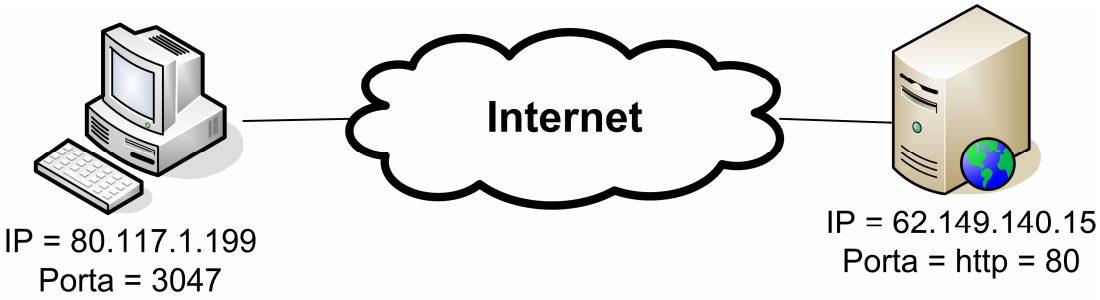
Apertura e chiusura di una connessione TCP

Struttura della rete



- Il client TCP è il browser Firefox 1.0.4, su Windows XP SP1
- Il server TCP è l'webserver di www.google.it

Setup della connessione

Nella fase di setup, il client TCP con indirizzo IP 80.117.199 e porta 3047, manda un messaggio di SYNchronize al server web che accetta connessioni sulla porta 80 (nel pacchetto risolto come http). Si possono osservare alcune cose:

1. Solo il flag SYN è attivo. Il numero di sequenza riportato è *relativo* alla connessione, ovvero è lo 0-esimo pacchetto della connessione;
2. La dimensione della finestra di ricezione è di 65535 Byte (circa 64 KByte);
3. Viene notificato al ricevitore che il MSS è di 1440;
4. Lo stack TCP/IP di Windows XP supporta TCP SACK (*Selective ACKnowledge*), che permette di richiedere ACK selettivi.

```
No.     Time        Source                Destination           Protocol Info
      1 0.000000    80.117.1.199          62.149.140.15         TCP      3047 > http [SYN] Seq=0
Ack=0 Win=65535 Len=0 MSS=1440

Frame 1 (62 bytes on wire, 62 bytes captured)
Ethernet II, Src: 00:00:01:00:00:00, Dst: e8:ec:20:00:01:00
Internet Protocol, Src Addr: 80.117.1.199 (80.117.1.199), Dst Addr: 62.149.140.15 (62.149.140.15)
Transmission Control Protocol, Src Port: 3047 (3047), Dst Port: http (80), Seq: 0, Ack: 0, Len: 0
    Source port: 3047 (3047)
    Destination port: http (80)
    Sequence number: 0    (relative sequence number)
    Header length: 28 bytes
    Flags: 0x0002 (SYN)
        0... .... = Congestion Window Reduced (CWR): Not set
        .0.. .... = ECN-Echo: Not set
        ..0. .... = Urgent: Not set
        ...0 .... = Acknowledgment: Not set
        .... 0... = Push: Not set
        .... .0.. = Reset: Not set
        .... ..1. = Syn: Set
        .... ...0 = Fin: Not set
    Window size: 65535
    Checksum: 0x73d2 (correct)
    Options: (8 bytes)
        Maximum segment size: 1440 bytes
        NOP
        NOP
        SACK permitted
```

Il ricevitore risponde con un messaggio di SYN/ACK, in cui accetta la connessione e a sua volte ne propone una al client. In questo caso la finestra di ricezione è più piccola, solo 5840 byte, probabilmente perché l'host è in un momento di grande carico.

