Final exam. Xarxes de Computadors (XC), Grau en Enginyeria Informàtica		20/01/2017	Fall 2016
NAME (CAPITAL LETTERS):	FAMILY NAME (CAPITAL LETTERS):	GROUP:	ID# (DNI/NIE):

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

Test (2.5 points).

All questions are multiple choice. Count as half if there is one error, 0 if more than one error.

1. About the TCP/IP architecture,
- ☒ The IP address identifies the network interface of a device and the port number identifies the application
- ☒ The architecture follows the hierarchical model of functional layers defined by ISO/OSI where the IP and TCP layers match the network and transport functional layers, respectively
- ☐ All network devices implement both IP and TCP protocols
- ☐ The IP protocol provides a reliable communication

2. About IP protocol
- ☐ When a router discards a datagram it sends an ICMP message always
- ☐ The IP protocol establishes an end to end connection
- ☒ Each time a datagram crosses a router the value of the TTL field is decremented by 1
- ☐ The “checksum” field is computed including all the fields in the IP header and the data field

3. About ARP protocol
- ☐ It sends a broadcast datagram to discover the IP address of a device
- ☐ It sends a broadcast datagram to discover the default router of the IP subnetwork
- ☐ It sends an Ethernet frame with its own MAC address as destination address
- ☒ It sends a broadcast Ethernet frame to discover the MAC address of a device

4. About TCP
- ☒ Its header includes a sequence number field
- ☐ The awnd (advertised window) field tells the number of unacknowledged bytes
- ☒ The SYN bit (flag) identifies the start of a connection
- ☐ The TWH (Three Way Handshake) takes 2 RTT

5. About TCP
- ☒ If no segments are lost the congestion window (cwnd) grows until it reaches the value of the advertised window (awnd) and the protocol stays in the Slow Start phase always
- ☒ When a segment is lost its retransmission starts after the RTO (Retransmission Timeout)
- ☒ During connection set-up the value of MSS (Maximum Segment Size) is established
- ☒ During the Congestion Avoidance phase the window increments, approximately, by 1 segment (MSS bytes) for each RTT

6. About the DNS protocol
- ☐ All DNS clients (user’s devices) must know the IP addresses of the “root” servers
- ☒ All DNS clients (user’s devices) must know the IP address of a DNS server (either local or from the ISP)
- ☒ When a DNS server does not have the required information it sends an iterative DNS Request message to the root server
- ☒ A local DNS server behaves as a client of the DNS root servers and TLD servers

7. A HTTP 1.1 (persistent) client
- ☒ May establish more than one TCP connections when communicating with the same or different HTTP servers
- ☐ Establishes a TCP connection for each requested object
- ☒ Uses the commands GET and POST to request contents from the HTTP server
- ☒ May establish a secure connection with the server using HTTPS

8. About UNICODE
- ☐ One character is always coded using 32 bits
- ☐ Defines a unique code for each character and graphic symbol using 7 bits per byte
- ☒ A character coded with UTF-8 may require one, two, three or four bytes.
- ☒ One of the charset MIME may use is UTF-8

