VIETNAM NATIONAL UNIVERSITY, HO CHI MINH CITY
UNIVERSITY OF TECHNOLOGY
FACULTY OF COMPUTER SCIENCE AND ENGINEERING

COMPUTER NETWORKS (LAB) (CO3094)

Assignment 2

NETWORK DESIGN

Advisor: Nguyễn Phương Duy
Students: Nguyễn Hữu Trùng Dương - 2052929
Huỳnh Tuấn Kiệt - 2052561
Nguyễn Phước Nguyên Phúc - 2053342
Nguyễn Mạnh Phú Quý - 2052680

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Contents

1 Introduction:

Due to global warming and many environmental problems these days, HCM University of Technology wants to rebuild the campus into a modern, friendly, and energy-saving place for all the students and tutors.

To achieve that purpose, a system monitoring activity of students in buildings needs to be built and in addition, in each classroom, measurement devices such as temperature, humidity, and light sensors also need to be implemented to calculate the energy usage in order to adjust the device and reduce the cost. To start deploying this project, HCMUT decided to build the system in building H6 of campus 2.

However, in order to make the operation of the system work better, the network design of the current building H6 needs to be reworked with a new design to utilize the features of the new system therefore, a group of students studying computer networks course is invited to counsel to offer appropriate solutions with the minimum cost for the current building H6.

2 System requirement:

In campus 2, the H6 building will implement a system of surveillance cameras at some point and the camera's data will be stored centrally in server room 106 H6. There are also computer rooms on floors 6 and 7.

To cater for monitoring, the University will invest in every classroom in the building H6 IoT devices include: 6 temperature sensors, 6 light sensors for large theory rooms (an area larger than 60 m2), the light control equipment; 3 temperature sensors, 3 light sensors for the remaining rooms (the smaller area of 60 m2), light control equipment.

Each operating spread on each floor will be fitted with 4 surveillance cameras. The classrooms will be equipped with desktop computers. In practice, the computer room will be fitted with air conditioner equipment control. The measurement device will collect data continuously every 1 minute in real-time and send it to the processing server every 5 minutes.

Description of data:

- A sensor will measure a different index but their data format size is 32 Kb
- Sensors will collect data for one minute once and after 5 minutes they send this data to the central server over the WIFI network
- The operation system of 24/7 surveillance cameras will store the data directly on a central server with a data transfer rate of 100 Mbps
- The computers in the classrooms will download about 200MB per day (peak hours are 7:00 to 17:30)
- Each device when connected to the WIFI network is used with 256 Kbps maximum speed in terms of time 7h30 to 17h30
- Building H6 has an administrative office with 10 computers
- The computers download about 200MB per day (peak hours are 8:00 am to 11:40 pm, 13h to 16h30) and send 10 emails per day with a maximum capacity of 10 MB per email.
- Each floor is the VLAN config and the system can connect to H6

2.1 Detailed system architecht:

2.1.1 H6 building:

- **Floors 2 to 5:** will have 6 small rooms (Height: 3m, Width: 10m, Depth: 5m), 3 large rooms (Height: 3m, Width: 20m, Depth: 5m).
- **Floor 1:** 6 small rooms, 3 large rooms and 1 server room (Height: 3m, Width: 10m, Depth: 5m).
- **Floors 6 and 7:** will have 4 small rooms (Height: 3m, Width: 10m, Depth: 5m), 2 large rooms (Height: 3m, Width: 20m, Depth: 5m), 3 computer room (Height: 3m, Width: 20m, Depth: 5m). In floors 6,7 will have 6 computer rooms, each room will have 32 computers.
- Each floor will have a switch for the camera and an access point from each room to connect
- Each room will have an access point for devices to connect to the WIFI network through a wireless connection. Height of each room is 3m.
- The Administrative office will have 10 computers

2.1.2 Device:

- The cameras only transmit data to the server room and their record can only be accessed by the admin in the administrative office or users in the server room. Therefore, our team network design must have separate VLAN between normal computers, devices with cameras, and admin devices, server room
- The camera will be implemented in the corridor of each floor.
- Maximum port when connecting to the switch is 1 GB
- Each switch from each floor then will connect to the main switch on floor 1
- The main switch then will connect to the final router before going out to the network
- Each camera will have a data transfer rate of 1 Mbps.
- Each computer in the server room will have a data transfer rate of 10 Mbps (to prevent the bandwidth to balance the network even though those computers connect to the same switch at the server and may have data transfer rate at 100 Mbps).

