ORDRE DES INGÉNIEURS DU QUÉBEC

SESSION DE NOVEMBRE 2018

Open-book examination
Calculators : only authorized models
Duration : 3 hours

16-EL-B1 Information Technology Networks

General information

- **1k = 1000**
- **Gbps = 1 000 000 000 bits/sec**
- **Mbps = 1 000 000 bits/sec**
- **Kbps = 1000 bits/sec**
- **Mbytes = 1 000 000 bytes**
- **Kbytes = 1 000 bytes**
- **Giga-Ethernet = 1 Gbps**
- **Fast-ethernet = 100 Mbps**
- **Maximal frame Ethernet = 1518 bytes**
- **Minimal frame Ethernet = 64 bytes**
- **Header Ethernet = 18 bytes**
- **Header IP = 20 bytes**
- **Header TCP = 20 bytes**
- **Header UDP = 8 bytes**

Question 1 (6 points)

A company is installing a video surveillance system in a building. The topology of this system is shown in Figure 1. There are 3 switches (2, 3 and 4) for connecting cameras, with N cameras per switch. All three switches have the same number of connected cameras. The links between the cameras and these switches are Fast Ethernet. These three switches are connected to switch 1 by giga-Ethernet links. The server processing the videos is also connected to switch 1. Each video camera takes 10 Kbytes photos every 40 milliseconds, and these photos are sent to a server connected to the same network. M bytes of data (useful data) are sent in each frame and **Ethernet-IP-TCP-Data** encapsulation is used.

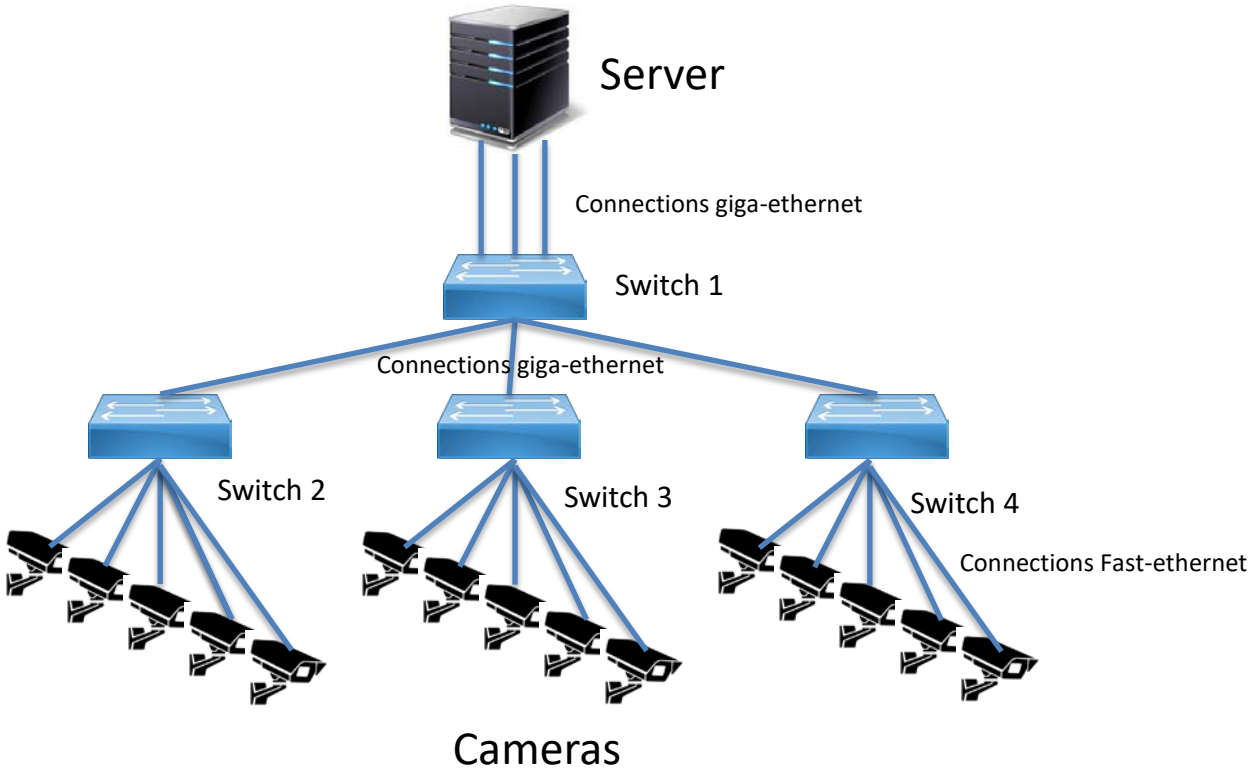

Figure 1

a) Considering only transmitted data frames and ignoring synchronization bytes, how many frames and bytes will be transferred for M = 1000 bytes of data? What is the transfer rate for a video transmission? Is it possible for each camera to send photos taken per second during the same second? Give the details of your calculations. **(2 pts)**

b) According to Figure 1, the connections between switches 2, 3 and 4 with switch 1 are giga-Ethernet links. Using the results of question a), how many cameras can be connected to a switch without exceeding the giga-Ethernet link capacity? Give the details of your calculations. **(2 pts)**

c) If we have 30 cameras (10 per switch), how many giga-Ethernet connections are needed between the server and switch 1 to receive all the videos? Use the results of question a). Justify your answers. **(2 pts)**

Question 2 (3 points)

A. When a file is transferred between two computers, two acknowledgment strategies are possible. After the file has been split into packets, either the individual packets are acknowledged by the recipient but not the entire file, or the file is acknowledged but not the packets individually. Compare these two approaches. **(1.5 point)**

B. Ethernet and wireless networks (Wi-Fi) have similarities and differences. One feature of Ethernet is that only one frame can be transmitted at a time. Does the 802.11 standard (Wi-Fi) share this property? Justify your answer. **(1.5 point)**

Question 3 (5 points)

Table 1 shows the configuration of the different machines in the network (Figure 2).