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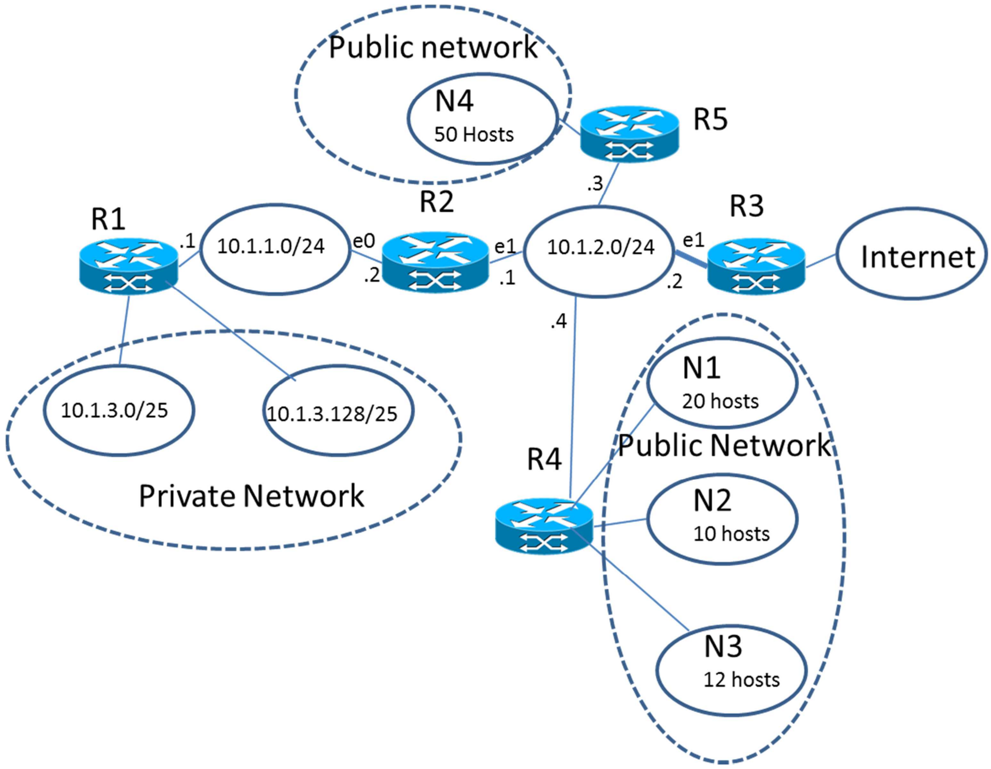
Problem 1 (2.5 points)

A business organization has a network as shown in the following diagram:



This network has been designed using private addressing, as indicated in the figure, and also using public addressing for networks N1, N2, N3 and N4. the network administrator has contracted with an ISP the range 220.10.0.0/25 for public networks taking into account the number of hosts shown in the figure.

a) Justify whether the IP public range allows the configuration of the networks using public addressing (0.25 points)

Total Hosts connected with public addresses is 50 + 20 + 10 + 12 = 102. A mask / 26 would not serve since it allows a maximum of 2^6 = 64 addresses. Mask / 25 we have an availability of 2^7 = 128 addresses, enough.

b) Fill in the following table with the most suitable distribution of public addresses (0.5 points)

Network	Number of IP addresses needed	Number of host-ID bits needed
N4	50+1router+Net+broadcast = 53	2^5 =32 (NO) 2^6 =64 (Yes) 6 bits
N1	20+1router+Net+broadcast = 23	2^4 =16 (NO) 2^5 =32 (Yes) 5 bits
N3	12+1router+Net+broadcast = 15	2^3 =8 (NO) 2^4 =16 (Yes) 4 bits
N2	10+1router+Net+broadcast = 13	2^3 =8 (NO) 2^4 =16 (Yes) 4 bits

c) Specify the IP addresses decided for each network. Fill in the table using the addresses ordered numerically, lower to higher (0.5 points)

Network	IP address (model indicated below)*	Mask	IP address
Contracted address	220.10.0.0XXXXXXX	/25	220.10.0.0
N4	220.10.0.00XXXXXX	/26	220.10.0.0
N1	220.10.0.010XXXXX	/27	220.10.0.64
N3	220.10.0.0110XXXX	/28	220.10.0.96
N2	220.10.0.0111XXXX	/28	220.10.0.112

* Put the IP address in this column with the last octet in binary to facilitate the calculation

d) If you later wish to merge the networks N2 and N3 indicate the resulting IP addressing . (0.25 points)

Network	IP Address (model indicated before)	Mask	IP Address
N3+N2	220.10.0.011XXXXX	/27	220.10.0.96

e) If the RIPv2 routing protocol is activated across the network, provide the routing table of R2 when RIP has converged. Use the hostid and interfaces shown in the figure (0.5 points)