3 Throughput, bandwidth:

3.1 Defenition:

Throughput : is the rate of production or the rate at which something is processed. When used in the context of communication networks, such as Ethernet or packet radio, throughput or network throughput is the rate of successful message delivery over a communication channel.

Bandwidth: is the maximum rate of data transfer across a given path. Bandwidth may be characterized as network bandwidth, data bandwidth, or digital bandwidth.

3.2 Calculation:

3.2.1 Sensor:

- The number of sensor in H6 building:

$$(6+6) \times (3 \times 5 + 2 \times 2 + 3 \times 2) + (3+3) \times (6 \times 5 + 4 \times 2) = 528(sensors)$$

- Throughput of sensor:

$$\frac{528 \times 32 \times 10 \times 60}{10 \times 3600} = 281.6(Kbps) = 0.2816(Mbps)$$

3.2.2 Classroom computer:

- The number of computer in H6 building:

$$9 \times 5 + 102 \times 2 = 249(computers)$$

- Throughput of classroom computer in H6 building:

$$\frac{249 \times 200 \times 8}{10 \times 3600} = 11.06(Mbps)$$

3.2.3 Administrative computer:

- Throughput of administrative computer in H6 building:

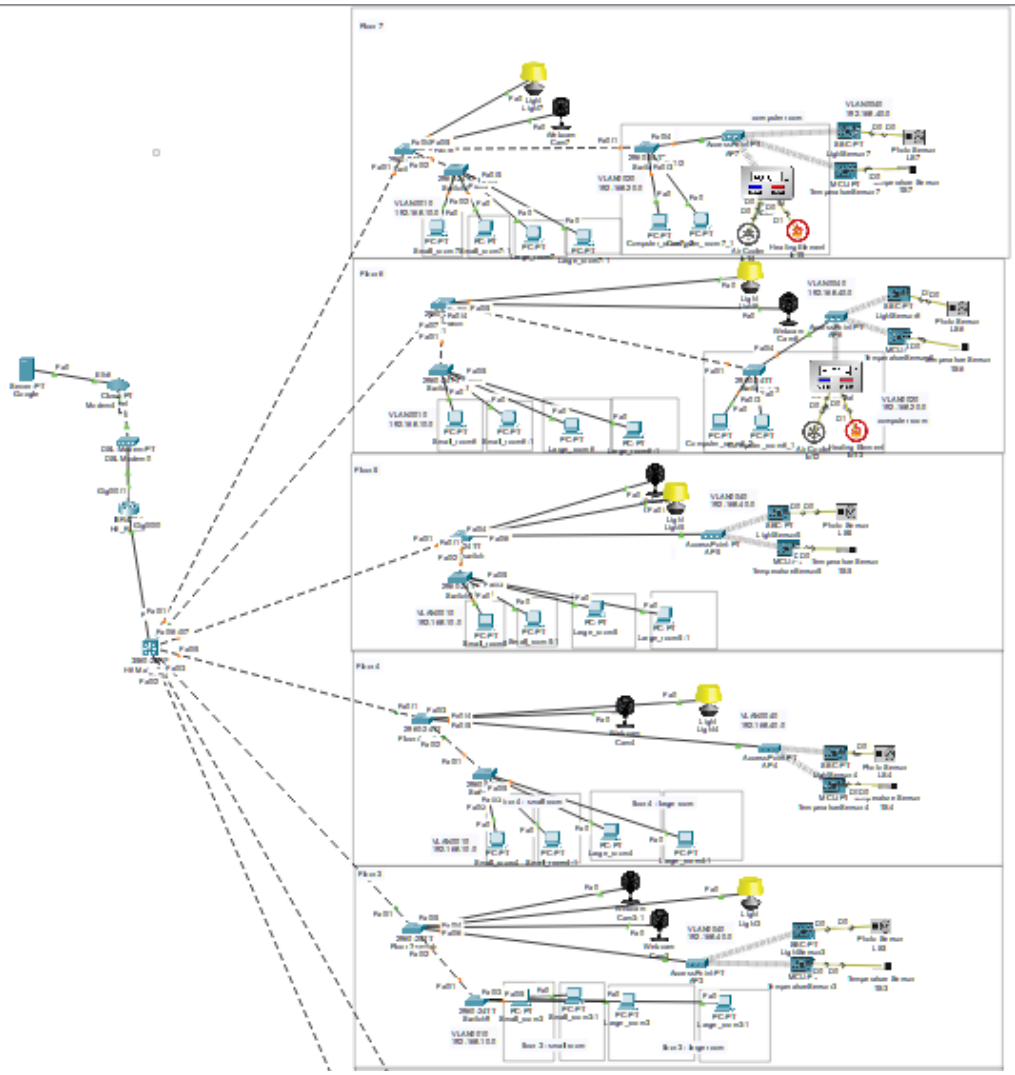
$$\frac{10 \times (200 + 10 \times 10) \times 8}{10 \times 3600} = 0.666(Mbps)$$

