Final Exam Xarxes de Computadors (XC), Grau en Enginyeria Informàtica		20/6/2018	Spring 2019
FIRST NAME (CAPITALS):	**NAME (CAPITALS):**	**GROUP:**	**DNI/ID:**

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

Quiz (2.5 points)

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

1. Regarding the address range 147.83.0.0/18:
- ☐ The broadcast address is 147.83.255.255.
- ☐ The broadcast address is 147.83.63.255.
- ☐ The netmask is 255.255.192.0.
- ☐ The last unicast IP address of the range is 147.83.63.254.

2. About IP: The maximum size of an IP packet is always limited by
- ☐ MTU.
- ☐ MSS.
- ☐ The size of an Ethernet frame.
- ☐ 65535 bytes.

3. About UDP:
- ☐ The header of the datagrams carry a checksum to detect corruption.
- ☐ The datagram header has an indication of the source and destination port.
- ☐ UDP ACKs allow flow control.
- ☐ The "three-way handshake" is not used.

4. About TCP:
- ☐ Provides in order and reliable delivery.
- ☐ The segments can be sent out of order.
- ☐ The optimal window determines the reception window.
- ☐ To close the connection you can send a RST or FIN.

5. About LANs:
- ☐ Switches use the RIP protocol to avoid loops.
- ☐ Switches use the spanning tree protocol to avoid loops.
- ☐ The ARP protocol uses broadcast Ethernet.
- ☐ The ICMP protocol uses broadcast Ethernet.

6. About Wi-Fi:
- ☐ Uses RTS/CTS to handle the hidden node problem.
- ☐ Uses CSMA/CD to handle the hidden node problem.
- ☐ The BSS Identifier (BSSID) is a 48-bit number.
- ☐ A Wi-Fi frame can be include up to 5 addresses.

7. In a DNS resolution:
- ☐ A server can query another to synchronize.
- ☐ A query for an MX record can return more than one answer.
- ☐ The TTL indicates the date of modification of a record.
- ☐ The root server logs have a low TTL to perform load balancing.

8. About Unicode:
- ☐ Can represent more than 100,000 characters.
- ☐ 4 bytes are always needed to represent any character.
- ☐ There are representations (UTF transformations) of fixed length.
- ☐ There are representations (UTF transformations) of variable length.

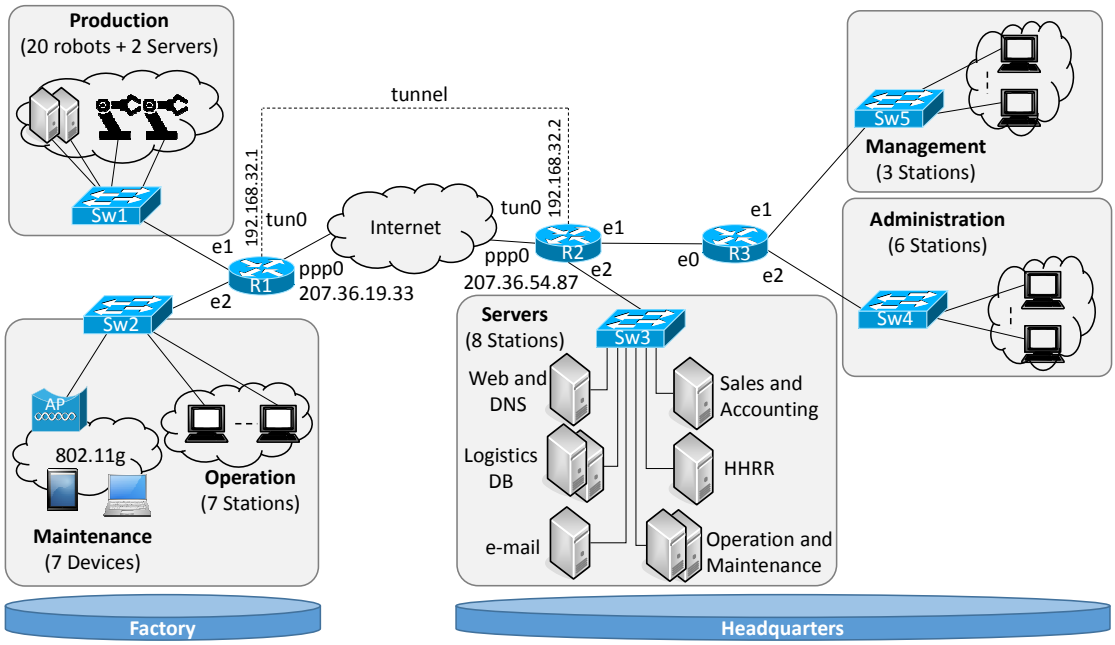
Final exam of Computer Networks (XC), Degree in Informatics Engineering		20/6/2019	Spring 2019
NAME:	SURNAME:	GRUP	ID

Duration: 2h45m. The test will be collected in 30 minutes. Please, answer the questions in the given tables.

