Laboratório V - Programação com soquetes TCP

Redes de Comunicação de Dados

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Com base nos códigos para Matlab de modelo cliente-servidor, obteve-se os resultados mostrados nas figuras abaixo com o auxílio de 2 computadores, um sendo cliente e outro servidor. Neste caso, o IP do servidor foi *192.168.139.252* e do cliente *192.168.138.46*. Utilizou-se a ferramenta Wireshark para a descoberta das informações da mensagem, endereço e protocolo utilizado (TCP).

Figura 1 - Transmissão de dados do servidor para o cliente.

Figura 2 - Transmissão do ACK para o servidor.

```
 1491 9.678440     192.168.139.252     192.168.138.46     TCP     66 3000 → 2051 [SYN, ACK] Seq=0 Ack=1 Win=8192 Len=0 MSS=1460 WS=256 SACK_PERM=1
▷ Frame 1491: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface 0
◢ Ethernet II, Src: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a), Dst: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
  ◢ Destination: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
      Address: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
      .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
      .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
  ◢ Source: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
      Address: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
      .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
      .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: IPv4 (0x0800)
◢ Internet Protocol Version 4, Src: 192.168.139.252, Dst: 192.168.138.46
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  ▷ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 52
    Identification: 0x27a8 (10152)
  ▷ Flags: 0x02 (Don't Fragment)
    Fragment offset: 0
    Time to live: 64
    Protocol: TCP (6)
    Header checksum: 0x7ba0 [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.139.252
    Destination: 192.168.138.46
    [Source GeoIP: Unknown]
    [Destination GeoIP: Unknown]
◢ Transmission Control Protocol, Src Port: 3000, Dst Port: 2051, Seq: 0, Ack: 1, Len: 0
    Source Port: 3000
    Destination Port: 2051
    [Stream index: 4]
    [TCP Segment Len: 0]
    Sequence number: 0    (relative sequence number)
    Acknowledgment number: 1    (relative ack number)
    1000 .... = Header Length: 32 bytes (8)
  ▷ Flags: 0x012 (SYN, ACK)
    Window size value: 8192
    [Calculated window size: 8192]
    Checksum: 0x402b [unverified]
    [Checksum Status: Unverified]
    Urgent pointer: 0
  ▷ Options: (12 bytes), Maximum segment size, No-Operation (NOP), Window scale, No-Operation (NOP), No-Operation (NOP), SACK permitted
  ▷ [SEQ/ACK analysis]
```

Figura 3 - Informações do primeiro pacote enviado para o cliente.

```
 1493 9.682001     192.168.139.252     192.168.138.46     TCP     55 3000 → 2051 [PSH, ACK] Seq=1 Ack=1 Win=65536 Len=1
▷ Frame 1493: 55 bytes on wire (440 bits), 55 bytes captured (440 bits) on interface 0
◢ Ethernet II, Src: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a), Dst: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
  ◢ Destination: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
      Address: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
      .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
      .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
  ◢ Source: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
      Address: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
      .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
      .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: IPv4 (0x0800)
◢ Internet Protocol Version 4, Src: 192.168.139.252, Dst: 192.168.138.46
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  ▷ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 41
    Identification: 0x27a9 (10153)
  ▷ Flags: 0x02 (Don't Fragment)
    Fragment offset: 0
    Time to live: 64
    Protocol: TCP (6)
    Header checksum: 0x7baa [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.139.252
    Destination: 192.168.138.46
    [Source GeoIP: Unknown]
    [Destination GeoIP: Unknown]
◢ Transmission Control Protocol, Src Port: 3000, Dst Port: 2051, Seq: 1, Ack: 1, Len: 1
    Source Port: 3000
    Destination Port: 2051
    [Stream index: 4]
    [TCP Segment Len: 1]
    Sequence number: 1    (relative sequence number)
    [Next sequence number: 2    (relative sequence number)]
    Acknowledgment number: 1    (relative ack number)
    0101 .... = Header Length: 20 bytes (5)
  ▷ Flags: 0x018 (PSH, ACK)
    Window size value: 256
    [Calculated window size: 65536]
    [Window size scaling factor: 256]
    Checksum: 0x9df5 [unverified]
    [Checksum Status: Unverified]
    Urgent pointer: 0
  ▷ [SEQ/ACK analysis]
    TCP payload (1 byte)
◢ Data (1 byte)
    Data: 02
    [Length: 1]
```

Figura 4 - Informações do segundo pacote de dados enviado para o cliente.