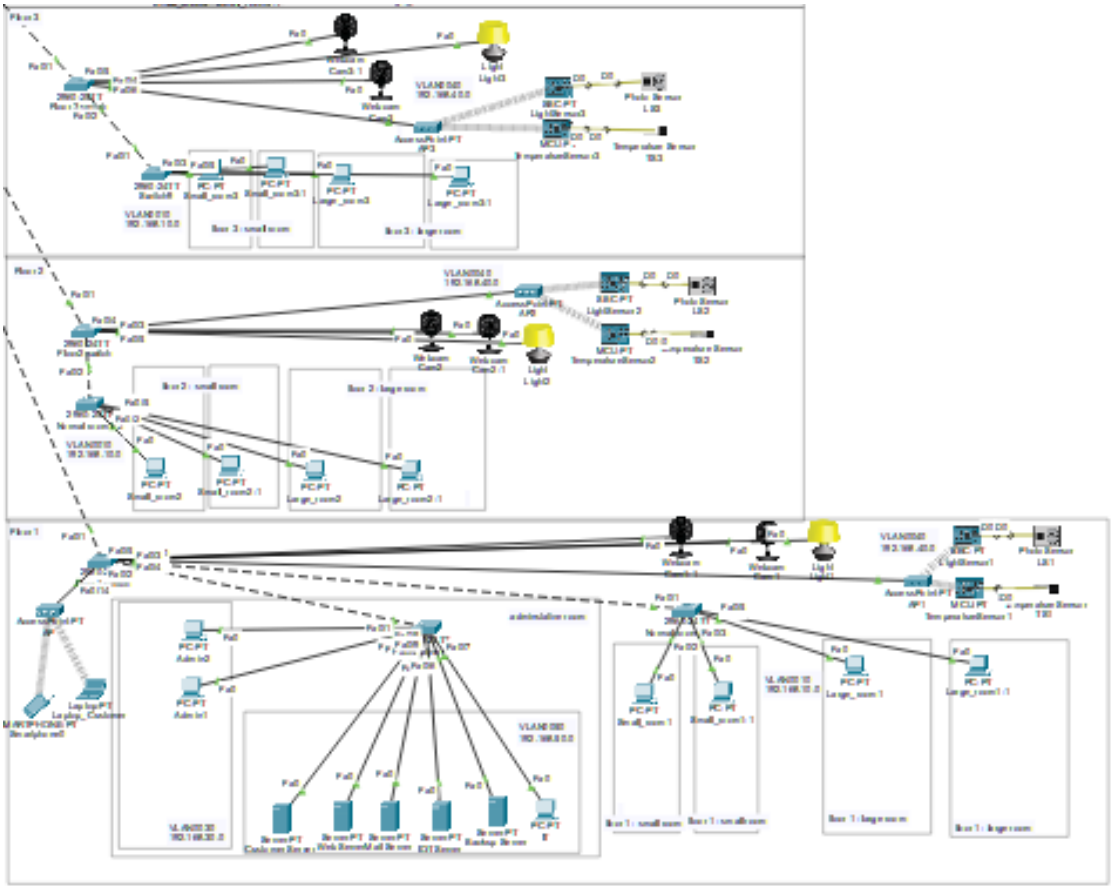
4 System design:

