Final exam Computer Networks (XC) Degree in Informatics Engineering		18/6/2015	Primavera 2015
Given name:	**Last name:**	**Group**	**ID**

Duration: 2h45m. The quiz will be collected in 30m. Answer in the same exam sheet. Review date will be anounced in the racó.

Test. (2,5 points) All questions are multiple choice: Count as half if there is one error, 0 if more.

1. In a HTTP 1.1 connection is possible to:
- ☐ Request multiple HTTP objects in a single request
- ☐ Send multiple consecutive HTTP requests
- ☐ Send multiple HTTP objects in parallel
- ☐ Receive multiple HTTP objects consecutively

2. DNS MX records are used to indicate:
- ☐ The SMTP server name for a client
- ☐ The SMTP server name for a DNS host
- ☐ The SMTP server name for a DNS domain
- ☐ The SMTP server name for a RFC822 e-mail address

3. There may be ports in full duplex and half duplex mode for network segments connected to a:
- ☐ Router
- ☐ Bridge
- ☐ Switch
- ☐ Hub

4. In the following algorithm the size of the TCP congestion window can increase exponentially until it reaches a threshold:
- ☐ congestion avoidance
- ☐ congestion detection
- ☐ slow start
- ☐ none of the above

5. Assuming shared capacities, which statement about fairness is wrong?
- ☐ UDP traffic does not affect the throughput of TCP traffic
- ☐ One can get a larger fraction of the bandwidth by opening multiple parallel TCP connections
- ☐ In competing TCP sessions sharing a link, the realized bandwidth approximately converges to an equal share if all sessions experience the same RTT
- ☐ UDP is often used by multimedia apps since the rate is not throttled by congestion control

6. A datagram is fragmented into three smaller datagrams. Which of the following is true?
- ☐ The “do not fragment” bit is set to 1 for all three datagrams
- ☐ The “more fragment” bit is set to 0 for all three datagrams
- ☐ The identification field is the same for all three datagrams
- ☐ none of the above

7. A best-effort delivery service such as IP includes:
- ☐ data error checking
- ☐ data error correction
- ☐ datagram acknowledgment
- ☐ none of the above

8. Which of the following functions does UDP perform?
- ☐ process-to-process communication
- ☐ host-to-host communication
- ☐ end-to-end reliable data delivery
- ☐ none of the above

9. When the IP hop-count field (TTL) reaches zero and the destination has not been reached, the following error message is sent:
- ☐ destination-unreachable
- ☐ time-exceeded
- ☐ parameter-problem
- ☐ none of the above

10. Which of the following statements about IP addressing is right?
- ☐ The subnet 200.23.16.0/22 has at most 1024 addresses.
- ☐ The address 200.23.192.16 is part of the subnet 200.23.16.0/22.
- ☐ The address 200.23.16.22 is part of the subnet 200.23.16.0/22.
- ☐ None of the above

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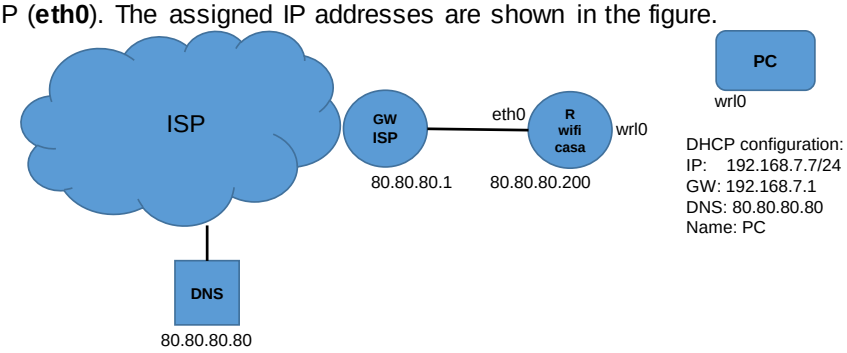
Problem 1 (2'5 points)

The figure shows a domestic network with and ADSL/cable router (**Router wifi casa**). The domestic network is WLAN using private IP addresses. PC is a wireless device, its interface is **wrl0** and uses DHCP for its configuration. The figure shows its configuration. The **router wifi casa** has two interfaces: the internal one WiFi (**wrl0**) and the external one to the ISP (**eth0**). The assigned IP addresses are shown in the figure.



a) (0'25 points) Complete the routing table for *router wifi casa*.

Destination network	Mask	Gateway	Interface

b) (0'25 points) The PC uses DHCP for its configuration. Show the sequence of **packets** exchanged between the PC and the DHCP server, which is located in *router wifi* casa.