1495 9.691302   192.168.139.252   192.168.138.46   TCP   1053 3000 → 2051 [FIN, PSH, ACK] Seq=2 Ack=1 Win=65536 Len=999

▷ Frame 1495: 1053 bytes on wire (8424 bits), 1053 bytes captured (8424 bits) on interface 0
◢ Ethernet II, Src: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a), Dst: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
    ◢ Destination: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
        Address: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
        .... ..0. .... = LG bit: Globally unique address (factory default)
        ....0 .... = IG bit: Individual address (unicast)
    ◢ Source: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
        Address: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
        .... ..0. .... = LG bit: Globally unique address (factory default)
        ....0 .... = IG bit: Individual address (unicast)
    Type: IPv4 (0x0800)
◢ Internet Protocol Version 4, Src: 192.168.139.252, Dst: 192.168.138.46
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
    ▷ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 1039
    Identification: 0x27aa (10154)
    ▷ Flags: 0x02 (Don't Fragment)
    Fragment offset: 0
    Time to live: 64
    Protocol: TCP (6)
    Header checksum: 0x77c3 [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.139.252
    Destination: 192.168.138.46
    [Source GeoIP: Unknown]
    [Destination GeoIP: Unknown]
◢ Transmission Control Protocol, Src Port: 3000, Dst Port: 2051, Seq: 2, Ack: 1, Len: 999
    Source Port: 3000
    Destination Port: 2051
    [Stream index: 4]
    [TCP Segment Len: 999]
    Sequence number: 2   (relative sequence number)
    [Next sequence number: 1002   (relative sequence number)]
    Acknowledgment number: 1   (relative ack number)
    0101 .... = Header Length: 20 bytes (5)
    ▷ Flags: 0x019 (FIN, PSH, ACK)
    Window size value: 256
    [Calculated window size: 65536]
    [Window size scaling factor: 256]
    Checksum: 0x4cb4 [unverified]
    [Checksum Status: Unverified]
    Urgent pointer: 0
    ▷ [SEQ/ACK analysis]
    TCP payload (999 bytes)
◢ Data (999 bytes)
    Data: 030405060708090a0b0c0d0e0f101112131415161718191a...
    [Length: 999]

Figura 5 - Informações do terceiro pacote de dados enviado para o cliente.

1571 10.209958   192.168.139.252   192.168.138.46   TCP   54 3000 → 2051 [ACK] Seq=1002 Ack=2 Win=65536 Len=0

▷ Frame 1495: 1053 bytes on wire (8424 bits), 1053 bytes captured (8424 bits) on interface 0
◢ Ethernet II, Src: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a), Dst: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
    ◢ Destination: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
        Address: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
        .... ..0. .... = LG bit: Globally unique address (factory default)
        ....0 .... = IG bit: Individual address (unicast)
    ◢ Source: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
        Address: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
        .... ..0. .... = LG bit: Globally unique address (factory default)
        ....0 .... = IG bit: Individual address (unicast)
    Type: IPv4 (0x0800)
◢ Internet Protocol Version 4, Src: 192.168.139.252, Dst: 192.168.138.46
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
    ▷ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 1039
    Identification: 0x27aa (10154)
    ▷ Flags: 0x02 (Don't Fragment)
    Fragment offset: 0
    Time to live: 64
    Protocol: TCP (6)
    Header checksum: 0x77c3 [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.139.252
    Destination: 192.168.138.46
    [Source GeoIP: Unknown]
    [Destination GeoIP: Unknown]
◢ Transmission Control Protocol, Src Port: 3000, Dst Port: 2051, Seq: 2, Ack: 1, Len: 999
    Source Port: 3000
    Destination Port: 2051
    [Stream index: 4]
    [TCP Segment Len: 999]
    Sequence number: 2   (relative sequence number)
    [Next sequence number: 1002   (relative sequence number)]
    Acknowledgment number: 1   (relative ack number)
    0101 .... = Header Length: 20 bytes (5)
    ▷ Flags: 0x019 (FIN, PSH, ACK)
    Window size value: 256
    [Calculated window size: 65536]
    [Window size scaling factor: 256]
    Checksum: 0x4cb4 [unverified]
    [Checksum Status: Unverified]
    Urgent pointer: 0
    ▷ [SEQ/ACK analysis]
    TCP payload (999 bytes)
◢ Data (999 bytes)
    Data: 030405060708090a0b0c0d0e0f101112131415161718191a...
    [Length: 999]