4.1 IP diagram:

STT	VLAN	Department	IP and Subnet mask
1	VLAN 10	Classroom	192.168.10.1/24
2	VLAN 20	Computer room	192.168.20.1/24
3	VLAN 30	Administrative office	192.168.30.1/24
4	VLAN 40	Sensor and Camera	192.168.40.1/24
5	VLAN 50	Sever room	192.168.50.1/24
6	VLAN 60	Other device	192.168.60.1/24

4.2 Packet Tracer design





In this design, we connect all switches into one multi-switch that connect to a main router. In the router, we set all the VLAN to the sub interface corresponding to their names

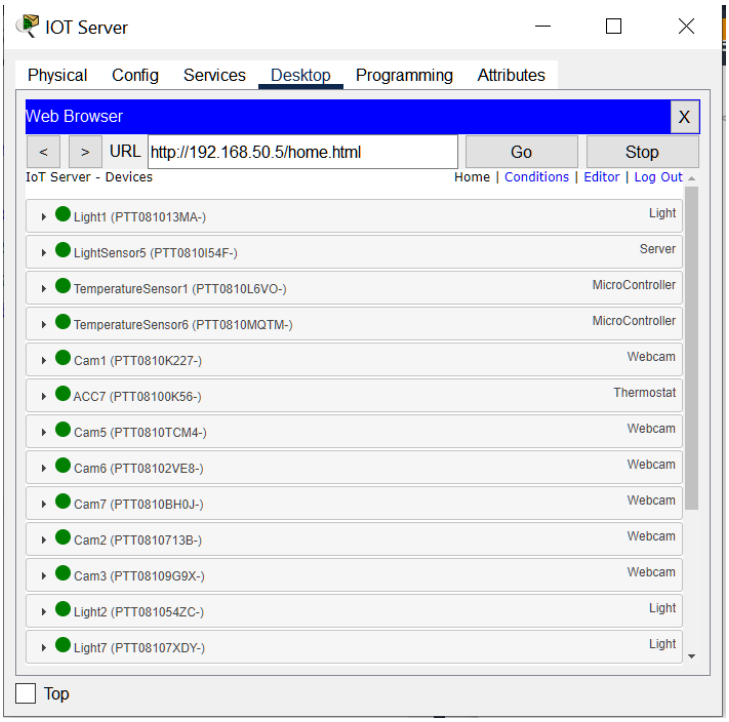
```
H6_router#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet0/0/0   unassigned      YES unset  up                    up
GigabitEthernet0/0/0.10192.168.10.1    YES manual up                    up
GigabitEthernet0/0/0.20192.168.20.1    YES manual up                    up
GigabitEthernet0/0/0.30192.168.30.1    YES manual up                    up
GigabitEthernet0/0/0.40192.168.40.1    YES manual up                    up
GigabitEthernet0/0/0.50192.168.50.1    YES manual up                    up
GigabitEthernet0/0/0.60192.168.60.1    YES manual up                    up
GigabitEthernet0/0/1   8.8.8.1         YES manual up                    up
GigabitEthernet0/0/2   unassigned      YES unset  administratively down down
Vlan1                  unassigned      YES unset  administratively down down
H6_router#
```