Network/mask	GW (@IP)	Interface	Metric
10.1.1.0/24	-	e0	1
10.1.2.0/24	-	e1	1
10.1.3.0/24	10.1.1.1	e0	2
220.10.0.0/26 (N4)	10.1.2.3	e1	2
220.10.0.64/26 (N1-2-3)	10.1.2.4	e1	2
0.0.0.0/0	10.1.2.2	e1	-

f) Specify the ACL output in the e1 interface of R3 if the rules are that Internet external users can only access to TCP port 80 of N1 + N2 + N3 + N4, and hosts both of our public and private network can access any server on the Internet. (0.5 points)

Action	Protocol	Source: @ IP/mask port	Destination: @ IP/mask port
Permit	TCP	0.0.0.0/0 ≥ 1024	220.10.0.0/25 80
Permit	TCP	0.0.0.0/0 < 1024	10.0.0.0/8 (10.1.0.0/22) ≥ 1024
Permit	TCP	0.0.0.0/0 < 1024	220.10.0.0/25 ≥ 1024
Deny	IP	Any -	Any -

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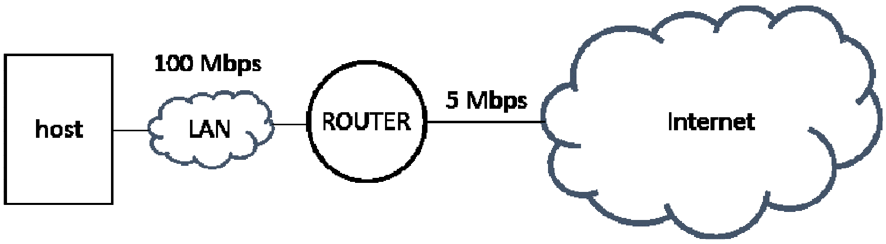
Problem 2 (1.5 points)

A computer is connected via Fast Ethernet to the access Router and the Internet. The Internet connection is at 5 Mbps. The computer transfers 5 files towards 5 remote servers simultaneously. The transfer program is FTP (File Transfer Program) which used TCP connexions. Four files have a size of de 10GB and the size of the fifth file is 100GB. There is no congestion neither in the Internet nor at the remote servers.



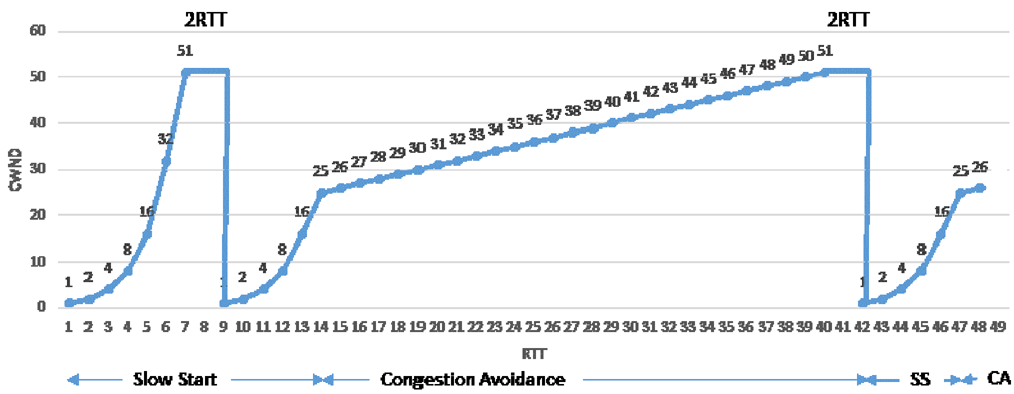
a) (0.5 points) Fins the average transmission rate for each file and make an estimation of the total time needed for completing the transfers considering optimal conditions. For the calculations, 1GB is 10^9 bytes.

