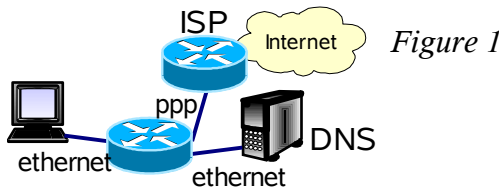


Duration: 1 hour. Answer the quiz and the problems in the same sheet.

Quiz. (6 points) All the questions are multi-answer: 0,6 point if correct, 0,3 if there is one error, 0 otherwise.



1. Say which statements are true regarding Figure 1 if the host router and DNS server have just booted and the following command is executed at the host:
ping www.cisco.com
- The host will do 1 ARP resolution.
 - The router will do 1 ARP resolution.
 - The DNS server will do 1 ARP resolution.
 - When the host receives the echo reply, the host ARP table will contain 2 entries.

- | | |
|--|---|
| <p>2. Say which statements are true regarding an IP network:</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> The IP datagram payload can be higher than 1500 bytes. <input type="checkbox"/> The only protocols that an IP datagram can encapsulate are UDP and TCP. <input type="checkbox"/> IP is a connection oriented protocol. <input checked="" type="checkbox"/> The maximum mask that can be used for a subnet is 30 bits. | <p>3. Say which statements are true regarding the following TCP/IP protocols:</p> <ul style="list-style-type: none"> <input type="checkbox"/> ICMP messages are encapsulated in UDP datagrams. <input checked="" type="checkbox"/> DHCP messages are encapsulated in UDP datagrams. <input type="checkbox"/> ICMP protocol uses the client/server paradigm. <input type="checkbox"/> UDP protocol can use the MTU path discovery algorithm. |
| <p>4. Say which of the following subnet partitions are valid if the base address is 200.0.0.0/24:</p> <ul style="list-style-type: none"> <input type="checkbox"/> One subnet with 200 hosts and another with 30 hosts. <input type="checkbox"/> 200.0.0.240/27 and 200.0.0.224/27. <input type="checkbox"/> 200.0.0.240/28 and 200.0.0.224/27. <input type="checkbox"/> 200.0.0.240/27 and 200.0.0.224/28. <input checked="" type="checkbox"/> 200.0.0.240/28 and 200.0.0.224/28. | <p>5. Say which of the following messages use broadcast addresses:</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> RIP version 1 update <input type="checkbox"/> NS query <input checked="" type="checkbox"/> ARP request <input type="checkbox"/> ARP reply <input checked="" type="checkbox"/> DHCP-DISCOVER <input type="checkbox"/> ICMP echo request |
| <p>6. Say which statements are true regarding DNS:</p> <ul style="list-style-type: none"> <input type="checkbox"/> The DNS replay message is always generated by an authoritative server. <input checked="" type="checkbox"/> The root servers have the addresses of the top level domain authorities. <input checked="" type="checkbox"/> A name server may return different IP addresses for the same name. <input checked="" type="checkbox"/> Several names may identify the same IP address. <input checked="" type="checkbox"/> A name resolution can be iterative or recursive. | <p>7. Say which statements are true regarding the routing protocols:</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> In general, OSPF is more convenient for large networks than RIP. <input checked="" type="checkbox"/> BGP protocol is more similar to RIP than to OSPF. <input type="checkbox"/> OSPF uses the same metric as RIP. <input type="checkbox"/> OSPF send link updates using TCP. |
| <p>8. Say which of the following statements are true for the subnet 170.0.0.0/27:</p> <ul style="list-style-type: none"> <input type="checkbox"/> The broadcast address is 170.0.0.255. <input type="checkbox"/> The mask in dotted point notation is 255.255.255.0 <input checked="" type="checkbox"/> The base address is a class B address. <input checked="" type="checkbox"/> There are addresses to number at most 1 router and 29 hosts. | |
| <p>9. Say which statements are true regarding a NAT router:</p> <ul style="list-style-type: none"> <input type="checkbox"/> If basic NAT is used, none of the TCP header fields have to be changed by the NAT router. <input type="checkbox"/> PAT may change the destination port of the TCP/UDP headers of the packets going from the internal to the external network. <input checked="" type="checkbox"/> PAT may change the destination port of the TCP/UDP headers of the packets going from the external to the internal network. <input checked="" type="checkbox"/> When PAT is used, multiple entries of the NAT table may belong to connections initiated at the same host. | |

```
12:40:37.443835 IP 192.168.1.100.23098 > 216.88.181.228.80: S 321330945:321330945(0) win 5840 <mss 1460,sackOK,timestamp 3631118 0,nop>
12:40:37.602829 IP 216.88.181.228.80 > 192.168.1.100.23098: S 2831251529:2831251529(0) ack 321330946 win 16384 <mss 1460,nop,nop,nop,timestamp 0 0,nop,nop,sackOK>
12:40:37.602903 IP 192.168.1.100.23098 > 216.88.181.228.80: . ack 1 win 46 <nop,nop,timestamp 3631158 0>
...
```