Then we set up an access-list to block a certain VLAN to connect to others

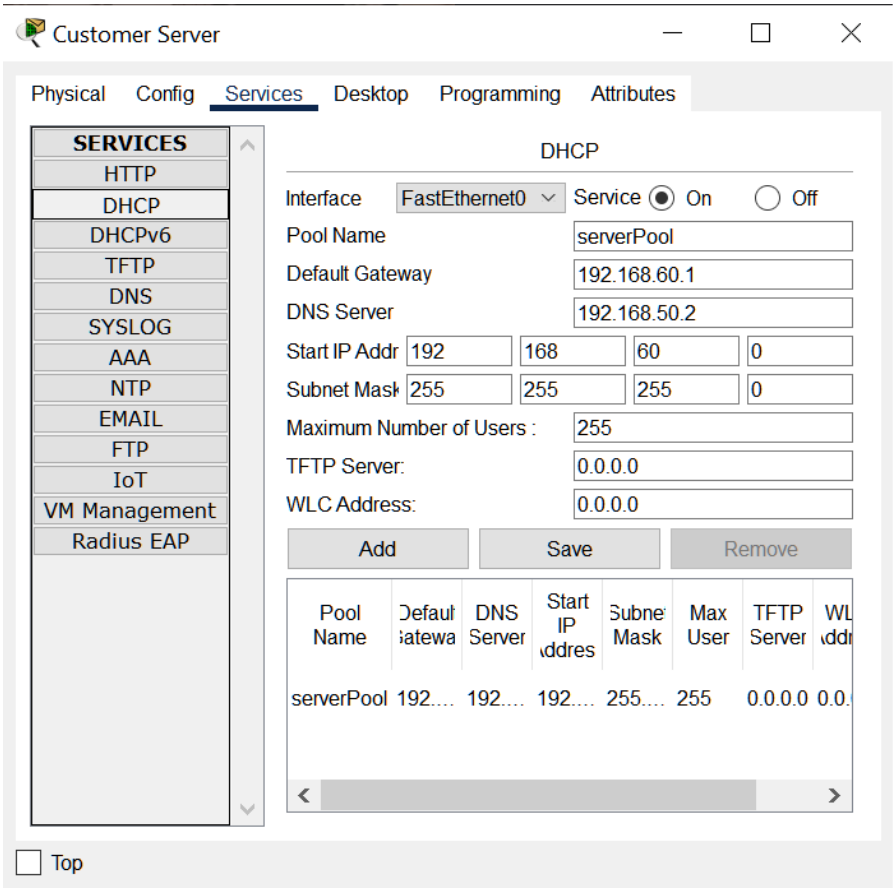
```
H6_router#show access-lists
Standard IP access list 1
    10 deny 192.168.60.0 0.0.0.255
    20 deny 192.168.50.0 0.0.0.255
    30 deny 192.168.40.0 0.0.0.255
    40 permit any
Standard IP access list 2
    10 deny 192.168.60.0 0.0.0.255
    20 deny 192.168.40.0 0.0.0.255
    30 permit any (25 match(es))
Standard IP access list 3
    10 deny 192.168.60.0 0.0.0.255
    20 permit any (7045 match(es))

H6_router#
```

Then we set up the servers corresponding to their functions For example: We set up the IOT server:



There is a customer server that provide IP address to customers, because we cannot set the static IP for all the customers



4.3 Checking the system

Only IOT devices, admin and IT computers are allowed to connected to the server

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	Cam1	IOT Server	ICMP		0.000	N	0	(edit)	(delete)
	Successful	Admin2	IOT Server	ICMP		0.000	N	1	(edit)	(delete)
	Successful	IT	IOT Server	ICMP		0.000	N	2	(edit)	(delete)

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Failed	Lapto...	IOT Server	ICMP		0.000	N	0	(edit)	(delete)
	Failed	Large...	IOT Server	ICMP		0.000	N	1	(edit)	(delete)

