

**Universidad de León**  
**School of Industrial, Computer and Aerospace Engineering**  
**Course on Distributed Systems and Networks**

**Homework #2. Basic TCP**

Submit a single .zip file containing your solutions to the HW exercises. Only .pdf and files are accepted. Submit via agora by 21:00 on Monday 14<sup>th</sup>-October-2024.

**Introduction**

The trace included below represents the lifecycle of a TCP connection between a client host (C) and a server (S). The C and the S processes run in their respective hosts (See fig. 1). Solve the questions included after the trace (The trace is composed of 11 packets which are numbered P<n> for convenience).

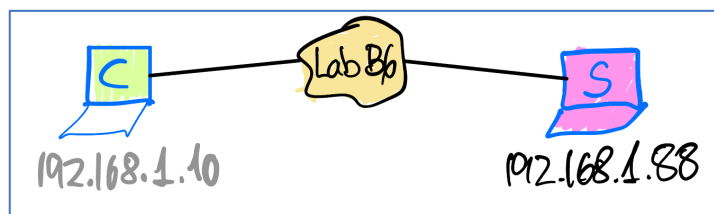


Figure 1. Client and Server hosts in Lab B6 network with their IP addresses

**tcpdump trace for TCP Analysis**

```
$ /usr/sbin/tcpdump -i eno1 -vvv -n -X tcp port 50001
tcpdump: listening on eno1, link-type EN10MB (Ethernet), capture size 262144 bytes
```

**P1**

```
14:49:25.354585 IP (tos 0x0, ttl 64, id 0, offset 0, flags [DF], proto TCP (6), length 64)
  192.168.1.10.49699 > 192.168.1.88.50001: Flags [SEW], cksum 0x3f42 (correct), seq 1959256602, win 65535,
options [mss 1460,nop,wscale 6,nop,nop,TS val 1470971714 ecr 0,sackOK,eol], length 0
0x0000: 4500 0040 0000 4000 4006 b705 c0a8 010a  E..@..@.....
0x0010: c0a8 0158 c223 c351 74c7 e21a 0000 0000  ...X.#.Qt.....
0x0020: b0c2 ffff 3f42 0000 0204 05b4 0103 0306  ....?B.....
0x0030: 0101 080a 57ad 3f42 0000 0000 0402 0000  ....W.?B.....
```

**P2**

```
14:49:25.354631 IP (tos 0x0, ttl 64, id 0, offset 0, flags [DF], proto TCP (6), length 60)
  192.168.1.88.50001 > 192.168.1.10.49699: Flags [S.E], cksum 0x83e1 (incorrect -> 0x00f0), seq 3404803869, ack
1959256603, win 65160, options [mss 1460,sackOK,TS val 4113457662 ecr 1470971714,nop,wscale 7], length 0
0x0000: 4500 003c 0000 4000 4006 b709 c0a8 0158  E.<..@.....X
0x0010: c0a8 010a c351 c223 caf1 2f1d 74c7 e21b  ....Q.#.!.t...
0x0020: a052 fe88 83e1 0000 0204 05b4 0402 080a  .R.....
0x0030: f52e 61fe 57ad 3f42 0103 0307  ....a.W.?B....
```

**P3**

```
14:49:25.354906 IP (tos 0x0, ttl 64, id 0, offset 0, flags [DF], proto TCP (6), length 52)
  192.168.1.10.49699 > 192.168.1.88.50001: Flags [.] , cksum 0x267b (correct), seq 1, ack 1, win 2058, options
[nop,nop,TS val 1470971714 ecr 4113457662], length 0
0x0000: 4500 0034 0000 4000 4006 b711 c0a8 010a  E..4..@.....
0x0010: c0a8 0158 c223 c351 74c7 e21b caf1 2f1e  ...X.#.Qt...../
0x0020: 8010 080a 267b 0000 0101 080a 57ad 3f42  ....&{.....W.?B
0x0030: f52e 61fe  ....a.
```

