Second Midterm. Xarxes de Computadors (XC), Grau en Enginyeria Informàtica		5/12/2019	Fall 2019
NAME (in CAPITAL LETTERS):	**FAMILY NAME (in CAPITAL LETTERS):**	**GROUP:**	**DNI/NIE:**

Time: 1hour and 30 minutes. The quiz will be collected in 25 minutes.

Test (3 points). Multiple choice questions. Half value if there is one error and 0 if there are more errors.

1. The end to end propagation delay between a client and a server is 10 ms. Device A transmits to B. The path includes two routers with an output buffer of 1 MB (10^6 bytes). The transmission bitrate of all links is 10 Mbps. The size of the packet is 1250 bytes. Consider that the acknowledgments are very small packets and that they do not experience congestion. Traffic from other users go through the same routers and share the output buffers from A to B. An estimation of the minimum RTT ("round trip time") and maximum RTT (without losses) is:

- ☐ Minimum RTT 23ms.
- ☐ Maximum RTT 1250ms.
- ☐ Minimum RTT 20ms and maximum RTT depends on the protocol being used.
- ☐ Maximum RTT 1621ms.

2. In a point to point protocol the packet size is 1000 bits, the transmission bitrate is 1 Mbps, the transmission time for the "*ack*" is negligible and the end to end propagation delay is 50 ms. The estimation of the maximum efficiency of the protocol (throughout or effective rate / transmission bitrate) is:

- ☐ *Stop&Wait* protocol (window = 1), approximate efficiency: 10%.
- ☐ *Stop&Wait* protocol (window = 1), approximate efficiency: 1%.
- ☐ *Go-back-N* protocol (continuous transmission) with a window size of 50 packets, approximate efficiency: 50%.
- ☐ The size of the transmission window determines the maximum number of unacknowledged packets.

3. About TCP.

- ☐ Receiving a duplicate acknowledgment means always that a segment has been lost.
- ☐ The field "*awnd*" (advertised window) in the header tells the number of bytes that have not been acknowledged.
- ☐ The MSS and the "*Window Scale*" may be established during the connection setup ("*Three Way Handshaking*").
- ☐ The protocol uses accumulated acknowledgments showing the number of the expected segment.

4. About the following TCP trace:

```
150.214.5.135.80 > 192.168.137.128.39599: P 726852531:726853991(1460) ack 1637 win 5240
192.168.137.128.39599 > 150.214.5.135.80: . ack 726853991 win 64240
150.214.5.135.80 > 192.168.137.128.39599: . 726853991:726855451(1460) ack 1637 win 5240
192.168.137.128.39599 > 150.214.5.135.80: . ack 726855451 win 64240
150.214.5.135.80 > 192.168.137.128.39599: . 726855451:726856911(1460) ack 1637 win 5240
192.168.137.128.39599 > 150.214.5.135.80: . ack 726856911 win 64240
```

- ☐ The client's payload (MSS) is 1500 bytes.
- ☐ The client's advertised window (*awnd*) is 64240 bytes.
- ☐ The server's window is 5240 bytes.
- ☐ At the end of the trace the server has sent 1636 bytes.

5. About TCP. Check the event that may occur under certain circumstances.

- ☐ If there are no losses the window keeps growing indefinitely.
- ☐ If there are no losses the congestion window keeps growing indefinitely.
- ☐ After sending the full window (*cwnd*) as back to back segments, if all segments are acknowledged, the congestion window may grow approximately in 1 segment.
- ☐ After sending the full window (*cwnd*) as back to back segments, if all segments are acknowledged, the congestion window does not change its value.

6. About WLAN.

- ☐ A WLAN access point may work as an Ethernet Bridge connecting the fixed and wireless segments.
- ☐ In a WLAN (IEEE 802.11) the MAC header may contain more than two MAC addresses.
- ☐ In a WLAN the access point manages the collisions using the CSMA/CA mechanism.
- ☐ In a WLAN (infrastructure mode) all the frames go through the access point; that is, there is no direct transmission between two stations.