All of the devices in the building can access to the internet

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	Small...	Google	ICMP		0.000	N	0	(edit)	(delete)
	Successful	Admin2	Google	ICMP		0.000	N	1	(edit)	(delete)
	Successful	Lapto...	Google	ICMP		0.000	N	2	(edit)	(delete)

5 The equipment list:

5.1 Sever:

We are using 5 severs in this assignment: Customer sever, web server, mail sever, IOT sever and backup sever

5.2 Router:

Router is a device that communicates between the internet and the devices in the building that connect to the internet. There are two types of router: Wired and wireless. In this assignment, we choose Router CISCO ISR4331/K9, price is 40.810.000 VND

5.3 Core Switch:

Core-switch is a high-capacity switch. This switch is used to connect all switches on each floor. In this assignment, we choose Switch Cisco WS-C3560-24TS-S. with price 31.120.000 VND

5.4 Switch:

A network switch is networking hardware that connects devices on a computer network by using packet switching to receive and forward data to the destination device. A network switch is a multiport network bridge that uses MAC addresses to forward data at the data link layer of the OSI model.

We choose Switch Cisco WS-C2960S-24TS-L with price 7.450.000 VND

5.5 Access-point:

Access point is a wireless network device that acts as a portal for devices to connect to a local area network. They are used for extending the wireless coverage of an existing network so that a huge number of customers can access when coming to the bank.

In this assignment, we choose Access Point LINKSYS WAP54G with price 1.140.000 VND

5.6 Equiment list:

Each floor will have 4 camera, there are 28 camera in H6 building. Moreover, H6 building also contains:

Floor	Equipment
1	5 Server 19 Computer 1 Router 1 Switch 1 Core switch 10 Access point
2	1 Switch 9 Computer 10 Access point
3	1 Switch 9 Computer 10 Access point
4	1 Switch 9 Computer 10 Access point
5	1 Switch 9 Computer 10 Access point
6	4 Switch 102 Computers 10 Access point
7	4 Switch 102 Computers 10 Access point

5.7 Expected cost:

Network connection devices:

- One final router, 40.810.000 VND
- One Main switch, a multilayer switch, 31.120.000 VND
- 7 switch , 7.450.000 VND each
- 70 access points 1.140.000 VND each

Tocal cost: 203.880.000 VND

Other IoT devices:

- 28 camera, 900.000 VND each
- 264 light sensor, 200.000 VND each
- 264 tempareture sensor, 100.000 VND each
- 63 light controller, 1.000.000 VND
- 6 air conditioner controller, 1.000.000 VND each

Tocal cost: 173.400.000 VND

Total cost for network: 377.280.000 VND

6 Analyze the advantages and disadvantages:

- Technical benefits:
  - Improved security: Set up 2 VLANs can also limit the access of internal users and specific device types to a specified network segment. (Data or User). This ensure that segments are accessed only by authorized users and devices. Example: A user can't connect and get the data from the IOT service and only the devices that are authorized can get the IOT data
  - Cost Savings and Simplified IT Management: Instead of upgrading Local Network, VLANs make this possible by utilizing existing bandwidth and uplinks. Further cost savings comes from simplified IT management, which reduces IT resource requirements
  - Broadcast Control: Because we configure 2 Vlan for each flor (One for user and one for data of IOT device) and each has a different role so we can devide a floor LAN into smaller VLANs, we can reduce broadcast traffic because each broadcast will be sent on to the relevant VLAN only.
  - Good performance within the local network: the system mainly rely on link layer mechanism to transfer data, the data transfer rate among devices on local network is pretty fast
- Life benefits:
  - Energy Saving: Because all the device is controled by the IOT, Electric devices are directly connected and can communicate with a controller computer. So we can set up the fit wattage also as control it operation that compatible with environmental conditions. We can reduce the amount of electric and increase the product life.,
  - Save time: By reducing the human effort, it saves a lot of our time. Saving time is one of the primary advantages of using the IoT platform
- Life benefits:
  - A packet can leak from one VLAN to other
  - Threat in a single system may spread a virus through a whole logical network