**P4**

```
14:49:25.354988 IP (tos 0x2,ECT(0), ttl 64, id 0, offset 0, flags [DF], proto TCP (6), length 67)
 192.168.1.10.49699 > 192.168.1.88.50001: Flags [P.], cksum 0x5148 (correct), seq 1:16, ack 1, win 2058, options
[nop,nop,TS val 1470971714 ecr 4113457662], length 15
 0x0000: 4502 0043 0000 4000 4006 b700 c0a8 010a E..C..@.@.....
 0x0010: c0a8 0158 c223 c351 74c7 e21b caf1 2f1e ...X.#.Qt...../
 0x0020: 8018 080a 5148 0000 0101 080a 57ad 3f42 ....QH.....W.?B
 0x0030: f52e 61fe 4865 6c6c 6f20 776f 726c 6420 ...a.hello.world
 0x0040: 3a2d 29 (->)
```

### P5

```
14:49:25.355008 IP (tos 0x0, ttl 64, id 12405, offset 0, flags [DF], proto TCP (6), length 52)
 192.168.1.88.50000 > 192.168.1.10.49699: Flags [.], cksum 0x83d9 (incorrect -> 0x2c79), seq 1, ack 16, win 509,
options [nop,nop,TS val 4113457662 ecr 1470971714], length 0
 0x0000: 4500 0034 3075 4000 4006 869c c0a8 0158 E..40u@.@.....X
 0x0010: c0a8 010a c351 c223 caf1 2f1e 74c7 e22a .....Q.#../.t..*
 0x0020: 8010 01fd 83d9 0000 0101 080a f52e 61fe .....a.
 0x0030: 57ad 3f42 W.?B
```

### P6

```
14:49:25.355097 IP (tos 0x2,ECT(0), ttl 64, id 12406, offset 0, flags [DF], proto TCP (6), length 92)
 192.168.1.88.50000 > 192.168.1.10.49699: Flags [P.], cksum 0x8401 (incorrect -> 0xaa70), seq 1:41, ack 16, win
509, options [nop,nop,TS val 4113457662 ecr 1470971714], length 40
 0x0000: 4502 005c 3076 4000 4006 8671 c0a8 0158 E..0v@.@..q...X
 0x0010: c0a8 010a c351 c223 caf1 2f1e 74c7 e22a .....Q.#../.t..*
 0x0020: 8018 01fd 8401 0000 0101 080a f52e 61fe .....a.
 0x0030: 57ad 3f42 536f 6c63 6974 7564 206e 6f20 W.?Bsolcitud.no
 0x0040: 7265 636f 6e6f 6369 6461 2070 6f72 2065 reonocida.por.e
 0x0050: 7374 6520 7365 7276 6964 6f72 ste.servidor
```

### P7

```
14:49:25.355131 IP (tos 0x0, ttl 64, id 12407, offset 0, flags [DF], proto TCP (6), length 52)
 192.168.1.88.50001 > 192.168.1.10.49699: Flags [F.], cksum 0x83d9 (incorrect -> 0x2c50), seq 41, ack 16, win
509, options [nop,nop,TS val 4113457662 ecr 1470971714], length 0
 0x0000: 4500 0034 3077 4000 4006 869a c0a8 0158 E..40w@.@.....X
 0x0010: c0a8 010a c351 c223 caf1 2f46 74c7 e22a .....Q.#../.ft..*
 0x0020: 8011 01fd 83d9 0000 0101 080a f52e 61fe .....a.
 0x0030: 57ad 3f42 W.?B
```

### P8

```
14:49:25.355447 IP (tos 0x0, ttl 64, id 0, offset 0, flags [DF], proto TCP (6), length 52)
 192.168.1.10.49699 > 192.168.1.88.50001: Flags [.], cksum 0x2644 (correct), seq 16, ack 41, win 2058, options
[nop,nop,TS val 1470971714 ecr 4113457662], length 0
 0x0000: 4500 0034 0000 4000 4006 b711 c0a8 010a E..4..@.@.....
 0x0010: c0a8 0158 c223 c351 74c7 e22a caf1 2f46 ...X.#.Qt...*/F
 0x0020: 8010 080a 2644 0000 0101 080a 57ad 3f42 ....&D.....W.?B
 0x0030: f52e 61fe ...a.
```

