Examen final de Xarxes de Computadors (XC), Grau en Enginyeria Informàtica		15/01/2019	Tardor 2018
NOM (en MAJÚSCULES):	**COGNOMS (en MAJÚSCULES):**	**GRUP:**	**DNI:**

Duració: 2h 45 minuts. El test es recollirà en 30 minuts.

Test. 3 points.
Questions can accept only one correct answer (RU) or multiple answers can be correct (MR).

- A correct RU answer counts 0.3 points, 0 if incorrect.
- An entire correct MR answer counts 0.4 points, a partially correct answer (i.e., only 1 error) 0.2 points, 0 points if 2 or more errors. The number of correct answers could be from one to all, i.e. at least one is always correct.

1. **RU.** Identify the correct order of layers of the ISO/OSI model starting from the bottom layer

- ☐ Network interface, Network, Transport, Network application
- ☐ Physical layer, Data Link, Transport, Network, Presentation, Session, Application
- ☐ Physical layer, Data Link, Network, Transport, Session, Presentation, Application
- ☐ Physical layer, Interface, Network, Transport, Presentation, Application
- ☐ Network interface, Network, Session, Transport, Application

2. **MR**. Identify the correct answer or answers

- ☐ MTU path discovery is a mechanism to discover the route between a source and a destination
- ☐ A gratuitous ARP is sent to discover duplicated @IP addresses oin a network
- ☐ The ICMP echo request and echo reply messages are used to verify the connectivity between a source and a destination
- ☐ DHCP can assign a default route to a host

3. **MR**. Identify the correct answer or answers

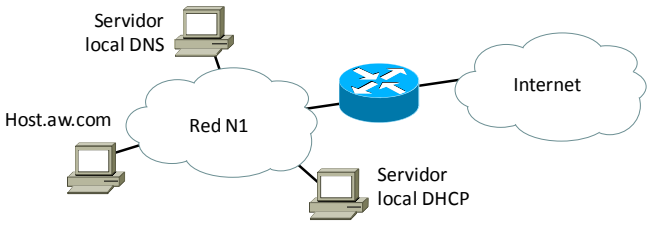
- ☐ 101.11.10.255/23 is a broadcast address
- ☐ 172.15.0.1/24 is a private @IP
- ☐ 200.10.10.131/27 and 200.10.10.161/27 belong to the same network
- ☐ With mask 255.255.255.192, there are 6 bits in the hostID

4. **MR**. Identify the correct answer or answers regarding WLAN 802.11

- ☐ There are only 2 MAC addresses (source and destination) in the header of the MAC frame
- ☐ The MAC protocol is called CSMA/CA
- ☐ The type of the MAC protocol used is called random
- ☐ The host listens the medium during frame transmission to verify that there are no collisions

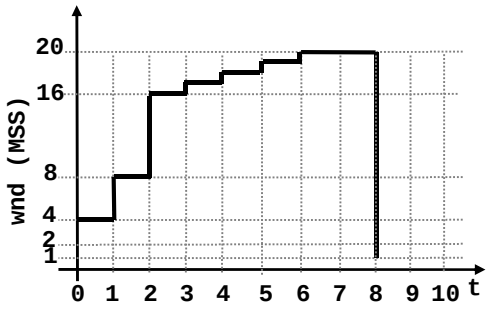
5. **MR**. The host in the figure sends a ping to www.aw.com. All DNS caches are empty and all equipment are configured correctly. Identify the correct answer or answers

- ☐ The local DNS server will solve the name asking to the Root-Server, to the NS of .com and to the NS of aw.com in this order
- ☐ There will be sent 2 DNS messages to the N1 network
- ☐ The host will perform a recursive request
- ☐ There will be sent 6 DNS messages to the Internet



6, **MR**. A client and a server open a TCP connection. Consider that the MSS is 600 bytes, the RTT is 10 ms, the RTO is 20 ms, and awnd = 15000 bytes. In the figure, the RTTs are counted starting from an arbitrary time during the connection indicated by 0. Identify the correct answer or answers

- ☐ The value of the cwnd at time 11 will be 4800 bytes
- ☐ The value of the ssthresh between time 0 and 7 is approx. 16 MSS
- ☐ Slow Start is used between time 2 and 6
- ☐ The value of the ssthresh at time 9 will be 6000 bytes



7. **MR**. A switch with 4 interfaces connects 4 hubs, each one connecting 3 stations (for a total of 12 stations). VLAN is not used

