Examen final de Xarxes de Computadors (XC), Grau en Enginyeria Informàtica		27/06/2018	Primavera 2018
NAME:	**SURNAME:**	**GROUP:**	**DNI:**

Duration: 2h45m. The quiz will be collected in 30 minutes.

Test (3 points).

Multi-answer questions (any number of correct answers possible).Half value if there is one error, value is 0 if more errors.

1. We have the range of addresses 100.0.0.0/28. We want to address in that range 1 subnetwork of 5 hosts and 2 subnetworks of 1 host.
- ☐ If we would want 3 subnetworks of 1 host instead of 2 subnetworks, we would not have enough addresses.
- ☐ 100.0.0.0/29 could be the subnetwork of 5 hosts.
- ☐ 100.0.0.10 could be a host in one of the two subnetworks of 1 host.
- ☐ 100.0.0.15 could be the broadcast address of one of the two subnetworks of 1 host.

2. About the protocols that support IP:
- ☐ The ARP messages are sent to obtain an IP address from a physical address.
- ☐ Every time a Router receives a datagram, it generates an ICMP informative message, in case no error has occurred.
- ☐ One of the uses of NAT is to save public addresses.
- ☐ The DHCP messages travel directly over IP.

3. Other issues related to IP:
- ☐ If we add an output tunnel through a Router, we should add at least one entry to the routing table.
- ☐ When using Split Horizon in RIP, the amount of information sent is reduced, although this is not the main objective.
- ☐ One of the objectives of the communication algorithms between Routers is to confirm the destination of the datagrams.
- ☐ The Protocol field in the IP header is optional.

4. About the TCP protocol:
- ☐ The value of the “advertised window” field of the header varies depending on the network congestion.
- ☐ The SS/CA algorithm only applies when there are losses.
- ☐ The Slow Start algorithm follows the Stop&Wait protocol, since it always waits for an ACK before sending the next data segment.
- ☐ Apart from the addresses (ports), the UDP header only has the Length and Checksum fields.

5. About LANs:
- ☐ The header of an Ethernet frame is transmitted before the LLC level header, when it exists.
- ☐ The CSMA/CD protocol includes an IPG field that allows indicating “silence” at the end of the transmission of a frame and before the transmission of the next one.
- ☐ SNAP is only used when there are LLC.
- ☐ In WLANs, as in CSMA/CD, there are no ACKs.

6. We have a switch with a 1 Gbps port connected to a server, and another 100 Mbps port connected to a Hub. The Hub has 2 PCs connected and we assume 80% efficiency.
- ☐ If the PCs transmit at their maximum speed towards the server, the output of the 1 Gbps port will be 100 Mbps.
- ☐ If the server transmits at its maximum speed, every PC will receive, as an average, at 80 Mbps.
- ☐ If in addition to the 2 PCs transmitting at their maximum speed, we have a third 1 Gbps port with another PC, this last PC will be limited to transmit at 920 Mbps.
- ☐ Under the conditions of the previous point, if we do not want the switch to loose frames, it should implement the flow control mechanism of “pause frames”.

7. About application layer protocols:
- ☐ The SMTP protocol allows a user to send and retrieve messages.
- ☐ With MIME, apart from other things, we manage that the SMTP protocol may continue sending content encoded as ASCII characters.
- ☐ The value of the Boundary element is calculated by the software that creates the e-mail message.
- ☐ HTTP has an option in the header that allows the client to indicate if the TCP connection is kept open or not once an interchange (HTTP Request and Response) is completed.

8. About characters:
- ☐ With UTF-8, characters may need 1 to 4 bytes.
- ☐ A specific character needs the same number of bytes independently of which “UTF” (8, 16, 32, ...) we are using.
- ☐ The “A” character is encoded in the same way in ASCII and in UTF-8, but this is not the case with character “a”.
- ☐ ISO/IEC 8859 is a standard with several parts, where each of it defines characters sets corresponding to different languages, each character needing one byte.

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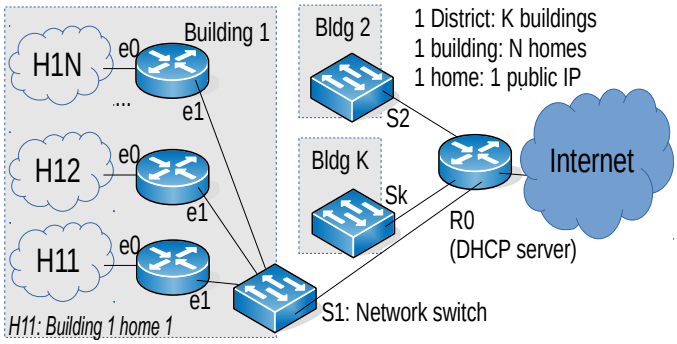
NAME (in CAPITAL LETTERS):	SURNAME (in CAPITAL LETTERS):	GROUP:	DNI/NIE:

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

Problem 1 (3 points)