The bottleneck is at the Internet connection at 5 Mbps.
As TCP shares equally the available bandwidth, each TCP connection will get 1 Mbps.
Transfer time for 10 GB: $10*10^9*8$ bits / 10^6 bits/sec = 80000 sec = 22'22 hours.
After 22'22 hours, there is a single TCP connection that will get 5 Mbps until the end of the transfer.
Transfer time for the rest of the fifth file (that is, 90GB): $90*10^9*8 / 5*10^6$ = 144000 sec = 40 hours.

In summary: all 5 connections get 1 Mpbs during 22'22 hours, and then the last connection enjoys a transmission rate of 5 Mbps during 40 additional hours.

There is a single TCP connection between the HOST and a remote server transferring a very large file (100GB). <u>Assume that when the windows reaches 50 segments there are losses</u>.
The MSS is 1250 bytes, the estimated RTT is 100 ms. and the retransmission timeout (RTO) is 200 ms.
b) (0.25 points) Determine the ssthres value after the first retransmission of a segment
Ssthres = 25.

c) (0.25 points) Draw a time diagram showing the evolution of the TCP window since the beginning of the connection. Show the SS (Slow Start) and CA (Congestion Avoidance) periods.

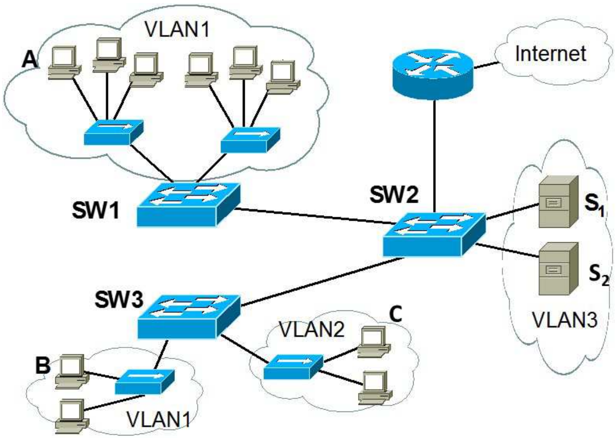


d) (0.25 points) Find out the number of RTT between two lost segments (TCP cycle).
The number of RTT between retransmissions is 42-9 = 33 RTT = 3'3 sec.

e) (0.25 points) Estimate the average transmission rate.
Each 33 RTT transmits 2+4+8+16+25+26+26+ ... +51 = 1056 new segments (the first one is the retransmitted segment).
1056 segments * 1250 octets/segment * 8 bits/octet / 33 * 100ms = 3'2 Mbps.

Problem 3 (1.5 ponts)

All the computers are connected at 100 Mbps (Fast Ethernet) while the links SW1-SW2, SW3-SW2,SW2-R, SW2-S1 and SW2-S2 are 1 Gbps links.



All VLAN1 computers (networks A and B) are downloading information from server S1. VLAN2 computers (network C) are inactive.

a) (0.25 points) Identify the MAC addresses stored in the MAC address table corresponding to the following switch ports:

a1) SW2: port S1

S1

a2) SW2: port SW1

MAC addresses of all 6 PC from network A

a3) SW2: port SW3

MAC addresses of the 2 PC from network B

a4) SW2: port Router

MAC address of the router interface

a5) SW1: port SW2

MAC address of the router interface

b) (0.25 points) Which links must be in “trunk” mode and which VLANs must be configured in each one?

SW2-SW3 (VLAN1, VLAN2) and SW2-R (VLAN1, VLAN2, VLAN3)

All PC (VLAN 1 and VLAN 2) are downloading data from serve S1 simultaneously using TCP. Consider that the performance of a “hub” is 80% and that of the switches is 100%.

c) (0.5 points) Identify the bottlenecks, how flow control operates at the switches and what is the downloading transfer rate of each PC (6 in network A, 2 in network B and 2 in network C).