- ☐ Only one station can transmit a frame at time to avoid collisions
- ☐ There are 12 collision domains
- ☐ The 12 hosts belong to the same network
- ☐ A frame transmitted in broadcast is received exclusively by the stations connected to the same hub of the source
- ☐ Up to four stations can transmit at time without creating a collision

8. **RU**. MIME is

- ☐ A protocol to download emails to the hosts
- ☐ A method used by SMTP to send emails hiding some destinations
- ☐ A standard that allows to send emails using text codifications different than ASCII and attaching files in any format
- ☐ A mechanism that allows to keep the emails in the server and to access them from any device

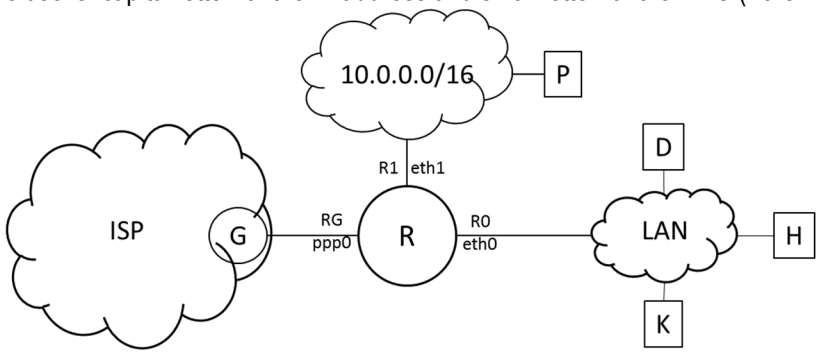
Final exam. Xarxes de Computadors (XC). Grau en Enginyeria Informàtica		15/01/2018	Fall 2018
NAME (in CAPITAL LETTERS):	FAMILY NAME (in CAPITAL LETTERS):	GRUP:	DNI/NIE:

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

Problem 1 (2'5 points).

The local network (LAN) uses private addresses. D is the local DNS server, the router R is the DHCP server, H is a web server (HTTP) and K is a device. All the devices have been configured correctly and are on, except K that is off.

The notation we use is: capital letter for the IP address and small letter for the MAC (Ethernet) address.



a) (0'25 points) Complete the sequence of Ethernet frames and IP packets transmitted when K is turned on and obtains its configuration.

Ethernet		IP		
src	**dst**	**src**	**dst**	**payload**
k				

After the configuration K knows its IP address (K), the IP address of the DNS server (D) and the IP address of the default router (R).

b) (0'5 punts) Complete the sequence of Ethernet frames and IP packets when the command "*ping www.domini*" is issued from K, until the first response is back. Consider that www is an HTTP server in the same domain, that is, H.

Ethernet		ARP		IP		
src	**dst**	**Q/R**	**message**	**src**	**dst**	**Payload**
k						

The routing table of router R is the following one:

Destination	Gateway	interface
192.168.168.0/24 (LAN)	----	eth0
10.0.0.0/16	----	eth1
11.11.0.0/16	10.0.0.11	eth1
G/32 (ISP)	----	ppp0
0.0.0.0/0	G	ppp0

c) (0'5 punts) Consider that the IP address of the router interface is the first IP address available in the subnetwork. That is, R0 is 192.168.168.1. The *traceroute* command allows the discovery of the sequence of router between source and destination.
From K (in the private network) the command "*traceroute 11.11.11.11"* is issued.
Complete the sequence of routers and interfaces shown by the *traceroute*.

From the device with IP address 11.11.11.11 the command "*traceroute K*" is issued.
Complete the sequence of routers and interfaces shown by the *traceroute*.

d) (0'5 punts) The command "*ping U*" is executed form device K. Consider that U is the address of an external server. Complete the sequence of IP datagrams that go through R. Identify the input and output interfaces. Note that the router performs NAT.

Interface	In/Out	Src IP address	Dst IP address	payload
eth0	in			

Which interface of the router R implements NAT ?

e) (0'25 punts) In order to connect with a remote LAN (192.168.200.0/24) a tunnel is setup from the remote router (RR) to router R (interface RG). Complete the new entries added in the routing table of R.

