

# TCP

1

IP port: 10.39.17.251

Source port: 54440

The image shows a Wireshark packet capture window titled 'lab08.pcapng'. The packet list on the left shows several packets, with packet 1462 highlighted. The packet details pane on the right shows the structure of packet 1462, which is a TCP SYN packet. The source port is 54440 and the destination port is 80. The packet bytes pane on the right shows the raw data of the packet.

| No.  | Time     | Source       | Destination    | Protocol | Length | Info                 |
|------|----------|--------------|----------------|----------|--------|----------------------|
| 1458 | 4.785042 | 10.39.17.251 | 10.3.0.4       | TLSv1.2  | 86     | Application Data     |
| 1459 | 4.795723 | 10.3.0.4     | 10.39.17.251   | TCP      | 60     | 52650 → 22443 [ACK]  |
| 1460 | 4.796466 | 10.39.17.251 | 10.3.0.20      | SMB2     | 406    | Create Request File: |
| 1461 | 4.797250 | 10.3.0.20    | 10.39.17.251   | SMB2     | 410    | Create Response File |
| 1462 | 4.812927 | 10.39.17.251 | 128.119.245.12 | TCP      | 66     | 54440 → 80 [SYN] Seq |
| 1463 | 4.814223 | 10.39.17.251 | 10.3.0.4       | TLSv1.2  | 800    | Application Data     |
| 1464 | 4.815833 | 10.3.0.4     | 10.39.17.251   | TLSv1.2  | 98     | Application Data     |
| 1465 | 4.815964 | 10.3.0.4     | 10.39.17.251   | TLSv1.2  | 96     | Application Data     |
| 1466 | 4.815984 | 10.39.17.251 | 10.3.0.4       | TCP      | 54     | 22443 → 52650 [ACK]  |
| 1467 | 4.816993 | 10.39.17.251 | 10.3.0.4       | TLSv1.2  | 94     | Application Data     |
| 1468 | 4.827738 | 10.3.0.4     | 10.39.17.251   | TCP      | 60     | 52650 → 22443 [ACK]  |

Frame 1462: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface 0

Ethernet II, Src: VMware\_a5:95:a9 (00:50:56:a5:95:a9), Dst: 10.39.17.251 (08:00:27:11:fb:80)

Internet Protocol Version 4, Src: 10.39.17.251, Dst: 128.119.245.12

Transmission Control Protocol, Src Port: 54440, Dst Port: 80

[Stream index: 2]

[Stream Packet Number: 1]

[Conversation completeness: Incomplete, DATA]

[TCP Segment Len: 0]

Sequence Number: 0 (relative sequence number)

Sequence Number (raw): 3507466404

0000 04 f9 38 9b 52 f2 00 50 56 a5 95 a9 08 00 45

0010 00 34 3b 91 40 00 80 06 00 00 0a 27 11 fb 80

0020 f5 0c d4 a8 00 50 d1 0f b0 a4 00 00 00 00 80

0030 fa f0 91 cc 00 00 02 04 05 b4 01 03 03 08 01

0040 04 02

Destination Port (tcp.dstport), 2 byte(s) | Packets: 2822 · Displayed: 2785 (98.7%) · Dropped: 0 (0.0%) | Profile: Default

2

IP dest: 128.119.245.12

Source port: 80

3

Mesmo que na 1.

4

Syn bit = 1

Seq nº = 0

5

Ack = 1 (houve um incremento no seq nº)

Seq nº = 0

6

Seq nº = 1

7

| # | Seq Number | Tempo de envio (s) | Próx. ACK esperado | Tempo do ACK (estimado) | RTT (s) |
|---|------------|--------------------|--------------------|-------------------------|---------|
| 1 | 152578     | 3.416831           | 154038             | 3.525749                | 0.1089  |
| 2 | 154038     | 3.417566           | 155498             | 3.530351                | 0.1128  |
| 3 | 155498     | 3.417566           | 156958             | 3.531622                | 0.1141  |
| 4 | 156958     | 3.417566           | 158418             | 3.531622                | 0.1141  |
| 5 | 158418     | 3.417566           | 159878             | 3.531622                | 0.1141  |
| 6 | 159878     | 3.417566           | 161338             | 3.531622                | 0.1141  |

```
EstimatedRTT = (1 - α) * EstimatedRTT_anterior + α * SampleRTT
α = 0.125
```

## 8

O primeiro segmento TCP (com o HTTP POST) tem 737 bytes de payload.