10. The previous dump shows the first 3 lines of a tcpdump capture done at the client side. From the following lines, select those that would be possible for the dump line number 4.
- 12:40:37.603176 IP 192.168.1.100.23098 > 216.88.181.228.80: P 1:1501(1500) ack 1 win 5840 <nop,nop,timestamp 3631158 0>
 - 12:40:44.603176 IP 192.168.1.100.23098 > 216.88.181.228.80: . ack 1 win 5840 <nop,nop,timestamp 3631158 0>
 - 12:40:44.603176 IP 216.88.181.228.80 > 192.168.1.100.23098: S 2831251529:2831251529(0) ack 321330946 win 16384 <mss 1460,nop,nop,nop,timestamp 0 0,nop,nop,sackOK>
 - 12:40:44.603176 IP 192.168.1.100.23098 > 216.88.181.228.80: S 321330945:321330945(0) win 5840 <mss 1460,sackOK,timestamp 3631118 0,nop>

Question 1. (4 points) One host downloads a web page of 29.200 bytes from an Internet server (20 segments of 1.460 bytes). In the following we will refer to these segments as s_1, \dots, s_{20} , and to the ack acknowledging each of these segments as a_1, \dots, a_{20} . Assume that TCP uses only Slow Start/Congestion Avoidance, delayed ack are not used and the delay between the client and the server is 100 ms. Assume that during the web page download, **the segment s_6 is lost**. No other segments or acks are lost.

1.A Complete the following table showing what is going on since s_1 is sent by the server, until a_{20} is received by the client. Give some explanations of the relevant events shown in the table. If you need any parameter not given in this question, assume a value, and briefly justify why you chose that value. The following conventions are used:

- The first column indicates time in 100 ms intervals. The s_1 transmission is chosen as the time origin.
- The ssthresh/cwnd columns give these values measured in MSS units at the server for the time given in the same row. If no value is written in one of these cells, the value of the previous cell is assumed.
- The segment/ack column indicates the segments (s_1, \dots, s_{20}) or acknowledgements (a_1, \dots, a_{20}) sent by the server, respectively client, at the time given at the same row.

$t/100$ ms	ssthresh/ MSS	cwnd/ MSS	segment / ack
0	∞	1	s_1
1			a_1
2		2	s_2, s_3
3			a_2, a_3
4		4	s_4, s_5, s_6, s_7
5			a_4, a_5, a_5
6		6	s_8, s_9, s_{10}, s_{11}
7			a_5, a_5, a_5, a_5
8	3	1	s_6
9			a_{11}
10		2	s_{12}, s_{13}
11			a_{12}, a_{13}
12		$\approx 3+1/3$	s_{14}, s_{15}, s_{16}
13			a_{14}, a_{15}, a_{16}
14		$\approx 4+1/4$	$s_{17}, s_{18}, s_{19}, s_{20}$
15			$a_{17}, a_{18}, a_{19}, a_{20}$
16		$\approx 5+1/5$	
17			
18			

We assume $RTO \approx RTT$, thus, the RTO triggers at $t = 800$ ms.

We assume also that the TCP receiver stores the out of sequence segments.

At $t = 1200$ ms cwnd = 3 MSS, and the TCP sender changes from slow-start to congestion avoidance.

1.B Assume that the host is connected to Internet with an ADSL line of 2 Mbps. Compute the optimal window in bytes and segments. Comment your assumptions.

Assumptions: the TCP sender sends a window every RTT. The bottleneck is the ADSL 2 Mbps access line:

$$v_{ef}[\text{bps}] \simeq \frac{W_{opt}[\text{bytes}] \times 8}{RTT} \rightarrow W_{opt}[\text{bytes}] = \frac{v_{ef} \times RTT}{8} = \frac{2 \times 10^6 \times 200 \times 10^{-3}}{8} = 50 \text{ kB}$$

$$\rightarrow W_{opt}[\text{segments}] = \left\lceil \frac{50}{1.46} \right\rceil = 35$$