Destination	Gateway	interface
192.168.0.0/30		
192.168.200.0/24		

f) (0'5 punts) Complete the rules of the *Firewall* configured at interface RG needed for enforcing the following conditions: 1) Clients in LAN can access external servers; 2) web server (H) must be reachable form the Internet; 3) the DNS server (D) must be allowed to resolve names of any domain in the internet; 4) the devices in network 11.11.0.0/16 are web clients (*http*) only; 5) the devices in network 10.0.0.0/16 are allowed to access any server in the Internet.
The first column of the table shows which of the previous condition/s implement.

# RULE	IN/OUT	SRC IP	SRC port	DST IP	DST port	ACTION
1	IN	ANY	< 1024			
1	OUT	192.168.168.0/24				

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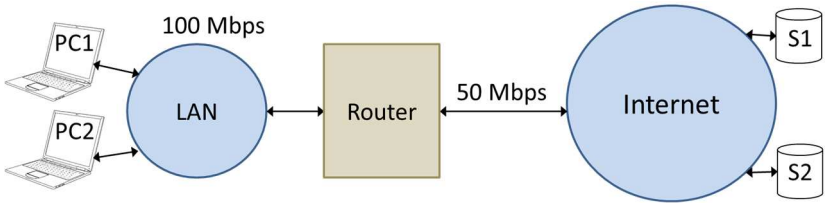
Exercise 2 (2 points)

We have two computers (PC1 and PC2) connected to a LAN, whose transmission speed is 100 Mbps. The LAN is connected to a Router that has 50 Mbps to access the Internet.



PC1 and PC2 establish 2 TCP connections with servers S1 and S2, respectively, to download very large files at the maximum possible speed from them. The agreed MSS is 1448 bytes. The IP address of S2 is 200.1.10.5, and that of PC2 is 147.83.39.20.

a) *(0,2 points)* With the available information, at what speed could both servers transmit?

b) *(0,3 points)* For the transmission from S1 to PC1, suppose there have been no losses and that half of the file has already been transmitted. If the RTT measured is 100 ms, how much should the value of the advertised window awnd sent by PC1 be, so that TCP does not allow a speed higher than 2 Mbps? Make the window a multiple of MSS and a power of 2.

Suppose that at a time of sending data from S2 to PC2 the following capture is made (the columns represent: 1) No. of the exchange line; 2) Time; 3) IP address and sending port; 4) IP address and receiving port; 5) Flags, 6) *(if there is data)* Sequence No.: Sequence No. of the next (Data Size), or *(if there is no data)* Ack Number.

```
1)  2)       3)                    4)                    5) 6)
1  2.100850 200.1.10.5.3287 > 147.83.39.20.2043: . 11025:12473(1448)
2  2.201934 147.83.39.20.2043 > 200.1.10.5.3287: . ack 11025
3  2.202032 200.1.10.5.3287 > 147.83.39.20.2043: . 12473:13921(1448)
4  2.202074 200.1.10.5.3287 > 147.83.39.20.2043: . 13921:15369(1448)
5  2.303513 147.83.39.20.2043 > 200.1.10.5.3287: . ack 11025
6  2.692975 200.1.10.5.3287 > 147.83.39.20.2043: . 11025: 12473(1448)
7  2.794419 147.83.39.20.2043 > 200.1.10.5.3287: . ack 13921
8  2.794503 200.1.10.5.3287 > 147.83.39.20.2043: . 13921:15369(1448)
9  2.795749 200.1.10.5.3287 > 147.83.39.20.2043: P 15369:16145(776)
10 2.896720 147.83.39.20.2043 > 200.1.10.5.3287: . ack 13921
11 3.252974 200.1.10.5.3287 > 147.83.39.20.2043: . 13921:15369(1448)
12 3.354419 147.83.39.20.2043 > 200.1.10.5.3287: . ack 16145
13 3.354519 200.1.10.5.3287 > 147.83.39.20.2043: . 16145:17593(1448)
14 3.354561 200.1.10.5.3287 > 147.83.39.20.2043: . 17593:19041(1448)
15 3.454561 147.83.39.20.2043 > 200.1.10.5.3287: . ack 17593
16 3.454835 200.1.10.5.3287 > 147.83.39.20.2043: FP 19041:20241(1200)
17 4.044446 147.83.39.20.2043 > 200.1.10.5.3287: . ack 19041
18 4.044555 200.1.10.5.3287 > 147.83.39.20.2043: FP 19041:20241(1200)
19 4.145837 147.83.39.20.2043 > 200.1.10.5.3287: F 1:1(0) ack 20242
20 4.145940 200.1.10.5.3287 > 147.83.39.20.2043: . ack 2
```

c) *(0,3 points)* How much is the value of the RTT and the RTO?

d) *(0,3 points)* If we did not have the Time column, can we know in which machine the capture is made?

e) *(0,3 points)* What has been the effective speed of the transmission?