Source	Destination	Protocol	Transport protocol	DHCP Message
		DHCP	UDP	Discover

c) (0'25 points) Complete the routing table of the PC once it is completely configured.

Destination network	Mask	Gateway	Interface

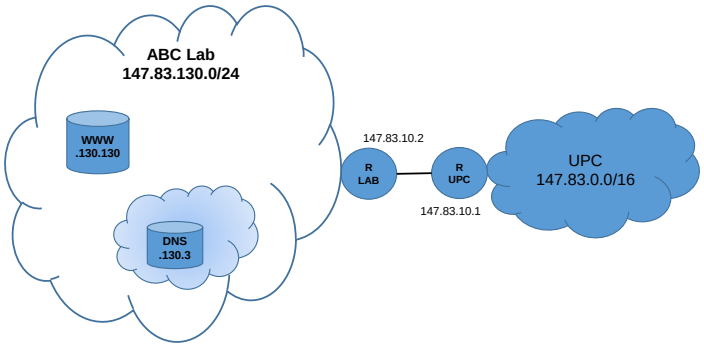
d) (0'75 points) After the configuration of the PC, ARP and DNS tables are empty. From the PC, the user accesses "www.abclab.upc.edu". Complete the **sequence of frames** observed at the router interfaces **wrl0** and **eth0** until the **first TCP segment arrives from UPC server**.

Assume that the router is on since a long time ago. Take into account that the router performs PNAT.

Use the following natation: PC (192.168.7.7), wpc (PC's MAC address), RI (192.168.7.1), wri (internal interface MAC address), R (80.80.80.200), r (external interface MAC address), GW (80.80.80.1), gw (MAC address of the ISP's router), UPC (IP address of the web server), DNS (80.80.80.80), 53 for the DNS server's port, 80 for HTTP server's port, and P1, P2, P3, P4 for the NAT's dynamic ports.

Router Interface	Ethernet			IP					Message Information
	Source	Destination	ARP Message	Source	Port	Destination	Port	Protocol	

The figure shows the network at UPC's ABC Lab (147.83.130.0/24). Router RLAB connects ABC Lab to UPC's network. The IP address of the external interface of RLAB is 147.83.10.2.



e) (0'25 points) The IP address assigned to the Lab's web server is 147.83.130.130/27.
What is its corresponding subnetwork (subnetwork address, broadcast address, and address for router RLAB)?
How many /27 subnetworks may be configured in the ABC Lab?

The subnetwork 147.83.130.192/26 is "moved" to the home. To do this, a tunnel is established between routers RLAB and router WifiCasa. The tunnel uses the subnetwork 10.0.0.0/30.
f) (0'25 punts) Modify and complete the routing table for router RLAB.

Destination network	Mask	Gateway	Interface
147.83.10.0	/23		eth0
147.83.130.0	/25		eth1
147.83.130.128	/26		eth2
147.83.130.192	/26		eth3
0.0.0.0	/0		eth0

g) (0'25 points) Assume that ARP and DNS tables contain already the information needed. From the PC a user accesses the server "www.abclab.upc.edu". Complete the **sequence of frames** observed at the router's **wrl0** and **eth0** until **first TCP segment arrives from UPC server**.
Use the same notation than in d) plus RLAB (147.83.10.2).

Router Interface	Ethernet header		IP External header		IP header					Message payload
	Source	Destination	Source	Destination	Source	Port	Destination	Port	Protocol	

h) (0'25 points) In order to improve security the home network must have access to the Internet exclusively through the tunnel going via UPC ABC Lab. Assume that the routing table is configured accordingly. Complete the rules for the Firewall (ACL rules) for the interface eth0 of *router wifi casa*.

Source IP	Source port	Destination IP	Destination port	Protocol	Action

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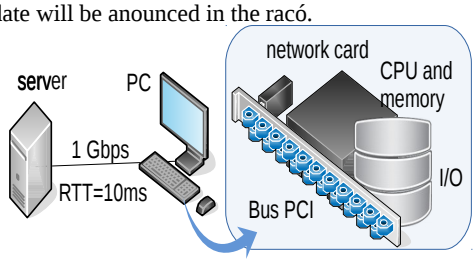
Problem 2 (2,5 points)

The PC of the figure downloads a large file from the server through a line of 1 Gbps. The PC has a very fast CPU and the network card is connected to a PCI bus of 1 Gbps. However, the bus also has other I/O devices connected, so the network card can only access at 10% of the capacity of the bus. Suppose that the RTT is 10 ms, the RTO 20 ms and the MSS 1460 B. Assume that TCP only uses slow start and congestion avoidance, and always sends an ack upon a segment arrival. The ack can confirm new data or be a duplicated ack..



