Final Exam of Xarxes de Computadors (XC), Grau en Enginyeria Informàtica		23/06/2017	Spring 2017
NAME:	SURNAME:	GROUP:	ID:

Duration: 2h 45 minutes. The test will be collected in 30 minutes.

Quiz (2.5 points).

Multiple choice questions (any number of correct answers). Half value if one error and 0 if more.

1. In the TCP/IP architecture
- ☐ A 'PC' with two interfaces can act as a 'router'.
- ☐ Any Internet traffic that leaves a local network uses the IP protocol.
- ☐ The IP protocol allows the communication between two 'host'.
- ☐ The IP protocol allows the communication between two processes.

2. About the IP protocol
- ☐ IPv6 addresses have 8 times more bits than IPv4.
- ☐ IP packets carry the address of the next hop.
- ☐ IP packets always follow the same path to reach the destination.
- ☐ Fragmentation can be avoided with a 'flag' in IP packets.

3. The ARP protocol
- ☐ Allows discovering the physical level address of the next hop.
- ☐ Allows discovering the physical level address of the final destination.
- ☐ Allows detecting devices with duplicate addresses on the Internet.
- ☐ Allows detecting devices with duplicate addresses in the same broadcast domain.

4. Regarding the TCP protocol, and in a local network:
- ☐ A 'switch' can do flow control.
- ☐ A 'switch' loses segments to reduce congestion.
- ☐ The 'congestion avoidance' phase is not reached if there are no losses.
- ☐ The 'slow start' phase is not reached if there are no losses.

5. Regarding the DNS protocol
- ☐ The NS records in each zone are saved in the 'root' servers.
- ☐ The 'root' servers only accept recursive requests.
- ☐ All clients (user devices) must know the IP address of a DNS server on their local network.
- ☐ All clients (user devices) must know the IP address of a DNS server anywhere on the Internet.

6. An HTTP 1.1 server
- ☐ Can deliver only one object for each TCP connection.
- ☐ Can receive new requests while serving a previous request.
- ☐ Can send a GET request to the client.
- ☐ Can deliver an object encoded in Base64.

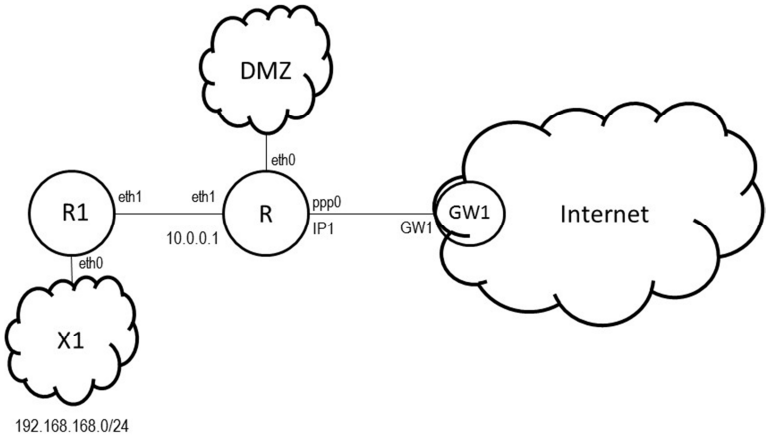
7. About email and MIME
- ☐ A message may include another complete message.
- ☐ A message can include the same object encoded in alternative forms.
- ☐ The 'Quoted Printable' encoding format is only used with Unicode text.
- ☐ The text/plain format can only contain ASCII text.

8. About UNICODE
- ☐ UTF-8 is a fixed-length encoding.
- ☐ The same character using different fonts is encoded with different values.
- ☐ The letter 'a' is encoded the same way in ASCII than in UTF-8
- ☐ UTF-16 is a fixed-length encoding.

Final exam, Xarxes de Computadors (XC), Grau en Enginyeria Informàtica		23/06/2017	Spring 2017
NAME (in CAPITAL LETTERS):	FAMILY NAME (in CAPITAL LETTERS):	GRUP:	DNI/NIE:

Duration: 2h 45 minutes. The quiz will be collected in 30 minutes.

Problem 1 (2'5 points).
The figure shows part of a company's network and its configuration. It uses the block of private addresses 192.168.168.0/24 for subnetwork X1, the subnetwork 10.0.0.0/30 for the link R-R1, and the range of public IP addresses available is 200.200.200.192/28. The ISP configures the address of router R with IP1 and the address of the ISP's router is GW1.



a) (0'5 points) What is the maximum number of servers that may be hosted in the DMZ (with public IP addresses)?

b) (0'5 points) Complete the routing table of router R.