Figura 6 - Informações do quarto pacote de dados enviados para o cliente.

```
  1113 6.688816    192.168.138.46    192.168.139.252    TCP    66 2051 → 3000 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=256 SACK PERM=1
```

```
▷ Frame 1113: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface 0
▲ Ethernet II, Src: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09), Dst: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
    ▲ Destination: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
        Address: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    ▲ Source: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
        Address: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
      Type: IPv4 (0x0800)
▲ Internet Protocol Version 4, Src: 192.168.138.46, Dst: 192.168.139.252
      0100 .... = Version: 4
      .... 0101 = Header Length: 20 bytes (5)
    ▷ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
      Total Length: 52
      Identification: 0x4312 (17170)
    ▷ Flags: 0x02 (Don't Fragment)
      Fragment offset: 0
      Time to live: 64
      Protocol: TCP (6)
      Header checksum: 0x6036 [validation disabled]
      [Header checksum status: Unverified]
      Source: 192.168.138.46
      Destination: 192.168.139.252
      [Source GeoIP: Unknown]
      [Destination GeoIP: Unknown]
▲ Transmission Control Protocol, Src Port: 2051, Dst Port: 3000, Seq: 0, Len: 0
      Source Port: 2051
      Destination Port: 3000
      [Stream index: 4]
      [TCP Segment Len: 0]
      Sequence number: 0    (relative sequence number)
      Acknowledgment number: 0
      1000 .... = Header Length: 32 bytes (8)
    ▷ Flags: 0x002 (SYN)
      Window size value: 8192
      [Calculated window size: 8192]
      Checksum: 0x5f4a [unverified]
      [Checksum Status: Unverified]
      Urgent pointer: 0
    ▷ Options: (12 bytes), Maximum segment size, No-Operation (NOP), Window scale, No-Operation (NOP), No-Operation (NOP), SACK permitted
```

Figura 7 - Informações da primeira confirmação enviada do cliente.

```
  1490 9.678164    192.168.138.46    192.168.139.252    TCP    66 [TCP Retransmission] 2051 → 3000 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=256 SACK PERM=1
```

```
▷ Frame 1490: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface 0
▲ Ethernet II, Src: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09), Dst: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
    ▲ Destination: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
        Address: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    ▲ Source: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
        Address: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
      Type: IPv4 (0x0800)
▲ Internet Protocol Version 4, Src: 192.168.138.46, Dst: 192.168.139.252
      0100 .... = Version: 4
      .... 0101 = Header Length: 20 bytes (5)
    ▷ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
      Total Length: 52
      Identification: 0x4319 (17177)
    ▷ Flags: 0x02 (Don't Fragment)
      Fragment offset: 0
      Time to live: 64
      Protocol: TCP (6)
      Header checksum: 0x602f [validation disabled]
      [Header checksum status: Unverified]
      Source: 192.168.138.46
      Destination: 192.168.139.252
      [Source GeoIP: Unknown]
      [Destination GeoIP: Unknown]
▲ Transmission Control Protocol, Src Port: 2051, Dst Port: 3000, Seq: 0, Len: 0
      Source Port: 2051
      Destination Port: 3000
      [Stream index: 4]
      [TCP Segment Len: 0]
      Sequence number: 0    (relative sequence number)
      Acknowledgment number: 0
      1000 .... = Header Length: 32 bytes (8)
    ▷ Flags: 0x002 (SYN)
      Window size value: 8192
      [Calculated window size: 8192]
      Checksum: 0x5f4a [unverified]
      [Checksum Status: Unverified]
      Urgent pointer: 0
    ▷ Options: (12 bytes), Maximum segment size, No-Operation (NOP), Window scale, No-Operation (NOP), No-Operation (NOP), SACK permitted
    ▷ [SEQ/ACK analysis]
```