Suppose that before the captured sequence there were no losses and that the advertised window *awnd* for the download is 4 MSS. Assume also that first a segment of a size smaller to one MSS has been sent, and that the rest of the segments sent afterwards are of a size of one MSS. **To answer the following questions it may be useful to draw the evolution of the windows**.

f) *(0,3 points)* Ignoring the smaller initial segment, how much is the value of the real (transmission) window at the start of the capture? How much time has it taken to get to it?

g) *(0,3 points)* How much is the threshold (*sshthres*) in exchange (line) 6?

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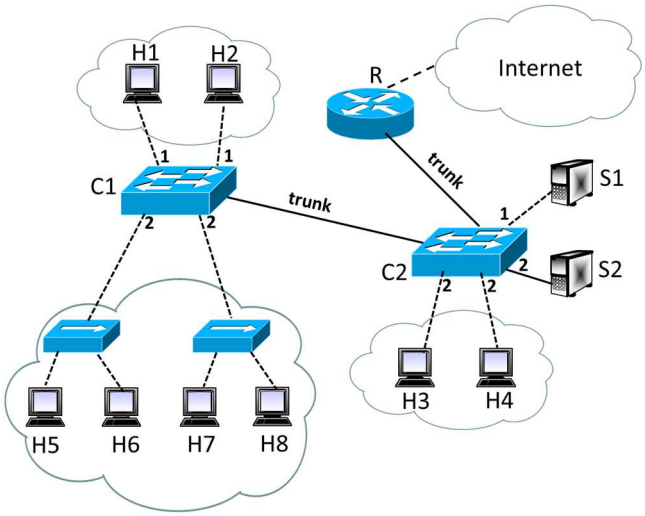
Exercise 3 (1 point)

We have the configuration of the figure with 2 VLANs, where a single router gives access to the Internet at 20 Mbps.

VLAN1 has two machines (H1 and H2) connected to switch C1 and an S1 server connected to switch C2. VLAN2 has machines H3 and H4 connected to C2, machines H5 and H6 connected to a hub and H7 and H8 connected to another hub. Both hubs are connected to C1. VLAN2 has a S2 server on C2.

All ports are 100 Mbps except the two trunks (C1-C2 and C2-R) and the port of S2, which are 1 Gbps. We consider that the hubs have an efficiency of 80%, and the switches 100%.



a) *(0,1 points)* If H5 sends a message to S1, which machines and devices will it go through?

b) *(0,2 points)* If H5 sends data at full capacity to S1 (and all other machines are stopped), at what speed can S1 receive them?

c) *(0,2 points)* If S2 wants to send data at maximum capacity at the same time to H3, H7 and H8 (with the rest of the machines stopped), at what speed can each one receive them?

d) *(0,1 points)* In the case of question "c", at what percentage of its capacity will S2 work?

e) *(0,2 points)* In the case of question "c", where will there be flow control and how will it be done?

f) *(0,2 points)* If H5, H6, H7 and H8 want to send data at full capacity to a machine on the Internet (beyond the Router), at what speed can they transmit?

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Problem 4 (1.5 points).

The client host.upc.edu wants to download the website web www.xc.com using HTTP 1.1 persistent. All DNS caches are initially empty. The page contains an HTML document with 6 objects:

- 1 picture hosted in the same web server,
- 3 pictures hosted in the server imatges.xc.com,
- 2 videos hosted at the server image.akamai.com.

Consider that:

- RTT = 100 ms, between the client and the servers www.xc.com and imatges.xc.com
- RTT = 30 ms, between the client and the server image.akamai.com
- RTT = 10 ms, between the client and its local DNS server
- RTT = 50 ms, between the local DNS server and any other DNS server
- 1 RTT to establish the TCP connection
- 2 RTT to close the TCP connection
- 1 RTT to download the HTML
- 10 RTT to download each picture
- 30 RTT to download each video

a) (0,5) Determine the number of TCP connections required to download the entire web page with all 7 objects

b) (1) The time needed by the client to download the entire web page (html, pictures and videos). Consider that: i) pipelining is not used, ii) it is not possible to have more than 1 TCP connection with the same server, iii) on the contrary, it is possible to start different communications with different destination in parallel.