Problem 1 (2.5 points)

The figure represents the network topology of a company, which includes two locations, Factory and the Headquarters, geographically separated. Three routers (R1..R3) and five switches (Sw1..5) are used for the network that is internally configured as 5 sub-networks (*Production* and *Operation and Maintenance* in Factory and *Management*, *Administration*, and *Servers* in the Headquarters) to facilitate its management. Routers R1 and R2 are used to connect the locations between them by an IP tunnel through the Internet.

The figure specifies the number of stations in every sub-network, as well as the name of the interfaces in the routers. Stations have a single interface named "e0".



The Internet access is provided by an ISP; routers R1 and R2 are connected to R1_ISP and R2_ISP, respectively through the ppp0 interface. The company has been assigned two public IPs 207.36.19.33 for R1 and 207.36.54.87 for R2, being the IP addresses for R1_ISP 207.36.19.1 and that for R2_ISP 207.36.54.1. The internal IP addressing has been planned based on the private IP address block 192.168.32.0/25.

Answer the following questions.

A) (0.75 points) complete the following table with the internal IP addressing plan by assigning sub-networks ordered by the number of IPs to be configured. Note that the mask must be configured to allow addressing the number of devices specified in the figure and be as tight as possible.

Sub-network	Number IPs to be configured	Prefix	mask
Tunnel	2	192.168.32.0	/30

B) (0.75 points) complete the routing table of router R2. Use route aggregation to the smallest mask, to reduce the routing table as much as possible, while maintaining reachability to all sub-networks and name the resulting sub-network concatenating the names of the aggregated ones. Add routes from more to less restrictive masks and use default routes when possible.

Sub-network	Prefix/mask	Gateway	Interface
ISP-R2	207.36.54.1/32	-	ppp0
Tunnel	192.168.32.0/30	-	tun0

C) (0.5 points) Imagine that a manager boots one of the stations in Management network (referred to as "Station"). Assume that all the ARP tables are empty and that the station sends a query to the DNS. Specify in the next table all the devices that will have the ARP table modified and their values when the station receives the reply message. Use the notation the <name of device>.<name of interface>, with <name of interface> in upper case for IP addresses (e.g., "R1.E1") and lower case for MAC addresses (e.g., "R1.e1").

Device name	IP address	MAC address

D) (0.5 points) To test the connectivity between the two locations, an operator executes a ping from the console of router R3 to the interface R1.e1. Write the IP addresses and the value in protocol field in the outer header of the IP datagram seen after the IP datagram leaves the following interfaces:

Output Interface	IP Header		
	Source address	Destination address	Protocol
R3.e0			
R2.tun0			
R2.ppp0			

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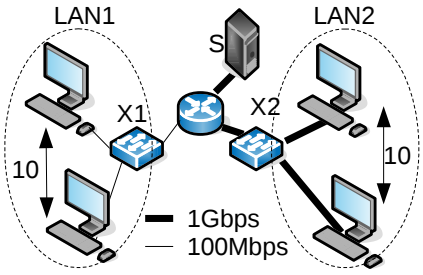
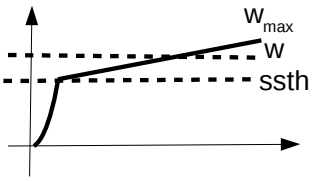
Problem 2. (2.5 points)

In the network of the figure there are 20 PCs that send data to the maximum throughput towards the server S using TCP. All links are full duplex. Those of the X1 switch are fastethernet (100 Mbps) and those of the X2 switch and the server are GigabitEthernet. The router has a queue that can store up to 2MB (2x106 bytes). Suppose that window scale is used, so that the router queue is filled and losses occur. To answer the following questions assume that the mean RTT is the same for all connections (note that this is an approximation).



2.1 (0,25 points) Compute the throughput of a PC of LAN1 and LAN2

2.2 (0,25 points) Suppose that the window of all connections follows a periodic saw shape as the figure shows. The figure indicates the maximum window Wmax, the average window W and the slow start sthreshold ssth. Say what is the relationship between Wmax and ssth.



2.3 (0,25 points) With the help of the previous sketch, compute the relationship between the maximum window (Wmax) and the average window (W) of a connection. To simplify, do not take into account the time in SS to do the calculation.

2.4 (0,25 points) Explain why the average window of PC connections in LAN1 (W1) can not be the same as that of the PCs in LAN2 (W2). Explain too why the maximum windows (Wmax1 and Wmax2) can not have the same value for the PC connections in LAN1 and LAN2.

2.5 (0,25 points) Compute the relationship between the maximum window of a LAN1 and LAN2 connections (Wmax2 / Wmax1).

2.6 (0,25 points) In order to have a simple estimate of the size of the windows we will make the approximation (coarse, not exact) that every time the router queue is full, the window of all connections reach their maximum value. Compute the maximum window for a LAN1 and a LAN2 connection.

2.7 (0,25 points) With the previous approach, estimate the mean RTT of a connection.

2.8 (0,25 points) Estimate the maximum RTT of a connection.

2.9 (0.25 points) Justify why the approximation in 2.6 is coarse (not exact).