A city district has an Internet access network as shown. Each building has an Ethernet network with several subnets, one for each home (Hij: home j in building i), connected to the building's switch. Each home router acts like a typical ISP home router: it does NAT, protects the home network, and gets a single public IP address from the DHCP server on the access network (R0). Each building in the district is connected by fiber to the R0 router with Internet access. All connections are 1Gbps. We use the 192.168.0.0/16 range for internal addressing at each household (e0 interface) and the Internet addresses in the 147.2.0.0/16 range we have for public IPs. We assume a maximum default value of N=60 households per building. Answer the following questions justifying your answers.

a) (0.5 points) How many public IPs can each building occupy (N=60), and how many buildings (K) could be connected in the district?

b) (0.5 points) When the maximum number of connections in the district is reached, with all public IP addresses allocated, what solution could be applied at the IP level to continue growing and which advantages and disadvantages will it have?

c) (0.5 points) As requests from homes for network connections are received (located in any building in the district), IP addresses have to be allocated to each one. What would be the effect of allocating consecutive IP addresses to the households in the same building? Propose the IP addressing ranges for building 1 starting from 147.2.0.0/16.

d) (0.5 points) What IP broadcast traffic will circulate on the network between R0 and the home routers, and how to limit it?

e) (0.5 points) When the web traffic in the neighborhood increases to saturate the Internet connection, a caching web proxy is connected to R0, what changes will be needed in the home user's applications or in the IP network (routers) to use it and what effect will it have on their IP traffic?

f) (0.5 points) Fill in the routing table of a PC (interfaces l0, e0) connected to the H11 network:

Target network	Interface	Gateway	Metric	Description
127.0.0.0/8				

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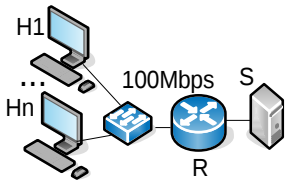
Problem 2 (2 points)

In the network of the figure all the links are 100 Mbps full duplex. The PCs H1... Hn (n in total) send data with a TCP connection each to the server S at the maximum speed allowed by the network. Suppose all TCP sockets use a 128 kB receiving buffer (1kB = 10^3 bytes). Suppose for simplicity that delays in the links are 0; TCP acks are never lost and arrive immediately at the destination. Suppose that on all PCs a throughput of 5 Mbps is measured, and an average RTT of 40 ms. To answer the following questions assume connections in steady state (they have started time ago). Assume segments of 1500 bytes.



2.1 (0.25 points) Compute how many stations (n) are sending data

2.2 (0,25 points) Compute approximately the average window (W) in bytes and segments that use the connections.

2.3 (0,25 points) Discuss with the results above if the TCP connections will have losses.

Suppose now that there are losses and that the congestion window cwnd of all the connections follows a periodic evolution with sawtooth shape. Suppose, for simplicity, that the RTT is constant.

2.4 (0.25 points) Make an sketch of the evolution of a period of the cwnd that is consistent with the values calculated in the previous items. Indicate in the figure the intervals where TCP will be in slow start (SS) and congestion avoidance (CA)

2.5 (0.25 points) Using the previous figure, compute approximately the value of the slow start threshold (ssth) and the maximum size of the window, in segments. For simplicity, do not take into account the SS phase.

2.6 (0.25 points) Calculate approximately the duration of the previous SS and CA intervals in RTTs.

2.7 (0.25 points) Calculate approximately how many segments are sent in each period

2.8 (0.25 points) Calculate approximately the throughput from the segments that are sent and the duration of a period. Is it 5 Mbps? If not, what's the reason?

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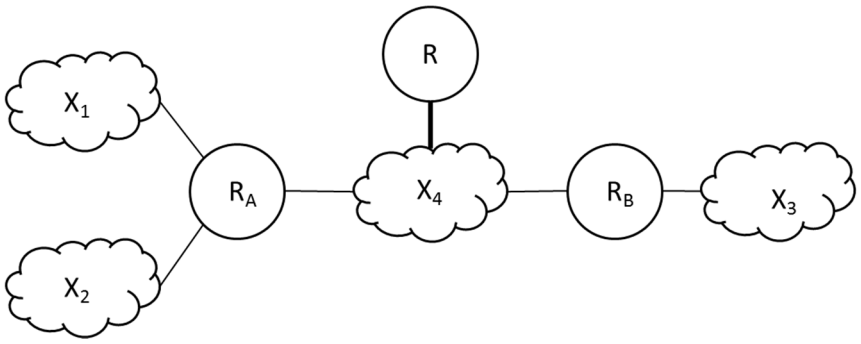
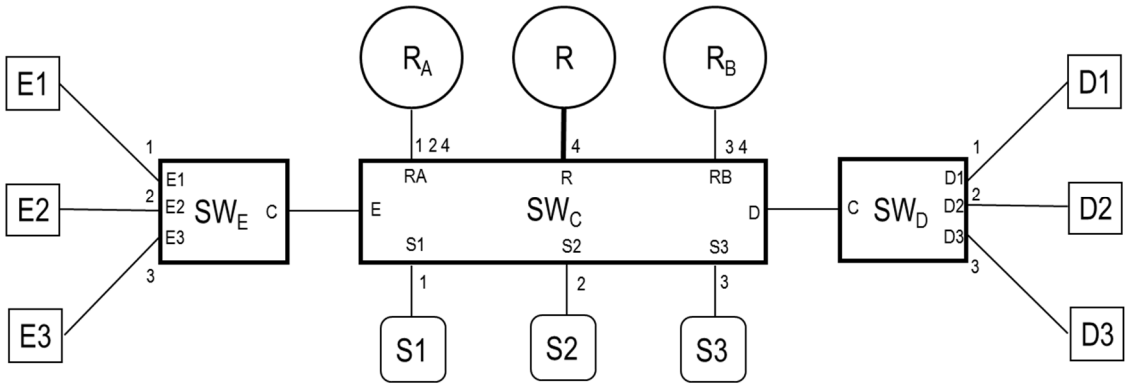
Time: 2 hours and 45 minutes. The quiz will be collected in 30 minutes.