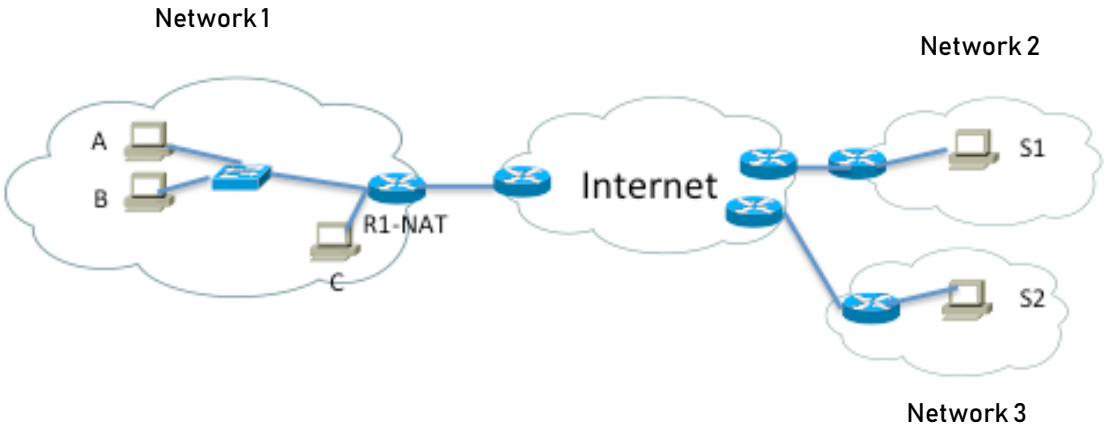

Figure 2.

Ethernet + IP + TCP + Data encapsulation is used in network 1.
IP + TCP + Data encapsulation is used between the R1-Nat router and the Internet router.

Tableau 1.

Machine ou router	IP address	Masque	Default Gateway	MAC address
A	192.168.15.16	255.255.255.224	192.168.15.1	11 :22 :33 :44 :55 :66
B	192.168.15.17	255.255.255.224	192.168.15.1	22 :33 :44 :55 :66 :77
C	192.168.15.165	255.255.255.224	192.168.15.161	33 :44 :55 :66 :77 :88
S1	132.170.17.45	255.255.0.0		
S2	167.145.67.85	255.255.0.0		
R1	192.168.15.1/ 192.168.15.161			11 :11 :11 :11 :11 :11
NAT	165.135.185.33			

Table 2 shows the different communications (connections) existing between the machines of the network 1 and the servers S1 and S2.

Tableau 2.

Connection	IP source	TCP port source	IP destination	TCP port destination
A → S1	192.168.15.16	4200	132.170.17.45	4000
A → S2	192.168.15.16	4300	167.145.67.85	4000
B → S1	192.168.15.17	4200	132.170.17.45	4300
C → S2	192.168.25.165	4200	167.145.67.85	6000
A → C	192.168.15.16	4400	192.168.25.165	5000

i. Give an example of a frame, for A→S1 communication, between A and R1. For this frame, specify only MAC addresses, IP addresses and TCP ports. **(1 pt)**

ii. Give an example of a packet, for A→S1 communication, between R1-Nat and the Internet router. For this package only, specify IP addresses and TCP ports. **(1 pt)**

iii. Is it possible for machine S1 (connection A→S1) to know the IP address of machine A? Justify your answer. **(1 pt)**

iv. Suppose we only have one IP address to communicate towards the Internet (165.135.185.33). Using NAT, what is the maximum number of connections that can be established from the local network towards the Internet? Justify your answer. **(1 pt)**

v. Is it possible for machine S2 to initiate a connection with machine C? Justify your answer. **(1 pt)**

Question 4 (3 points)

a. During an http request on Internet with IPv4, a transport protocol (TCP) and **IP-TCP-http-Data** encapsulation are normally used. Give three reasons for not using IP-http-Data. **(1.5 pt)**

b. There are several technologies for wireless communications (WiFi, Bluetooth, DSRC, Mics, etc.). These technologies are used in different contexts or application types. Give two reasons why WiFi cannot be used for all contexts or applications. **(1.5 pt)**

Question 5 (3 points)

A company received the IP network address 175.15.3.0/24 for its network. This company needs 11 subnets.

By optimizing the number of nodes per subnet,

a) Give the total number of subnets possible, nodes per subnet and the mask in abbreviated format. **(1 pt)**

b) Do nodes 175.15.3.29 and 175.15.3.35 belong to the same subnet? Justify your answer. **(1 pt)**

c) If we have the address 175.15.3.X / 27, what is the number of subnets and nodes we can have? **(1 pt)**