Considering the performance of the hub, each hub in network A can receive 80Mbps.
Then, the SW2-SW1 link transmits 160 Mbps only.
The hub in network B can receive 80 Mbps. The hub in network C can receive 80 Mbps.
Then, the SW2-SW3 link transmits 160 Mbps only.
The link SW2-R would transmit 320 Mbps, up and down.
At the very beginning, flow control at the switches does is not activated (SW2 links are 1 Gbps).
Server S1 will try to transmit at 1 Gbps but losses will occur and TCP will act distributing 100 Mbps for each PC (10 PC mean 10 TCP connections).
Then, SW1 and SW3 will activate the flow control allowing each one 200 Mbps from SW2.
SW22 will then limit the traffic coming from the router at 400 Mbps, but this does not limit the transfer rate from S1.
There will be losses at the router and hubs. S1 will transmit in total 320 Mbps only. TCP will distribute this among all the clients.
PC in network A will get 80/3=26.6 Mbps; PC in network B will get 80/2=40 Mbps, and the ones in network C will get 40 Mbps.

With the aim of improving the overall performance, <u>all hubs are removed and PC are connected directly to the switches</u> at 100 Mbps.

Let us suppose that all PC download information from both servers at the same time at the maximum bit rate.

d) (0.5 points) Identify the bottlenecks, how flow control operates at the switches and what is the downloading transfer rate of each PC (6 in network A, 2 in network B and 2 in network C).

SW2 will apply flow control to the servers allowing 500 Mbps to each one.
The traffic coming back from the router (1 Gbps) will split between SW1 and SW3. As SW1 has 6 PC it may absorb 600 Mbps. SW3 has 4 PC and may absorb 400 Mbps.
Each PC will receive 100 Mbps in total, 50 Mbps from S1 and 50 Mbps from S2.

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

Problem 4 (2 points)

We want to send from a host (h1.upc.edu) an email message to x@y.org that includes a short greeting text in Catalan or Spanish and a document in PDF format. Assume that our mail server is smtp.upc.edu.
Consider the hosts: (a) h1.upc.edu, (b) smtp.upc.edu, (c) dns.upc.edu, (d) dns.y.org. Assume that all DNS caches are empty.

a) (0.25 pt) List the sequence of DNS and SMTP requests and responses sent and received by h1.upc.edu required to deliver the message to smtp.upc.edu.

Destination	Protocol	Description request	Description response
c	DNS	Recursive request, record A of **b**	Register A of (b)
b	SMTP	HELO name	220 OK reply (2XX)
b	SMTP	mail from: sender@upc.edu	250 OK reply
b	SMTP	rcpt to: x@y.org	250 OK reply
b	SMTP	data	354 OK reply (3XX)
b	SMTP	<content of the message> \n.	250 OK reply
b	SMTP	quit	221 OK reply

b) (0.25 pt) Indicate which DNS request and responses can send and receive smtp.upc.edu to decide to deliver the message to the mailbox of the final recipient.

dig -t mx y.org
y.org. 14400 IN MX 10 custmx.cscdns.net.
Also the NS and A records for y.org

c) (0.5 pt) Indicate the structure (MIME headers) that forms the body of the message.

```
MIME-Version: 1.0
Content-Type: multipart/mixed; boundary="BB"

--BB
Content-Type: text/plain; charset=utf-8
Content-Transfer-Encoding: quoted-printable

Hola, aqu=C3=AD est=C3=A1 el doc.


--BB
Content-Type: application/pdf
Content-Transfer-Encoding: base64

JVBERi0xLjUKJbXtrvsKMyAwIG9iago8PCAvTGVuZ3RoIDQgMCBSCiAgIC9GaWx0ZXIgL0Zs...
dHhyZWYKNzI4OTUKJSVFT0YK
--BB--
```

d) (0.25 pt) How does the recipient know which character set to be used to present the text of the message?

Based on the charset attribute of the text/plain content type.

e) (0.25 pt) Which protocols can the mailbox owner of x@y.org use to read the message?

IMAP or POP.