Os cinco seguintes tem o valor padrão de 1460 bytes, que é o Maximum Segment Size (MSS) para redes Ethernet típicas.

| Segmento | Número de Sequência | Comprimento TCP |
|----------|---------------------|-----------------|
| 1 (POST) | 152578              | 737 bytes       |
| 2        | 153315              | 1460 bytes      |
| 3        | 154775              | 1460 bytes      |
| 4        | 156235              | 1460 bytes      |
| 5        | 157695              | 1460 bytes      |
| 6        | 159155              | 1460 bytes      |

|     |          |              |                |     |      |            |  |
|-----|----------|--------------|----------------|-----|------|------------|--|
| 272 | 3.308734 | 10.20.75.128 | 128.119.245.12 | TCP | 66   | 50466 → 80 | [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=256 SACK_PERM                      |
| 273 | 3.309049 | 10.20.75.128 | 128.119.245.12 | TCP | 66   | 50467 → 80 | [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=256 SACK_PERM                      |
| 308 | 3.416798 | 10.20.75.128 | 128.119.245.12 | TCP | 54   | 50466 → 80 | [ACK] Seq=1 Ack=1 Win=65280 Len=0  |
| 309 | 3.416831 | 10.20.75.128 | 128.119.245.12 | TCP | 54   | 50467 → 80 | [ACK] Seq=1 Ack=1 Win=65280 Len=0  |
| 310 | 3.417300 | 10.20.75.128 | 128.119.245.12 | TCP | 791  | 50467 → 80 | [PSH, ACK] Seq=1 Ack=1 Win=65280 Len=737 [TCP PDU reassembled in 499]      |
| 311 | 3.417566 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=738 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]        |
| 312 | 3.417566 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=2198 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]       |
| 313 | 3.417566 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=3658 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]       |
| 314 | 3.417566 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=5118 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]       |
| 315 | 3.417566 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=6578 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]       |
| 316 | 3.417566 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=8038 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]       |
| 317 | 3.417566 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=9498 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]       |
| 318 | 3.417566 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=10958 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]      |
| 319 | 3.417566 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=12418 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]      |
| 333 | 3.525749 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=13878 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]      |
| 335 | 3.530351 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=15338 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]      |
| 336 | 3.530351 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [PSH, ACK] Seq=16798 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499] |
| 340 | 3.531622 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=18258 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]      |
| 341 | 3.531622 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=19718 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]      |
| 342 | 3.531622 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=21178 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]      |
| 343 | 3.531622 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=22638 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]      |
| 344 | 3.531622 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=24098 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]      |
| 345 | 3.531622 | 10.20.75.128 | 128.119.245.12 | TCP | 1514 | 50467 → 80 | [ACK] Seq=25558 Ack=1 Win=65280 Len=1460 [TCP PDU reassembled in 499]      |

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O espaço mínimo de buffer anunciado foi: 65280 bytes.

A janela nunca foi reduzida para zero, nem para um valor muito pequeno.

Conclusão: O emissor nunca foi travado (throttled) por falta de espaço no buffer do recetor.