La dimensione dell'MSS in questo caso è 1460, ovvero 1500 (dimensione massima del payload della trama Ethernet, dove viaggiano incapsulati i pacchetti IP) meno 20 byte dell'header IP, meno 20 byte dell'header TCP.
Anche il server accetta TCP SACK.

```
No.     Time        Source                Destination           Protocol Info
      2 0.093750    62.149.140.15         80.117.1.199          TCP      http > 3047 [SYN, ACK]
Seq=0 Ack=1 Win=5840 Len=0 MSS=1460

Frame 2 (62 bytes on wire, 62 bytes captured)
Ethernet II, Src: e8:ec:20:00:01:00, Dst: 00:00:01:00:00:00
Internet Protocol, Src Addr: 62.149.140.15 (62.149.140.15), Dst Addr: 80.117.1.199 (80.117.1.199)
Transmission Control Protocol, Src Port: http (80), Dst Port: 3047 (3047), Seq: 0, Ack: 1, Len: 0
    Source port: http (80)
    Destination port: 3047 (3047)
    Sequence number: 0    (relative sequence number)
    Acknowledgement number: 1    (relative ack number)
    Header length: 28 bytes
    Flags: 0x0012 (SYN, ACK)
        0... .... = Congestion Window Reduced (CWR): Not set
        .0.. .... = ECN-Echo: Not set
        ..0. .... = Urgent: Not set
        ...1 .... = Acknowledgment: Set
        .... 0... = Push: Not set
        .... .0.. = Reset: Not set
        .... ..1. = Syn: Set
        .... ...0 = Fin: Not set
    Window size: 5840
    Checksum: 0xc1f9 (correct)
    Options: (8 bytes)
        Maximum segment size: 1460 bytes
        NOP
        NOP
        SACK permitted
    SEQ/ACK analysis
        This is an ACK to the segment in frame: 1
        The RTT to ACK the segment was: 0.093750000 seconds

No.     Time        Source                Destination           Protocol Info
      3 0.093750    80.117.1.199          62.149.140.15         TCP      3047 > http [ACK] Seq=1
Ack=1 Win=65535 Len=0
```

Il client manda un ACK di conferma al server. Si può notare che ora il *Sequence Number* è uguale a 1, come l'*Acknowledgement Number*.
In questo primo segmento non vengono inviati dati, anche se nulla lo vieterebbe.

```
Frame 3 (54 bytes on wire, 54 bytes captured)
Ethernet II, Src: 00:00:01:00:00:00, Dst: e8:ec:20:00:01:00
Internet Protocol, Src Addr: 80.117.1.199 (80.117.1.199), Dst Addr: 62.149.140.15 (62.149.140.15)
Transmission Control Protocol, Src Port: 3047 (3047), Dst Port: http (80), Seq: 1, Ack: 1, Len: 0
    Source port: 3047 (3047)
    Destination port: http (80)
    Sequence number: 1    (relative sequence number)
    Acknowledgement number: 1    (relative ack number)
    Header length: 20 bytes
    Flags: 0x0010 (ACK)
        0... .... = Congestion Window Reduced (CWR): Not set
        .0.. .... = ECN-Echo: Not set
        ..0. .... = Urgent: Not set
        ...1 .... = Acknowledgment: Set
        .... 0... = Push: Not set
        .... .0.. = Reset: Not set
        .... ..0. = Syn: Not set
        .... ...0 = Fin: Not set
    Window size: 65535
    Checksum: 0x058e (correct)
    SEQ/ACK analysis
        This is an ACK to the segment in frame: 2
```

Chiusura della connessione

Il server vuole ora chiudere la connessione. Per realizzare questo, invia un pacchetto al client con settata la flag FIN.

```
No.     Time        Source                Destination           Protocol Info
     79 17.921875   62.149.140.15         80.117.1.199          TCP      http > 3047 [FIN, ACK]
Seq=28042 Ack=2100 Win=9763 Len=0

Frame 79 (54 bytes on wire, 54 bytes captured)
Ethernet II, Src: e8:ec:20:00:01:00, Dst: 00:00:01:00:00:00
Internet Protocol, Src Addr: 62.149.140.15 (62.149.140.15), Dst Addr: 80.117.1.199 (80.117.1.199)
Transmission Control Protocol, Src Port: http (80), Dst Port: 3047 (3047), Seq: 28042, Ack: 2100,
Len: 0
    Source port: http (80)
    Destination port: 3047 (3047)
    Sequence number: 28042    (relative sequence number)
    Acknowledgement number: 2100    (relative ack number)
    Header length: 20 bytes
    Flags: 0x0011 (FIN, ACK)
        0... .... = Congestion Window Reduced (CWR): Not set
        .0.. .... = ECN-Echo: Not set
        ..0. .... = Urgent: Not set
        ...1 .... = Acknowledgment: Set
        .... 0... = Push: Not set
        .... .0.. = Reset: Not set
        .... ..0. = Syn: Not set
        .... ...1 = Fin: Set
    Window size: 9763
    Checksum: 0x69ad (correct)
```

