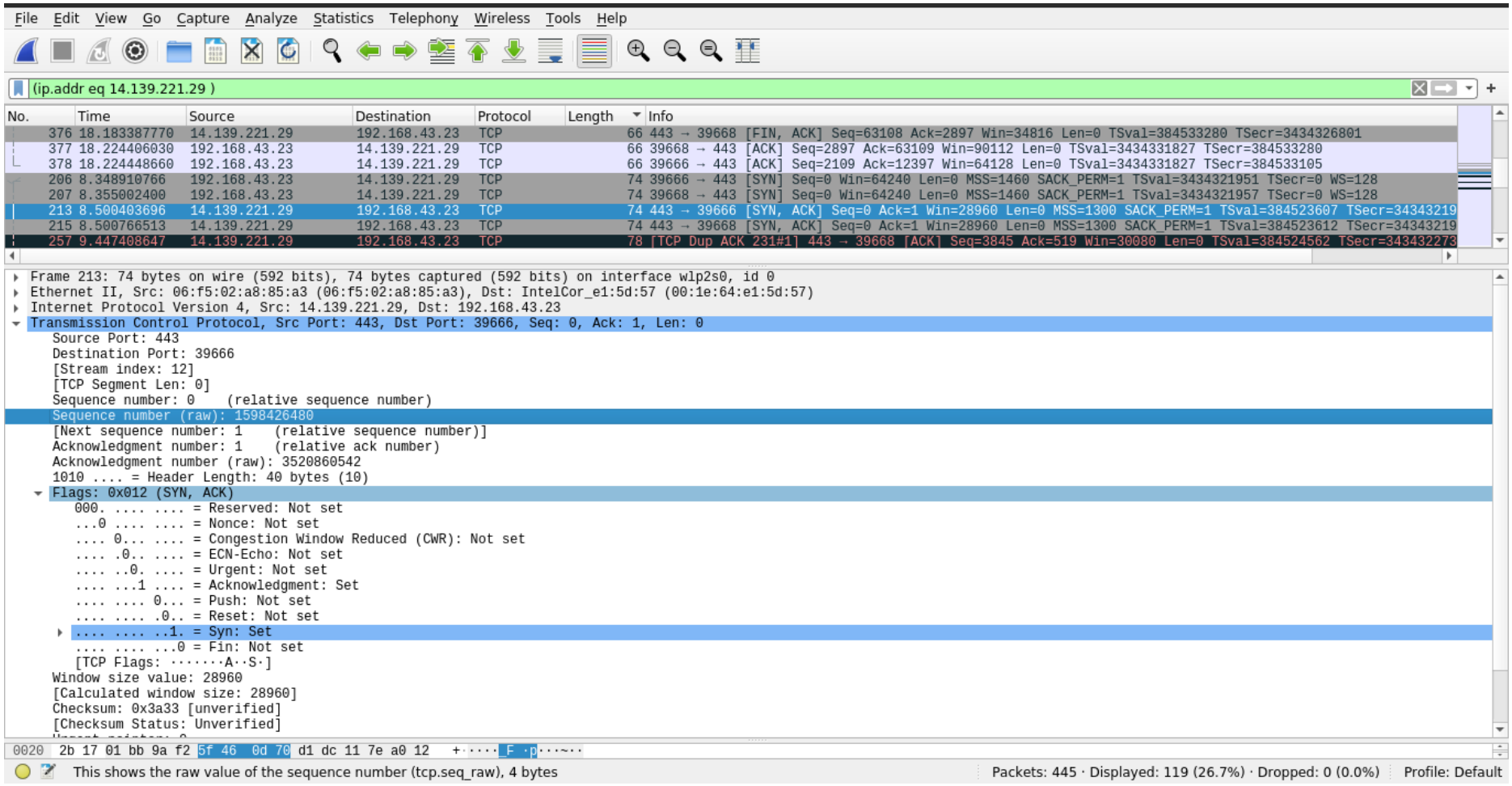


(e) What is it in the segment that identifies the segment as a SYN segment?

Answer. In the above figure,It is indicated by the Syn flag in the Flags section, which is set to 1.

(f) What is the sequence number of the SYN-ACK segment sent by nitdgp.ac.in to the client computer in reply to the SYN?

Answer. Relative sequence number is 0. And actual sequence number is **1598426480**. The sequence number of the TCP SYN segment is 0 since it is used to initate the TCP connection between the client computer and nitdgp.ac.in.



(g) What is the value of the Acknowledgement field in the SYN-ACK segment?

Answer. According to the above figure, the value of the acknowledgement field in the SYNACK segment is 1.

(h) How did nitdgp.ac.in determine that value?

Answer. According to the above figure, the value of the ACK acknowledgement field in the SYNACK segment is determined by the server nitdgp.ac.in. The server adds 1 to the initial sequence number of SYN segment from teh client computer. For this case, the initial sequence number of SYN segment from the client computer is 0, thus the value of the ACK acknowledgement field in the SYNACK segment is 1.

(i) What is it in the segment that identifies the segment as a SYN-ACK segment?

Answer. A segment will be identified as a SYNACK segment if both SYN flag and Acknowledgement in the segment are set to 1.