Electrical and Information Technology

Communication and Networks

Problems Transport

2016

Problems

1. Describe the steps of the thre way handshake that initialises a TCP session. How many segments are sent? Which flags are set in the segments?

2. What happens if the cleint in a TCP session wants to end the session, but the server has more data to send? Which segments are sent and which flags are set in the segments?

3. Assume a TCP session has a sender window of size 10,000 byte. Last received ACK number is 20,001. The sender now receives a segment where the ACK number is 24,001. In reply the sender sends two segments, each with payload size set to 1,500 byte.

   (a) What is the sender window before reception of the latest ACK?

   (b) What is the sender window after reception of the latest ACK?

(c) What is the sender window after the transmission of the two last segments?

4. A UDP datagram has 16 byte data in the payload.

   (a) What is the efficiency for this UDP datagram?

   (b) Assume the UDP datagram is encapsulated in an IPv6 packet (no options). What is now the efficiency?

   (c) Now assume the IPv6 packet is encapsulated in en Ethernet II frame. What is now the efficiency?

5. A TCP segment has 16 byte data in the payload.

   (a) What is the efficiency for this TCP segment?

   (b) Assume the TCP segment is encapsulated in an IPv6 packet (no options). What is now the efficiency?

   (c) Now assume the IPv6 packet is encapsulated in en Ethernet II frame. What is now the efficiency?

6. The vector below shows a UDP header in hexadecimal form.
   {06 32 00 0d 00 1c e2 17}
   What is the

   (a) source port?

   (b) destination port?

   (c) total length of the datagram?

   (d) the payload length?

   (e) the direction of the transmission (from client to server or *vise versa*)?

7. The vector below shows a TCP header in hexadecimal form.
{00 53 00 17 00 00 00 01 00 00 00 00 50 02 07 ff 00 00 00 00}
What is the

   (a) source port?
   (b) destination port?
   (c) SEQ number?
   (d) ACK number?
   (e) header size?
   (f) type of segment?
   (g) window size?

8. Below are printouts from a number of consecutive Ethernet II frames containing TCP segments. Draw an event diagram/time chart with two time lines, one for each host, showing the frames as arrows For each frame specify

   (a) type of TCP segment.
   (b) TCP SEQ number.
   (c) TCP ACK number.
   (d) TCP window size.

   Frame 1:

```
0000:  00 00 0c 07 ac 01 00 08 - 74 41 af a7 08 00 45 00
0010:  00 30 88 14 40 00 80 06 - d5 dc 82 eb 12 bd 82 eb
0020:  84 43 09 93 00 17 f2 d2 - 7a 29 00 00 00 00 70 02
0030:  40 00 2f a2 00 00 02 04 - 05 b4 01 01 04 02
...
...
```

   Frame 2:

```
0000:  00 08 74 41 af a7 00 00 { 0c 07 ac 01 08 00 45 00
0010:  00 2c 53 3a 00 00 7e 06 - 4c bb 82 eb 84 43 82 eb
0020:  12 bd 00 17 09 93 a9 65 - ab 46 f2 d2 7a 2a 60 12
```

```
0030:  0b b8 24 38 00 00 02 04 - 05 b0 00 00
...
...
```

Frame 3:

```
0000:  00 00 0c 07 ac 01 00 08 - 74 41 af a7 08 00 45 00
0010:  00 28 88 15 40 00 80 06 - d5 e3 82 eb 12 bd 82 eb
0020:  84 43 09 93 00 17 f2 d2 - 7a 2a a9 65 ab 47 50 10
0030:  44 40 03 69 00 00 00 00 - 00 00 00 00
...
...
```

Frame 4:

```
0000:  00 08 74 41 af a7 00 00 { 0c 07 ac 01 08 00 45 00
0010:  00 2b 53 3b 00 00 7e 06 - 4c bb 82 eb 84 43 82 eb
0020:  12 bd 00 17 09 93 a9 65 - ab 47 f2 d2 7a 2a 50 18
0030:  0b b8 23 e8 00 00 ff fd - 18 00 00 00
...
...
```

Frame 5:

```
0000:  00 00 0c 07 ac 01 00 08 - 74 41 af a7 08 00 45 00
0010:  00 2e 88 16 40 00 80 06 - d5 dc 82 eb 12 bd 82 eb
0020:  84 43 09 93 00 17 f2 d2 - 7a 2a a9 65 ab 4a 50 18
0030:  44 3d ef 3f 00 00 ff fb - 18 ff fb 1f
...
...
```

Frame 6:

```
0000:  00 08 74 41 af a7 00 00 { 0c 07 ac 01 08 00 45 00
0010:  00 31 53 3c 00 00 7e 06 - 4c b4 82 eb 84 43 82 eb
0020:  12 bd 00 17 09 93 a9 65 - ab 4a f2 d2 7a 30 50 18
0030:  0b b8 04 eb 00 00 ff fa - 18 01 ff f0 ff fe 1f
...
...
```

9. Packets of 512 bytes payload are being sent over a 64-kbps channel. Derive the time to send 500 packets over

   (a) TCP

   (b) UDP

10. A network uses 128 bytes-segments. If there is a congestion window of 8 segments and with 300 bytes of unprocessed data, what is the size of the receive window?