Il ricevitore risponde con ACK e la connessione in un verso termina.
Nell'altra direzione la connessione rimane aperta, e il client può ancora inviare dati.

```
No.     Time        Source                Destination           Protocol Info
     80 17.921875   80.117.1.199          62.149.140.15         TCP      3047 > http [ACK] Seq=2100
Ack=28043 Win=65199 Len=0

Frame 80 (54 bytes on wire, 54 bytes captured)
Ethernet II, Src: 00:00:01:00:00:00, Dst: e8:ec:20:00:01:00
Internet Protocol, Src Addr: 80.117.1.199 (80.117.1.199), Dst Addr: 62.149.140.15 (62.149.140.15)
Transmission Control Protocol, Src Port: 3047 (3047), Dst Port: http (80), Seq: 2100, Ack: 28043,
Len: 0
    Source port: 3047 (3047)
    Destination port: http (80)
    Sequence number: 2100    (relative sequence number)
    Acknowledgement number: 28043    (relative ack number)
    Header length: 20 bytes
    Flags: 0x0010 (ACK)
        0... .... = Congestion Window Reduced (CWR): Not set
        .0.. .... = ECN-Echo: Not set
        ..0. .... = Urgent: Not set
        ...1 .... = Acknowledgment: Set
        .... 0... = Push: Not set
        .... .0.. = Reset: Not set
        .... ..0. = Syn: Not set
        .... ...0 = Fin: Not set
    Window size: 65199
    Checksum: 0x9120 (correct)
    SEQ/ACK analysis
        This is an ACK to the segment in frame: 79
```

Ora è il momento di terminare la connessione anche nell'altro verso: il client manda un segmento TCP con la flag FIN settata.

```
No.     Time        Source                Destination           Protocol Info
     83 24.921875   80.117.1.199          62.149.140.15         TCP      3047 > http [FIN, ACK]
Seq=2100 Ack=28043 Win=65199 Len=0

Frame 83 (54 bytes on wire, 54 bytes captured)
Ethernet II, Src: 00:00:01:00:00:00, Dst: e8:ec:20:00:01:00
Internet Protocol, Src Addr: 80.117.1.199 (80.117.1.199), Dst Addr: 62.149.140.15 (62.149.140.15)
Transmission Control Protocol, Src Port: 3047 (3047), Dst Port: http (80), Seq: 2100, Ack: 28043,
Len: 0
    Source port: 3047 (3047)
    Destination port: http (80)
    Sequence number: 2100    (relative sequence number)
    Acknowledgement number: 28043    (relative ack number)
    Header length: 20 bytes
    Flags: 0x0011 (FIN, ACK)
```

```
        0... .... = Congestion Window Reduced (CWR): Not set
        .0.. .... = ECN-Echo: Not set
        ..0. .... = Urgent: Not set
        ...1 .... = Acknowledgment: Set
        .... 0... = Push: Not set
        .... .0.. = Reset: Not set
        .... ..0. = Syn: Not set
        .... ...1 = Fin: Set
    Window size: 65199
    Checksum: 0x911f (correct)
```

Il server riscontra il pacchetto con un ACK e la connessione è definitivamente chiusa in entrambe le direzioni.

```
No.     Time        Source                Destination           Protocol Info
     86 25.031250   62.149.140.15         80.117.1.199          TCP      http > 3047 [ACK] Seq=28043
Ack=2101 Win=9763 Len=0

Frame 86 (54 bytes on wire, 54 bytes captured)
Ethernet II, Src: e8:ec:20:00:01:00, Dst: 00:00:01:00:00:00
Internet Protocol, Src Addr: 62.149.140.15 (62.149.140.15), Dst Addr: 80.117.1.199 (80.117.1.199)
Transmission Control Protocol, Src Port: http (80), Dst Port: 3047 (3047), Seq: 28043, Ack: 2101,
Len: 0
    Source port: http (80)
    Destination port: 3047 (3047)
    Sequence number: 28043    (relative sequence number)
    Acknowledgement number: 2101    (relative ack number)
    Header length: 20 bytes
    Flags: 0x0010 (ACK)
        0... .... = Congestion Window Reduced (CWR): Not set
        .0.. .... = ECN-Echo: Not set
        ..0. .... = Urgent: Not set
        ...1 .... = Acknowledgment: Set
        .... 0... = Push: Not set
        .... .0.. = Reset: Not set
        .... ..0. = Syn: Not set
        .... ...0 = Fin: Not set
    Window size: 9763
    Checksum: 0x69ac (correct)
    SEQ/ACK analysis
        This is an ACK to the segment in frame: 83
        The RTT to ACK the segment was: 0.109375000 seconds
```