R			
Network	**Mask**	**Gateway**	**Interface**

c) (0'5 points) A device in X1 issues the command "*ping 200.200.200.200*". Complete the sequence of Ethernet frames and datagrams traversing X1 until the first response reaches the device. The device is configured already and the ARP tables are empty. The IP address of the device is "A", its MAC address is "a"; the IP address of the router's interface is "R1" and its MAC address is "r1".

Ethernet header		ARP message		IP header			data
source	**destination**	**type**	**contents**	**source**	**destination**	**protocol**	**message**

d) (0'5 points) Router R performs PAT. Which interfaces must perform PAT? Why?

Complete the table with the information of the datagrams that will go through the interface ppp0 of router R when a device in X1 executes "*ping 147.83.3.3*". Use U to refer to address 147.83.3.3.

IP header			**data**
source	**destination**	**protocol**	**message**

e) (0'5 points) A Firewall is configured in router R implementing the following rules:
1) clients in the private network may access servers in the Internet without any restrictions,
2) only the servers in the DMZ may be accessed from the Internet (TCP connections and "ping" commands),
3) hosts in the DMZ cannot establish connections to external servers in the Internet, with the exception of the DNS server (port 53).
Complete the following table with the rules of the access control list <u>needed at interface ppp0</u> of router R. Use the notation: DMZ (200.200.200.192/28) and X1 (192.168.168.0/24).

Direction	**Src @**	**Src port**	**Dst @**	**Dst port**	**Protocol**	**Action**

Examen final de Xarxes de Computadors (XC), Grau en Enginyeria Informàtica		23/6/2017	Spring 2017
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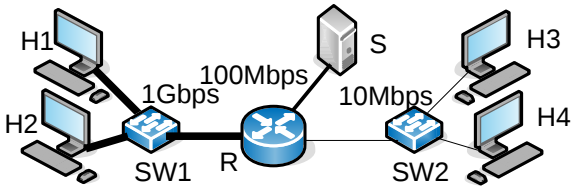
Duration: 2h45m. The quiz will be collected in 30 minutes. Answer in the same questions sheet.

Problema 2 (2 points)



In the network of the figure all SW1 switch ports are 1 Gbps, SW2 10 Mbps and the R-S link 100 Mbps. All links are full duplex. Switches have flux control enabled (that is, can act if necessary). Each PC sends data with a TCP connection to the server S at the maximum throughput allowed by the network. Suppose that router R has a memory of 1 MB (10^6 bytes) for each interface, which can store all the pending datagrams to transmit (and datagrams are discarded if the memory is exhausted). Suppose that the memory of the Ethernet card driver of the PCs is unlimited. This memory stores the TCP segments waiting to be transmitted over the Ethernet card. All TCP sockets of the PCs and the server have a 60 kB reception buffer. Suppose for simplicity that delays in the links are 0; TCP acks are never lost and arrive immediately to the destination. In order to answer the following questions, assume that the connections are in steady state (they have been started time ago). Justify the answers

2.1 (0,5 punts) Say where is the bottleneck and what is the throughput of each TCP connection.

2.2 (0,5 punts) Discuss whether there will be TCP segment losses

2.3 (0,5 punts) Compute approximately the RTT (Round Trip Time) that, on average, each TCP connection will have. Suppose that between the throughput vef, window W and RTT averages of a TCP connection is fulfilled vef = W / RTT.

2.4 (0,25 punts) Discuss what will be the main cause of the RTT delay that will experience the TCP connections of H1 and H2. Compute approximately how many bytes *B* there will be, on average, in the router R queue (waiting to be transmitted).

2.5 (0,25 punts) Discuss what will be the main cause of the RTT delay that will experience the TCP connections of H3 and H4. Compute how many bytes there will be, on average, in the queue of H3 and H4 Ethernet card driver.