11. Two hosts are communicating use a 5-KB receive window. A packet take 15ms to go from one host to the other. The receiver takes 2ms time to receive a packet and start sending the acknowledgment. What is the maximum data rate that can be achieved in this communication?

12. Someone posting to comp.protocols.tcp-ip complained about a throughput of 122kbps on a 256-kbps link with a 128ms round-trip delay between the United States and Sweden, and a throughput of 33kbps when the link was routed over a satellite with a 500ms round-trip delay.

    (a) What is the utilization over the two links?

    (b) What does the window size appear to be for the two cases?

    (c) How big should the window size be for the satellite link?

Solutions

1. Client send first segment where SYN is flag set. Server replies with a segment where SYN and ACK flags are sent. Session in direction from client to server is now open. Client sends segments where ACK flag is set. Session is now open in both directions.

2. Client send segment where FIN flag is set. Server answers with segment where ACK flag is set. Now the session from client to server is closed, but the other direction is still open. Server continues to send data. When all data is sent the server ends with a segment where the FIN flag is set which the cliente replies by sending a segment where the AC flag is set. Now also the direction from server to client is closed.

3. (a) The sender window contains byte 20,001 to 30,000.
   (b) The sender window contains byte 24,001 to 34,000.
   (c) The sender window contains byte 27,001 to 34,000.

4. (a) $16/(16+8)$
   (b) $16/(16+8+40)$
   (c) $16/(16+8+40+26)$

5. (a) $16/(16+20)$
   (b) $16/(16+20+40)$
   (c) $16/(16+20+40+26)$

6. (a) 0632_{16}
   (b) $000d_{16}$

(c) $001c_{16} = 44_{10}$

(d) $44 - 8 = 36$

(e) The destination port is 13_{10} so it can be assumed that this is directed from a client to a server. 13 is a well-known destination port for services, check e.g., *http://www.iana.org/assignments/service-names-port-numbers/service-names-port-numbers.xhtml*.

7. (a) 0053_{16}

(b) 0017_{16}

(c) 1

(d) 0

(e) The SYN flags is the only one set so this is the first segment of a TCP session.

(f) $07ff_{16} = 2047_{10}$

8. (a) Frame 1:From client to server

1. SYN
2. 0xf2d27a29
3. 0
4. 0x4000 = 16384

(b) Frame 2: From server to client

1. SYN+ACK
2. 0xa965ab46
3. 0xf2d27a2a
4. 0x0bb8 = 3000

(c) Frame 3: From client to server

1. ACK
2. 0xf2d27a2a
3. 0xa965ab47
4. 0x4440 = 17472

(d) Frame 4: From server to client
   1. ACK+PUSH
   2. 0xa965ab47
   3. 0xf2d27a2a
   4. 0x0bb8 = 3000

(e) Frame 5:From client to server
   1. ACK+PUSH
   2. 0xf2d27a2a
   3. 0xa965ab47
   4. 0x443d = 17469

(f) Frame 6: From server to client
   1. ACK+PUSH
   2. 0xa965ab4a
   3. 0xf2d27a30
   4. 0x0bb8 = 3000

9. (a) Total size of all packets the header of TCP= $500 \times (512 + 20) \times 8 = 2128000$ bits. Time required $= 2128000/64000 = 33.25$s.

   (b) Total size of all packets the header of TCP= $500 \times (512 + 8) \times 8 = 2080000$ bits. Time required $= 2080000/64000 = 32.5$s.

10. Segment size = 128 bytes. Size of the congestion window = 8 segments = $8 \times 128 = 1024$bytes. Size of the receiving window = 1500 bytes. Maximum size of data that a host can send is the minimum of the two window sizes mentioned above (in order to prevent the buffers from overflowing). Hence, maximum size of data = 1024 bytes.

11. Window size = 5KB = 40960 bits. Total time for round trip = Time to send packet + delay at receiver + Time to send acknowledgment = 15 + 2 + 15 = 32ms. Data rate $\leq$ TCP Window size/Round-trip time. Hence, maximum data rate $= 40960/(32 \times 10^{-3}) = 1280000$bps =1280 kbps.

12. (a) For the first case, the utilization is $120/256 = 47\%$. For the second case (satellite), the utilization is $33/256 = 13\%$.

    (b) In order to ensure that the buffers do not overflow, the window size $\geq$ Data rate $\times$ round-trip time. For the first case $W = (120 \times 10^3) \times (128 \times 10^{-3}) = 15360$ bits =1920 bytes;
    For the second case $W = (33 \times 10^3) \times (500 \times 10^{-3}) = 16500$ bits =2063 bytes.

    (c) The highest data rate is 256 kbps, hence the window size should be $W = (256 \times 10^3) \times (500 \times 10^{-3}) = 128000$ bits=16000 bytes.