### P9

```
14:49:25.355464 IP (tos 0x0, ttl 64, id 0, offset 0, flags [DF], proto TCP (6), length 52)
 192.168.1.10.49699 > 192.168.1.88.50001: Flags [.], cksum 0x2643 (correct), seq 16, ack 42, win 2058, options
[nop,nop,TS val 1470971714 ecr 4113457662], length 0
 0x0000: 4500 0034 0000 4000 4006 b711 c0a8 010a E..4..@.@.....
 0x0010: c0a8 0158 c223 c351 74c7 e22a caf1 2f47 ...X.#.Qt...*/G
 0x0020: 8010 080a 2643 0000 0101 080a 57ad 3f42 ....&C.....W.?B
 0x0030: f52e 61fe ...a.
```

### P10

```
14:49:25.355493 IP (tos 0x0, ttl 64, id 0, offset 0, flags [DF], proto TCP (6), length 52)
 192.168.1.10.49699 > 192.168.1.88.50001: Flags [F.], cksum 0x2641 (correct), seq 16, ack 42, win 2058, options
[nop,nop,TS val 1470971715 ecr 4113457662], length 0
 0x0000: 4500 0034 0000 4000 4006 b711 c0a8 010a E..4..@.@.....
 0x0010: c0a8 0158 c223 c351 74c7 e22a caf1 2f47 ...X.#.Qt...*/G
 0x0020: 8011 080a 2641 0000 0101 080a 57ad 3f43 ....&A.....W.?C
 0x0030: f52e 61fe ...a.
```

### P11

```
14:49:25.355509 IP (tos 0x0, ttl 64, id 0, offset 0, flags [DF], proto TCP (6), length 52)
 192.168.1.88.50001 > 192.168.1.10.49699: Flags [.], cksum 0x2c4d (correct), seq 42, ack 17, win 509, options
[nop,nop,TS val 4113457663 ecr 1470971715], length 0
 0x0000: 4500 0034 0000 4000 4006 b711 c0a8 0158 E..4..@.@.....X
 0x0010: c0a8 010a c351 c223 caf1 2f47 74c7 e22b .....Q.#../.Gt..+
 0x0020: 8010 01fd 2c4d 0000 0101 080a f52e 61ff ....M.....a.
 0x0030: 57ad 3f43 W.?C
```

### Questions about the trace above

1. Which packets make up the 3-way handshake phase of the connection?
2. What is the client's IP address and TCP port?
3. Likewise, what is the server's IP address and TCP port?
4. What is the ISN (Initial Sequence Number) specified by the client? In which packet do you identify it?
5. What is the ISN (Initial Sequence Number) specified by the server? In which packet do you identify it?
6. When the server receives the ISN from the client, it should respond with a TCP segment that has the SYN flag set and an ACK SN that should be one plus the received ISN. Check that this holds in the relevant packets. Which packets are those?
7. What is the purpose of packet P3?
8. Packet P4 is used by the client to send a block of bytes which SN covers the range 1:15. Is that true?
9. What packets sent by the server acknowledge the block of data mentioned in the preceding question? List them all.
10. What's the purpose of sending segments with no payload, if any? Set an example of one of such segments?
11. Calculate the MTU of the underlying Ethernet, by hand.
12. Identify the first *small segment* that appears on the data transfer phase included in the trace (A small segment is one that has a size less than MSS?)
13. Check that packet P9 has its ACK flag set. Use the hex dump for identifying the position of the ACK bit. You will want to consult the TCP header from RFC 9293.
14. Check whether all of the segments that belong to the data transfer phase have their ACK flag set.
15. Identify some data transfer segments that have their SYN flag set
16. Which flags are set in the TCP segment which IP packet was sent in P11.