Final Exam Xarxes de Computadors (XC), Grau en Enginyeria Informàtica		23/6/2017	Spring 2017
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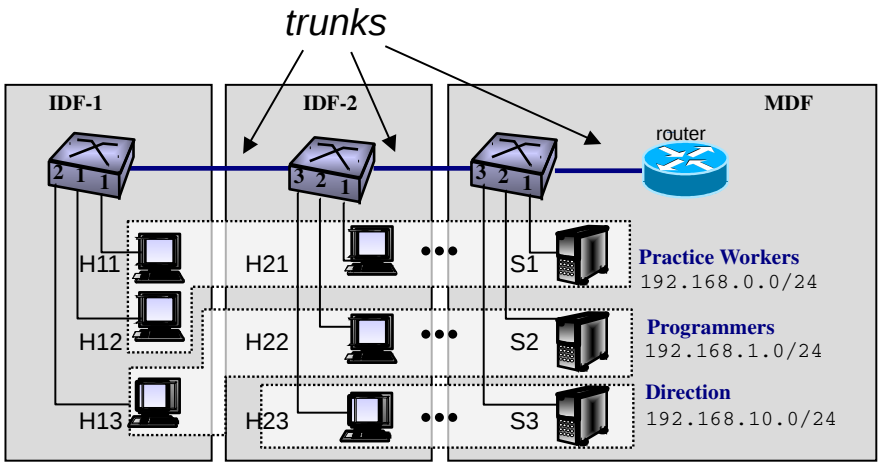
Duration: 2h45m. Answer in the same document. The back side can be used as a draft.

Problem 3 (1.5 points: each section 0.3)
An organization has the local network of the figure. All PCs are connected with Fast Ethernet. The switches and the router are interconnected with 1 Gbit Ethernet in trunk mode. There are 3 VLANs and three offices: IDF-1, IDF-2, MDF. In MDF there are the server PCs and in the other offices there are only client PCs.



1) List the devices that appear in the broadcast domains of each server:

S1:

S2:

S3:

2) List the devices appear in each server's collision domains:

S1:

S2:

S3:

3) If all client PCs (H *) send data with UDP at the maximum speed and in a sustained way to the server of its own VLAN, indicate which of the 4 following mechanisms acts and the reason: a) loss of UDP packets, b) flow control in the switches, c) queueing and packet loss in the router, d) only the speed limitation of each server.

4) If all client PCs (H *) receive data with UDP at the maximum speed and in a sustained way from the server of its own VLAN, indicate which of the 4 following mechanisms acts and the reason: a) loss of UDP packets, b) flow control in the switches, c) queueing and packet loss in the router, d) only the speed limitation of each server.

5) How does answer 3 change if now all client PCs only send to the same server that is one hop beyond the router, connected with Fast Ethernet? Indicate which of the 4 mechanisms acts and why.

Examen final de Xarxes de Computadors (XC), Grau en Enginyeria Informàtica		22/6/2017	Primavera 2017
Name:	**Surname:**	**Group**	**Name:**

Duration: 2h45m. The quiz will be collected in 30m. Answer the problems in the same exam sheet.

Exercise 4 (1.5 points)

We want to send from a client machine `c1.upc.edu`, which we will call C, a request for an HTML page to an HTTP server `s1.otro.com`, which we will call S.

Assume that the local DNS of the `upc.edu` domain is `dns.upc.edu` (we will call it U) and the one of `otro.com` is `dns.otro.com` (we will call it O). Assume that all DNS caches are empty.

a) (0.4 pt) List the sequence of DNS and HTTP requests and responses sent and received by c1.upc.edu (machine C) to deliver the HTTP request to s1.otro.com.

Destination	Protocol	Description of the request	Description of the response
U	DNS	Recursive request from C, record A from **S**	

b) (0.4 pt) List the sequence of DNS and HTTP requests and responses sent and received by `dns.upc.edu` (machine U). If the requests go to machines not identified before, give a suitable name.

Destination	Protocol	Description of the request	Description of the response
O	DNS	Recursive request from C, record A from **S**	

c) (0.3 pt) Indicate the values of the following possible fields of the HTTP Request header, starting with the command line (request line). Write down "N/A" if the field is not applicable. In line 4, give the value needed to close the TCP connection.

Line	Field:	Value
Request		
1	Host:	
2	Accept:	
3	Content-Type:	
4	Connection:	

d) (0.4 pt) In response to the above HTTP Request, we receive:

```
HTTP/1.1 200 OK
Date: Fri, 23 Jun 2017 07:59:00 GMT
Last-Modified: Tue, 24 Feb 2017 08:32:26 GMT
ETag: "ec002-afa-fd67ba80"
Content-Type: text/html

-- message body --
```

Answer the following questions:

What is inside the body of the message?	
Can the body of the message include UTF-8 characters?	
If there were UTF-8 characters, how many octets would we need to encode each character?	
We change the request so that the result of the request is a PDF document	
Which header field (of those included above) would change value, and what would the new value be?	
What do the values of the `Etag` field represent?	