| No. | Time     | Source          | Destination    | Protocol | Length | Info   |
|-----|----------|-----------------|----------------|----------|--------|--|
| 99  | 1.167283 | 142.250.184.164 | 10.20.75.128   | TCP      | 6      | Packet length (bytes) [ ] Seq=1 Ack=2 Win=1027 Len=0 SLE=1 SRE=2 |
| 206 | 2.754894 | 10.20.75.128    | 142.250.184.10 | TCP      | 55     | 50300 → 443 [ACK] Seq=1 Ack=1 Win=252 Len=1                      |
| 210 | 2.774767 | 142.250.184.10  | 10.20.75.128   | TCP      | 66     | 443 → 50300 [ACK] Seq=1 Ack=2 Win=1035 Len=0 SLE=1 SRE=2         |
| 227 | 2.972496 | 10.20.75.128    | 35.190.80.1    | TCP      | 55     | 50312 → 443 [ACK] Seq=1 Ack=1 Win=251 Len=1                      |
| 228 | 2.992049 | 35.190.80.1     | 10.20.75.128   | TCP      | 66     | 443 → 50312 [ACK] Seq=1 Ack=2 Win=1044 Len=0 SLE=1 SRE=2         |
| 252 | 3.207275 | 10.20.75.128    | 142.250.200.78 | TCP      | 55     | 50302 → 443 [ACK] Seq=1 Ack=1 Win=255 Len=1                      |
| 253 | 3.225656 | 142.250.200.78  | 10.20.75.128   | TCP      | 66     | 443 → 50302 [ACK] Seq=1 Ack=2 Win=1031 Len=0 SLE=1 SRE=2         |
| 263 | 3.304395 | 10.20.75.128    | 142.250.201.74 | TLSv1.2  | 119    | Application Data   |
| 264 | 3.304448 | 10.20.75.128    | 142.250.201.74 | TLSv1.2  | 93     | Application Data   |
| 265 | 3.304462 | 10.20.75.128    | 142.250.201.74 | TLSv1.2  | 195    | Application Data   |
| 272 | 3.308734 | 10.20.75.128    | 128.119.245.12 | TCP      | 66     | 50466 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=256 SACK_PERM |
| 273 | 3.309049 | 10.20.75.128    | 128.119.245.12 | TCP      | 66     | 50467 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=256 SACK_PERM |
| 274 | 3.320735 | 142.250.201.74  | 10.20.75.128   | TCP      | 60     | 443 → 50303 [ACK] Seq=1 Ack=66 Win=1050 Len=0                    |
| 275 | 3.320735 | 142.250.201.74  | 10.20.75.128   | TCP      | 60     | 443 → 50303 [ACK] Seq=1 Ack=105 Win=1050 Len=0                   |
| 276 | 3.320735 | 142.250.201.74  | 10.20.75.128   | TCP      | 60     | 443 → 50303 [ACK] Seq=1 Ack=246 Win=1050 Len=0                   |
| 277 | 3.320735 | 142.250.201.74  | 10.20.75.128   | TLSv1.2  | 93     | Application Data   |
| 278 | 3.365660 | 10.20.75.128    | 142.250.201.74 | TCP      | 54     | 50303 → 443 [ACK] Seq=246 Ack=40 Win=253 Len=0                   |
| 290 | 3.383364 | 142.250.201.74  | 10.20.75.128   | TLSv1.2  | 127    | Application Data   |
| 291 | 3.383364 | 142.250.201.74  | 10.20.75.128   | TLSv1.2  | 560    | Application Data   |
| 292 | 3.383364 | 142.250.201.74  | 10.20.75.128   | TLSv1.2  | 85     | Application Data   |
| 293 | 3.383364 | 142.250.201.74  | 10.20.75.128   | TLSv1.2  | 93     | Application Data   |
| 294 | 3.383487 | 10.20.75.128    | 142.250.201.74 | TCP      | 54     | 50303 → 443 [ACK] Seq=246 Ack=689 Win=250 Len=0                  |
| 295 | 3.384682 | 10.20.75.128    | 142.250.201.74 | TLSv1.2  | 89     | Application Data   |

Com essa imagem confirmamos mesmo que nenhum dos pacotes mostra Window size value=0

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| tcp.analysis.retransmission |      |        |             |
|-----------------------------|------|--------|-------------|
| No.                         | Time | Source | Destination |
|                             |      |        |             |

Verificação feita com o filtro: tcp.analysis.retransmission

Resultado: Não foram encontradas retransmissões nos pacotes capturados.

Conclusão: Todos os segmentos TCP foram entregues com sucesso, sem necessidade de reenviar

## 11

| No. | Time     | Source         | Destination  | Protocol | Length | Info  |
|-----|----------|----------------|--------------|----------|--------|---|
| 302 | 3.416603 | 128.119.245.12 | 10.20.75.128 | TCP      | 66     | 80 → 50466 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM WS=128 |
| 303 | 3.416603 | 128.119.245.12 | 10.20.75.128 | TCP      | 66     | 80 → 50467 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM WS=128 |
| 332 | 3.525656 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=738 Win=30720 Len=0                              |
| 334 | 3.530901 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=2198 Win=33664 Len=0                             |
| 337 | 3.531564 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=3658 Win=36608 Len=0                             |
| 338 | 3.531564 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=5118 Win=39552 Len=0                             |
| 339 | 3.531564 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=6578 Win=42368 Len=0                             |
| 346 | 3.556225 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=8038 Win=45312 Len=0                             |
| 347 | 3.556225 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=9498 Win=48256 Len=0                             |
| 348 | 3.556225 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=10958 Win=51200 Len=0                            |
| 349 | 3.556225 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=12418 Win=54144 Len=0                            |
| 350 | 3.556225 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=13878 Win=56960 Len=0                            |
| 369 | 3.639458 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=15338 Win=59904 Len=0                            |
| 372 | 3.639741 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=16798 Win=62848 Len=0                            |
| 375 | 3.646213 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=18258 Win=65792 Len=0                            |
| 376 | 3.646213 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=19718 Win=68736 Len=0                            |
| 381 | 3.650307 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=21178 Win=71680 Len=0                            |
| 382 | 3.650307 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=22638 Win=74496 Len=0                            |
| 387 | 3.665960 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=24098 Win=77440 Len=0                            |
| 388 | 3.665960 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=25558 Win=80384 Len=0                            |
| 389 | 3.665960 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=27018 Win=83328 Len=0                            |
| 390 | 3.665960 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=28478 Win=86272 Len=0                            |
| 399 | 3.671951 | 128.119.245.12 | 10.20.75.128 | TCP      | 60     | 80 → 50467 [ACK] Seq=1 Ack=29938 Win=89088 Len=0                            |