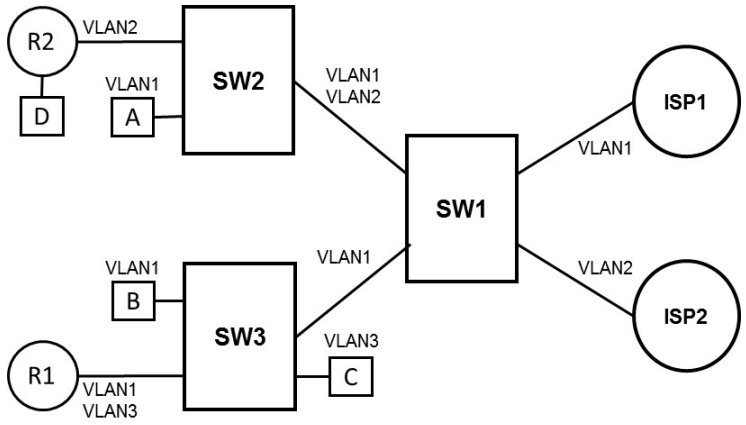
2.10 (0.25 points) Say whether the maximum windows will be actually larger or smaller than those estimated in section 2.6. Justify the answer.

Final exam. Xarxes de Computadors (XC). Grau en Enginyeria Informàtica		20/06/2019	Spring 2019
NAME (in UPPERCASE LETTERS):	FAMILY NAME (in UPPERCASE LETTERS):	GROUP:	DNI/NIE:

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

Problem 3 (1 point)

The figure shows a network including the configuration of the VLANs. VLAN1 provides access to the Internet via ISP1 and VLAN2 via ISP2. According with this configuration D has access to Internet via R2 and ISP2. The rest of the hosts (A, B and C) have access to the Internet via ISP1. The links in the figure show the VLAN defined. All of them are 1Gbps links.



For each of the following scenarios identify the sequence of devices each flow follows, the bottleneck, how flow control applies, and what is the maximum transmission speed the hosts may achieve.

a) Hosts A, B and D send traffic towards the Internet. C does not generate traffic. What is the transmission speed A, B and D may achieve?

b) Hosts A, B and D send traffic towards the Internet. C does not generate traffic. If host A transmits 250Mbps, what is the transmission speed B and D may achieve?

c) As in the previous scenario but now C transmits as much as possible to ISP1.

Suppose that C must transmit a continuous flow at 300Mbps towards D.

d) Which will be the path of the flow? Do we need any change in the configuration?

e) In the previous scenario, what is the transmission rate A may achieve when transmitting towards B?

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Problem 4 (1.5 points) According to the following message:

```
Return-Path: <fr@a.org>
Received: from mx1.upc.es (localhost [127.0.0.1])
      by mbox-1.upc.es with SMTP;
      Mon, 17 Jun 2019 10:10:12 +0200
Received: from mail.a.org
      by mx1.upc.es with SMTP id x5JHI04
      for <xc@upc.edu>; Mon, 17 Jun 2019 10:10:11 +0200
Received: from fr.local
      (Authenticated sender: fr)
      by mail.a.org with SMTP id 095D9B
      for <xc@upc.edu>; Mon, 17 Jun 2019 10:10:10 +0200 (CEST)
To: xc@upc.edu
From: fr sender <fr@a.org>
Subject: Logo
Message-ID: <c315223f-7565@a.org>
Date: Mon, 17 Jun 2019 10:10:10 +0200
MIME-Version: 1.0
Content-Type: multipart/alternative; boundary="C5C74"

This is a multi-part message in MIME format.
--C5C74
Content-Type: text/plain; charset=utf-8
Content-Transfer-Encoding: 7bit

El logo *UPC*

--C5C74
Content-Type: multipart/related; boundary="98BA2"

--98BA2
Content-Type: text/html; charset=utf-8
Content-Transfer-Encoding: 7bit

<html>
  <head>
    <meta http-equiv="content-type" content="text/html; charset=UTF-8">
  </head>
  <body>
    <p>El logo <b>UPC</b></p>
    <p><img src="cid:p1.4F61@a.org" alt=""></p>
  </body>
</html>

--98BA2
Content-Type: image/png; name="logo_upc.png"
Content-Transfer-Encoding: base64
Content-ID: <p1.4F61@a.org>
Content-Disposition: inline; filename="logo_upc.png"

iVBORw0KGgoAAAANSUhEUgAAAJEAAACKCAYAAACqyah7AAAAAXNSR0IArs4c6QAAAgtpVFh0
NzbjRolAREi5In+uYRZcJDLPEhzv/4+E/wKicXTRs39VDQAAAABJRU5ErkJggg==
--98BA2--
--C5C74--
```

a) (0.25 points) What DNS resource records has required the originating email server (a.org) to send it (to upc.edu)? Indicate why.

b) (0.25 points) What are the parts and content types in each part?

c) (0.25 points) The text "This is a multi-part message in MIME format." Will be seen by the user or not, and why?

d) (0.25 points) With reference to the attachment, what does "Content-Transfer-Encoding: base64" mean and what does the base64 encoding do?

e) (0.25 points) How can you detect that the message end?

f) (0.25 points) What the name of the receiver mailbox server and which lines indicate that.