7. Check the correct sentences referred to an Ethernet switch with VLAN.

- ☐ The Ethernet switch applies flow control to all the frames that go from one VLAN to a different one.
- ☐ El STP ("*Spanning Tree*") protocol avoids loops in a VLAN by disabling some switch ports.
- ☐ *Broadcast* frames are retransmitted to all the other ports belonging to the same VLAN.
- ☐ *Broadcast* frames are retransmitted to all the other ports belonging to any VLAN.

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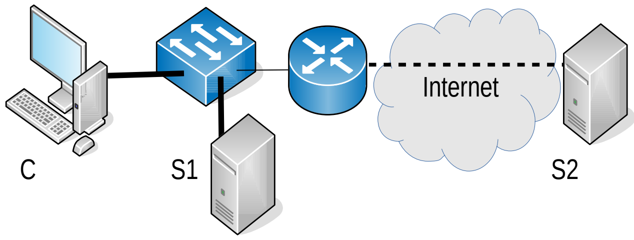
Name:	**Surname:**	**Group:**	**ID:**

Duration 1h30m. Please provide answers in this document.

Problem 1 (4 points).

We assume a non-congested Internet.
All connections are 1 Gb/s full-duplex,
except switch-router at 100 Mb/s full-duplex.
Minimum latency (RTT): C-S1 1ms, C-S2 50ms.
The router queues are 10 KB.
We use decimal units 1 Gbps = 1000 Mbps, 1 kB = 1000 bytes



a) Determine the optimal reception window of C when downloading content from S1 and also from S2:
C-S1: Wopt (bytes) =
C-S2: Wopt (bytes) =

b) Determine the effective speed (average for the entire transfer) of reception of C when downloading content from S1 and S2, if the window announced by both servers is 10000 bytes.
C-S1: Vef (Mb/s) =
C-S2: Vef (Mb/s) =

From now on we have window scaling 4 ($x2^4$): the announced window is 160KB, for S1 y S2:

c) Determine the maximum window for each transfer and what it depends on:
C-S1: Wmax =
C-S2: Wmax =

d) Towards the end of a long TCP transfer, what state the connections will be in? (SS-CA)
C-S1:
C-S2:

e) Indicate the value of ssthresh towards the end of a long TCP transfer:
C-S1: ssthresh =
C-S2: ssthresh =

f) Determine the medium transfer window and what determines it:
C-S1: W =
C-S2: W =

g) Indicate the maximum RTT value towards the end of a long TCP transfer:
C-S1: RTT =
C-S2: RTT =

h) Indicate the effective speed of long simultaneous TCP transfers from S1 and S2 to C considering the RTT of the previous item:
C-S1: Vef =
C-S2: Vef =

h) What is the effect of interrupting one connection on the other?
C-S1 (stopping C-S2): Vef =
C-S2 (stopping C-S1): Vef =

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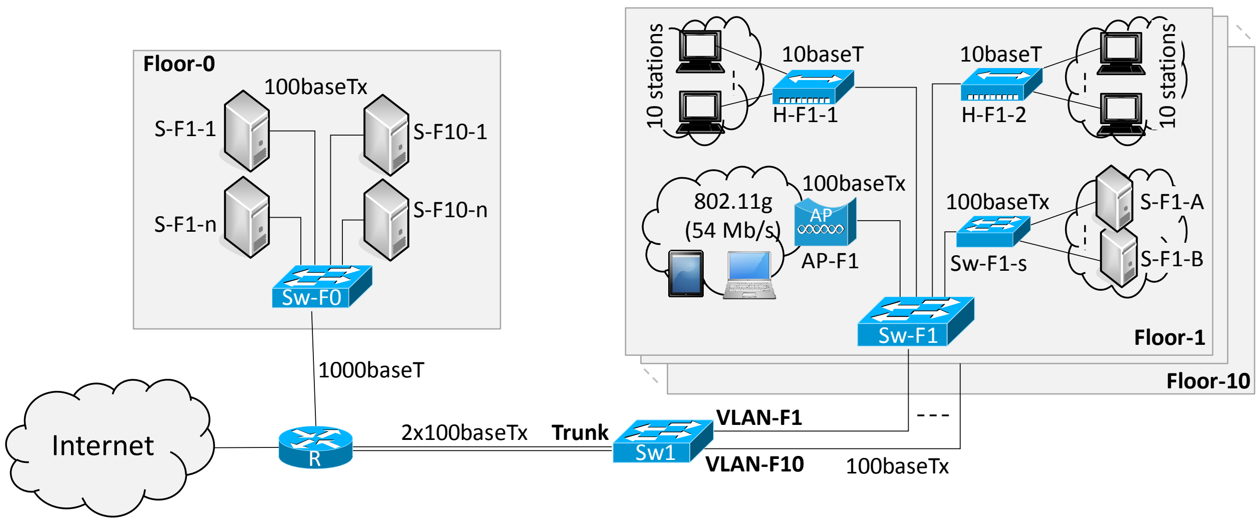
Duration: 1h30m. Please answer the questions in the table.