Os Ack Numbers estão a subir de forma constante

O recetor confirma 1460 bytes por ACK, ou seja, um segmento de cada vez.

Não existem casos em que o recetor envia ACKs para dois segmentos de cada vez (2920 bytes).

Isso indica que o recetor está a usar um comportamento de ACK por segmento, típico em redes estáveis e rápidas.

## 12

Throughput = Total de dados transferidos / Tempo total da transferência

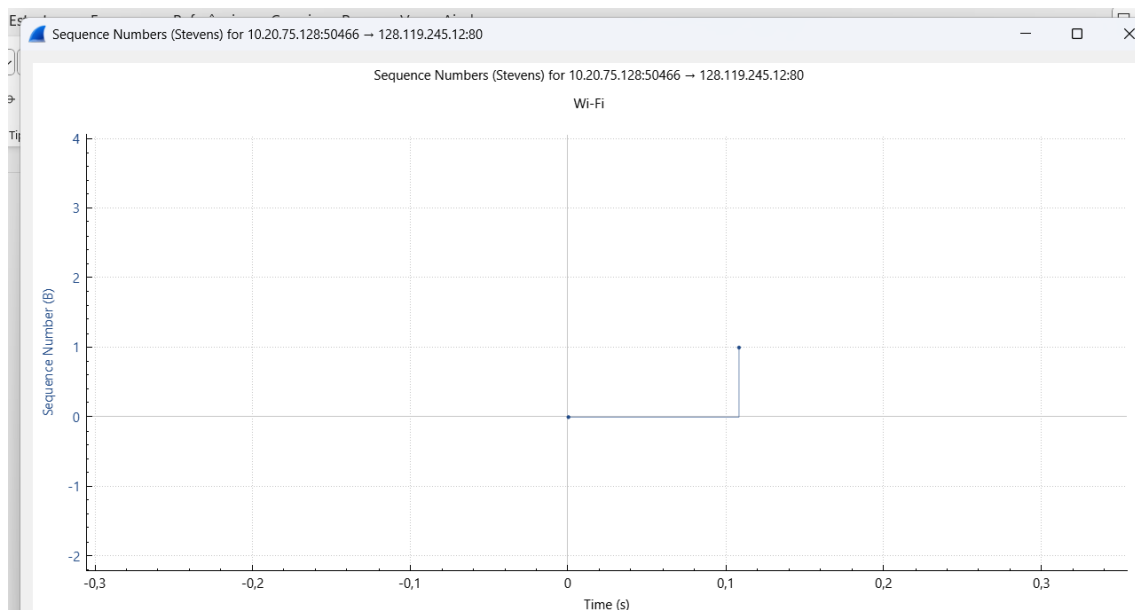
Total de dados transferidos = 29938 - 152578 = 1460 \* 10 = 14.600 bytes

## 13

Na minha própria captura, o gráfico “Time-Sequence Graph (Stevens)” não apresentou dados suficientes para observar claramente as fases de slow start e congestion avoidance.

Isso pode ter acontecido porque:

- A captura foi demasiado curta.
- Ou nem todos os pacotes foram capturados no início ou fim da transmissão.



## 14

Mesmo sem um gráfico visível, a análise dos segmentos enviados e reconhecidos indica que o TCP iniciou com slow start, enviando pacotes em ritmo acelerado, e depois entrou na fase de congestion avoidance, com ritmo de envio estabilizado e constante — em conformidade com o comportamento esperado do TCP