Problem 3 (1 point)

The figure shows the configuration of a network and its IP subnetworks. The configuration of the routers RA and RB allows connectivity among all subnetworks. The access to the Internet is through router R.



Next figure shows the detail of the network infrastructure including the Ethernet switches. All links are Fast Ethernet (100Mbps) but the link SWC-R that is a 1Gpbs link.
The configuration includes 4 VLAN and the VLAN associated to each port is shown by its number. The names of the ports of the switches are identified by their corresponding labels.
For instance: port RA of switch SWC supports VLAN 1, 2 and 4 (in mode trunk)
Devices E1 and D1 belong to network X1 and VLAN1; E2 and D2 to X2 and VLAN2; E3 and D3 to X3 and VLAN3.



a) (0.1 points) Which VLAN/s should be configured on link SWC-SWE?

Which VLAN/s should be configured on link SWC-SWD?

Ethernet switches apply flow control when necessary. In the following questions identify the ports that intervene in each case using the notation SWx-id_port; specify "NONE" if flow control does not apply (x identifies the switch and id_port is the label of the port of the switch).

b) (0.2 points) Only the devices in X1 (E1 and D1) send data to their server S1.

Port where flow control applies:			
Ports where the max rate is enforced:			

Maximum throughput that the devices can attain:

c) (0.2 points) **All** devices send data **towards their server** (Ex and Dx towards Sx) simultaneously.

Port where flow control applies:			
Ports where the max rate is enforced:			

Maximum throughput that each one of the devices can attain:

Throughput at the server's links:

d) (0.25 points) **All** devices **download** data from their corresponding server (Sx towards Ex and Dx) simultaneously.

Port where flow control applies:			
Ports where the max rate is enforced:			

Maximum throughput that each one of the devices can attain:

Throughput at the server's links:

e) (0.25 points) Devices E1 and D1 **send** data at the maximum throughput achievable **towards the three servers** S1, S2 and S3.

Show the sequence of network devices flowed by each one of the flows:

E1 a S1	SWE SWC
D1 a S1	
E1 a S2	
D1 a S2	
E1 a S3	
D1 a S3	

Port where flow control applies:			
Ports where the max rate is enforced:			

Maximum throughput that each one of the devices can attain:

Throughput at the server's links:

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Problem 4 (1 point)

We have the following machines (between brackets the character or characters we will use to refer to them):
PC `client.upc.edu` (CU), HTTP server `hserver.destination.com` (HD), DNS server `dns.upc.edu` (DU), DNS server `dns.destination.com` (DD), SMTP server `smtp.upc.edu` (SU), SMTP server `smtp.destination.com` (SD).

a) (0,5 pt) Assuming that all DNS caches have information about all necessary name servers, **list** the sequence of DNS and SMTP requests and responses sent and received, by any of the mentioned machines, since the moment when PC wants to send an e-mail to the address *`myfriend@destination.com`* until the moment in which the e-mail arrives to his/her server. In column "Type" answer "Recursive" or "Iterative" in case of DNS, or "SMTP" in case of SMTP.

Origin	Destin.	Type	Description or request	Description of response
CU	DU	Recursive	Record A of SU	IP address of SU

b) (0,2 pt) Following with the same configuration of machines, CU requests a web page to HD. **Complete** the following table with the command line (*request line*) of the HTTP Request and the values of the header fields in the table. Write "N/A" if the field is not applicable. Assume that the URL is only the name of the machine. In line 4, provide the value to force the closing of the TCP connection.

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

c) (0,3 pt) As answer to the previous HTTP Request, we receive:

```
HTTP/1.1 200 OK
Date: Wed, 27 Jun 2018 10:59:00 GMT
Last-Modified: Tue, 24 Feb 2018 08:32:26 GMT
Content-Type: text/html

-- message body --
```

Answer to the following questions:

What is the content of the message body?	
What is the use of the field `Last-Modified`?	
How could we restrict that the characters of the HTML page are encoded in UTF-8?	
Assuming that we restrict to UTF-8 encoding and that the page has only content in English, how many bytes do we need to encode every character?	
If we include characters of a Japanese alphabet, should we change to UTF-16 or UTF-32? What would happen if we would not do it?	