Problem 2 (3 points)

The figure represents the network topology of a 11-floor multi-company office building. There are 10 floors for offices, where the network of every office floor *i* has been designed identically to support up to 20 workstations that are wired to two different hubs (H-F*i*-1..2), two floor servers (S-F*i*-A..B), and includes a WiFi access point (AP-F*i*); office floors are connected to the rest of the network through an Ethernet switch (Sw-F*i*). A common Ethernet switch (Sw1) connects the different office floors and VLANs are configured to isolate the network traffic of each floor; VLAN configuration is shown in the interfaces when applicable. The building includes a common space for hosting servers in Floor-0. Finally, the network of the building is connected to the Internet through a router (R).

The efficiency of the switches is 100%, that of the hubs is 80%, and that of the access-point is 66.7% (two thirds). The technology of the interfaces is shown in the figure, where 10baseT interfaces are half-duplex and 100baseTX/1000baseT are full-duplex (consider the double link between the Sw1 and R as just one with 200Mb/s of aggregated bitrate).



Answer the following questions in the next table for the scenarios that are given: (*i*) the bottlenecks that would be created, (*ii*) which would be the mechanism(s) that would regulate the throughput of the stations, (*iii*) the throughput that active stations would achieve.

Assume that data exchange in the scenarios is independent, based on TCP, takes place for all the office floors at the same time and that stations that are not active do not transmit.

A) (0.75 points) All the workstations in each office floor (*i*) upload data to server S-F*i*-1 in Floor-0.

B) (0.75 points) 10 mobile devices in each office floor (*i*) download data from server S-F*i*-A in the same office floor *i*.

C) (0.25 points) Servers S-F*i*-A and S-F*i*-B in the same office floor *i* synchronize data among them.

Q	Bottleneck (Hub-F, AP-F, SW-F, Sw1, R, Interface)	Flow Control Mechanism(s)	Throughput per station/device/server (Mb/s)
A)			
B)			
C)			

There are four different companies in the building, where company A occupies floor 1, company B floor 2, company C floors 3-6, and company D floors 7-10.

D) (0.75 point) In the case of the companies C and D in multiple floors, the synchronization operation involves also multi-floor exchange. Assume that this synchronization is independent of the single-floor one (scenario C) and it consists of just one of the servers per office floor *i* (e.g., S-F*i*-A) sending and receiving simultaneously data to/from the servers in other office floors (one per floor) of the company. Then, multi-floor synchronization for company C, involves servers {S-F3-A, S-F4-A, S-F5-A, S-F6-A}. Note that the synchronization of companies C and D is carried out simultaneously.

Q	**Bottleneck (Hub-F, AP-F, SW-F, Sw1, R, Interface)**	**Flow Control Mechanism(s)**	**Throughput per station/device/server (Mb/s)**
D)			

E) (0.5 point) What is the main change that can be done to improve the speed of data synchronization of servers in the multi-floor scenario D, without expending money for upgrading the network? What would be the throughput achieved?

Proposed change	**Throughput per server (Mb/s)**

F) (0.5 points) Which are the contents of the MAC table in *Sw1* after the previous activity?
Answer in the following table, where:

- the *Y/N* field specifies whether at least one host in the entry would be in the MAC table;
- the *output port* field specifies the name of the connected network device, e.g., *Sw-F1* specifies the interface that connects Sw1 to the switch in Floor 1.

MAC addresses learned in Sw1	**Y/N**	**Output Port**
Floor-0: Servers		
Floor-1: Stations		
Floor-1: Mobile devices		
Floor-1: Servers		
Floor-3: Stations		
Floor-3: Mobile devices		
Floor-3: Servers		