Figura 8 - Informações da segunda confirmação enviada do cliente.

```
▷ Frame 1492: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0
◢ Ethernet II, Src: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09), Dst: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
    ◢ Destination: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
        Address: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    ◢ Source: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
        Address: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: IPv4 (0x0800)
    Padding: 000000000000
◢ Internet Protocol Version 4, Src: 192.168.138.46, Dst: 192.168.139.252
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
    ▷ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 40
    Identification: 0x431a (17178)
    ▷ Flags: 0x02 (Don't Fragment)
    Fragment offset: 0
    Time to live: 64
    Protocol: TCP (6)
    Header checksum: 0x603a [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.138.46
    Destination: 192.168.139.252
    [Source GeoIP: Unknown]
    [Destination GeoIP: Unknown]
◢ Transmission Control Protocol, Src Port: 2051, Dst Port: 3000, Seq: 1, Ack: 1, Len: 0
    Source Port: 2051
    Destination Port: 3000
    [Stream index: 4]
    [TCP Segment Len: 0]
    Sequence number: 1    (relative sequence number)
    Acknowledgment number: 1    (relative ack number)
    0101 .... = Header Length: 20 bytes (5)
    ▷ Flags: 0x010 (ACK)
    Window size value: 256
    [Calculated window size: 65536]
    [Window size scaling factor: 256]
    Checksum: 0x9ffe [unverified]
    [Checksum Status: Unverified]
    Urgent pointer: 0
    ▷ [SEQ/ACK analysis]
```

Figura 9 - Informações da terceira confirmação enviada do cliente.

```
▷ Frame 1496: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0
◢ Ethernet II, Src: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09), Dst: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
    ◢ Destination: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
        Address: HewlettP_00:d7:0a (c8:d3:ff:00:d7:0a)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    ◢ Source: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
        Address: HewlettP_00:d7:09 (c8:d3:ff:00:d7:09)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: IPv4 (0x0800)
    Padding: 000000000000
◢ Internet Protocol Version 4, Src: 192.168.138.46, Dst: 192.168.139.252
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
    ▷ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 40
    Identification: 0x431b (17179)
    ▷ Flags: 0x02 (Don't Fragment)
    Fragment offset: 0
    Time to live: 64
    Protocol: TCP (6)
    Header checksum: 0x6039 [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.138.46
    Destination: 192.168.139.252
    [Source GeoIP: Unknown]
    [Destination GeoIP: Unknown]
◢ Transmission Control Protocol, Src Port: 2051, Dst Port: 3000, Seq: 1, Ack: 1002, Len: 0
    Source Port: 2051
    Destination Port: 3000
    [Stream index: 4]
    [TCP Segment Len: 0]
    Sequence number: 1    (relative sequence number)
    Acknowledgment number: 1002    (relative ack number)
    0101 .... = Header Length: 20 bytes (5)
    ▷ Flags: 0x010 (ACK)
    Window size value: 252
    [Calculated window size: 64512]
    [Window size scaling factor: 256]
    Checksum: 0x9c19 [unverified]
    [Checksum Status: Unverified]
    Urgent pointer: 0
    ▷ [SEQ/ACK analysis]
```

Figura 10 - Informações da quarta confirmação enviada do cliente.

Figura 11 – *Mensagem trocada*.