2.1 (0,25 points) Given the restriction of the PCI bus, compute what would be the effective throughput and optimum window (in bytes) to achieve it.

2.2 (0,25 points) Suppose now that the client and server TCP sockets have buffers of 65 kB (kilo bytes). What will be advertised window?, can the throughput above be achieved? What throughput can be achieved?

Suppose the following sections that the PCI card has a buffer that can store only 5 TCP segments. Suppose also that the connection is in steady state, that is, long time has passed since the start of the connection.

2.3 (0,5 points) Compute what will be the slow start threshold (ssth) at the server in segments. Justify your answer.

2.4 (1 punt) Make a sketch of the evolution of the congestion window (cwnd) of the server. The diagram must represent a period: from a lost segment transmission until another lost segment under the same conditions is transmitted again. Indicate clearly when segments are lost and what is the duration of the period in RTTs.

2.5 (0,25 points). How many duplicated acks are transmitted in each period?

2.6 (0,25 points). Compute the throughput in bps.

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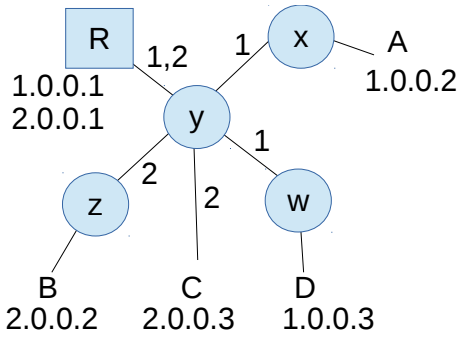
Problem 3 (1,5 points)

The diagram at right shows an Ethernet LAN with one router (R), four switches (w-z) and four hosts (A-D). The switches are configured with two VLANs and the labels next to each link show the VLANs active on the link (note, some links are active in multiple VLANs).



Each VLAN is assigned an IP subnet.
Specifically, VLAN 1 is assigned subnet 1.0.0.0/8, VLAN 2 subnet 2.0.0.0/8. The router belongs to two subnets and can send/receive packets using two VLAN ids. Hosts are configured with the VLAN corresponding to their IP subnet.

a) If host B sends a packet to host C, what switches and routers does the packet pass through?
Explain why and list them in order.

b) If host A sends a packet to host C, what switches and routers does it pass through?
Explain why and list them in order.

c) If A transfers a large file to B, while C transfers a large file to D, what maximum data rate could each approximately get, assuming that the links are all 1 Gb/s duplex links? Please specify the bottleneck and control flow action, if any.

d) What maximum bandwidth could they each get if C was in subnet 1.0.0.0/8 instead?

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Problem 4 (1 point)

Using HTTP, we want to download an HTML document that contains the following components:

- The structure of the page (HTML document) (servidor.xc.com)
- 2 images hosted on the same server where the HTML document is located
- 3 External banners, each of them located on the server of its sponsoring company.

Given that the client uses HTTP / 1.1 (persistent) without pipelining, indicate how many RTT will take to download the HTML document and its embedded components in two different cases:

a) The client connects directly to Internet. Assume that the document served by servidor.xc.com specifies the URL from which you have to download other components, and that the local hosts file does not have cached the IP addresses of the domains to which the URL,s belong, but they are cached in client's primary DNS. Indicate also the number of connections established by the client's computer and with who are they.

b) The client connects to the Internet via a PROXY server. Is this PROXY who gets all the components of the page from the specified URL,s and serves them to the client. Assume that the PROXY does pipelining, to minimize download times, and that it has a Hosts file with already cached the IP addresses of all the components' domains to download. Indicate also the number of connections established with the PROXY in its intermediation between client and internet, and with who they are.

In order to simplify the calculations, you can assume that: 1) the RTT is the same for client and PROXY connections with any server; 2) page or images requests can be sent together with the client connection ACK, the connection establishment time is 1RTT, 3) connection closing time is 2RTT, but consider the download time ends when viewed the entire page, even if there are still some open connections, 4) any downloaded component fits in one MSS, and the transfer speed allows as many simultaneous connections to different servers as needed, but with a transmission window of 1 MSS with each server; 5) assume a simple browser is used, it only opens TCP connections upon request; 6) the PROXY only allows one single simultaneous connection with the client.

a)

Wihout PROXY		RTT																RTT	Comments
Destinatin Server	Action	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	TOTAL	

b)

WITH PROXY		RTT																RTT	Comments
Destinatin Server	Action	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	TOTAL	