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

Computer Network (CO3093)

Assignment 2

COMPUTER NETWORK DESIGN FOR BUILDING OF THE BANK

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HO CHI MINH CITY, NOVEMBER 2021

Member list & Workload

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Contents

1 Suitable network structures

1.1 Requirements analysis

- Using new technologies for network infrastructure including 100/1000 Mbps wired and wireless connection.
- The network is organized according to the VLAN structure: That is, dividing the center's network into sub-networks for departments. Computers in each of these VLANs can access each other, but computers on the outside network will not be able to access the VLANs of these departments.
- The network connects to outside by 2 leased line (for WAN connection) and 1 ADSL (for Internet access) with a load-balancing mechanism.
- High security, robustness when problems occur, easy to upgrade the system.
- BB Bank's Computer Network is estimated for a growth rate of 20% in 5 years (in terms of the number of users, network load, branch extensions, ..).

1.2 Solution

The whole network will be a LAN which connect to central router and Internet. This LAN will be divided into 7 VLAN for 7 floors.

1.2.1 Headquarters

We have 100 workstations which will be divided into 7 floors: each floor has 14 workstations, 2 additional workstations is added for IT room at first floor. Each floor use 1 switch to divide the machines, this switch is connected to the central switch of each floor. Therefore, we can expand the number of machines when needed, just add more Switches (if the additional number exceeds the number of ports of the original switch).

Since the number of workstations at each floor is not too much, we will use 20-24 port switches to make access switches for each floor, and the remaining ports can be used for future expansion.

The first floor is where we put 5 Servers and 12 network devices. Since all translation activities take place on the 1st floor, we will install a Wireless network to provide the network for customers. Each customer laptop accesses about 50Mb/-day.

We use 1 central switch for the whole building. This switch is a Layer 3 switch and is connected to the central router. So that we can configure this switch to allow or

not allow VLANs to access each other.

Regarding the bank's servers, our team found out that there are usually the following servers:

- **Web server**: customers can access to get information about their accounts in the bank as well as other services.
- **File server**: to share the information.
- **Mail server**: to send and receive mail.
- **DHCP Server**: provides and assigns IP addresses for network devices.
- **DNS server**: translate domain names to IP addresses as requested.
- **Database server**: to store the database.
- **Backup server**: store backup's information.

We will use 5 servers as the followings:

- 3 Database Server
- 1 File Server
- 1 DHCP Server

The internet connection from outside to the company network is through an ADSL connection.

1.2.2 Branches

For 2 branches:

- The 1^{st} floor is where 3 Servers and network devices are located and a WiFi transmitter modem for customers. The first floor of the branch office is the workplace of the IT department (5 Workstations), the Transaction department (15 Workstations) and the Branch Manager/Manager (5 Workstations).The 2^{nd} floor is the working place of the Finance and Accounting department, equipped with 25 Workstations.

- Each floor will use a 32-port switch, these two switches will connect to the total switch and connect to the branch's router. Similar to the center, we can expand the number of machines thanks to the remaining number.

The network system is classified into 3 levels:

- **Level 1**: Central router, branch router and Internet network.
- **Level 2**: The central switch of the building.
- **Level 3**: Departmental VLAN network.

- About connecting to external network: The company will hire 2 Leased Line and 1 ADSL line.

- The company will use the ADSL line to connect to the Internet. Allow the company's computer to access the Internet, as well as set up the WiFi network for the Client.

- 2 Leased Lines will be used to connect to 2 branches to ensure the stability of network transmission.

- The solution for branch expansion here is that we can easily connect to the new branch through a new Lease Line.

- At the same time, the company divides the network according to the VLAN structure and uses the Layer 3 Switch to make the core switch, so it can customize the access to the VLAN of the departments with the external network as well as with each other. This ensures the security of the company.

- Departments can also easily expand their model by installing more PCs and Switches in each room.

2 Minimum equipment, IP diagram, and wiring diagram (cabling)

2.1 Recommended equipment and typical specifications

2.1.1 Switch Cisco WS-C3560X

- 24 ports 10/100/1000 ports Gigabit Ethernet POE+ with optional uplink network modules.
- 435W POE power budget with up to 30W per port.
- Backup dual fan and power supply.
- Layer 2 switching with static routing and SVI support.
- 64MB flash memory and 256 memory (DRAM).
- USB Type-A and Type-B ports for storage and control respectively and an out-of-band Ethernet management port.

2.1.2 Multilayer Switch Layer 3

Model	JSH4726GBM
Ports	24 x RJ45
Standard	IEEE 802.3 IEEE 802.3u
MAC Address Table	8000
Data speed	10/100 Mbps

2.1.3 Cisco ASR 1001-X Router

- ESP bandwidth 2.5 Gbps (default) to 5/10/20 of forwarding performance (optional software option)
- DRAM memory: 4GB
- Flash memory 8GB
- External USB flash memory 1-GB USB flash memory support
- 6 Gigabit Ethernet Small Form-Factor Pluggable (SFP) ports

2.1.4 Cisco-Linksys WAP610N Wireless-N Access Point with Dual-Band

[H]

Data Link Protocol	IEEE 802.11n (draft), IEEE 802.11b, IEEE 802.11a, IEEE 802.11g.
Wireless Security	WEP, Wi-Fi Protected Access^{TM} 2 (WPA2), Wireless MAC Filtering.
Interfaces	1 x Network - Ethernet 10Base-T/100Base-TX/1000Base-T - RJ-45.
Bandwidth	2.4GHz - 5GHz

2.1.5 Cisco Firewall ASA 5540

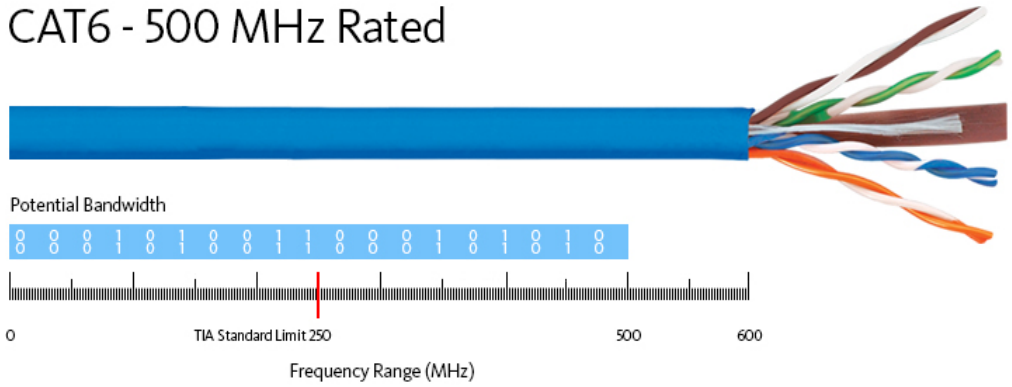
Firewall Throughput	Up to 650 Mbps
Maximum Firewall and IPS	Up to 500 Mbps with AIP SSM-20 Up to 650 Mbps with AIP SSM-40
VPN Throughput	Up to 325 Mbps
Concurrent Sessions	400,000
IPsec VPN Peers	5000

2.1.6 Cable 5

Network cable, at distances of less than 100m, uses UTP (Unshielded Twisted-Pair) Cable. It is often used to connect between the computer and the Switch.

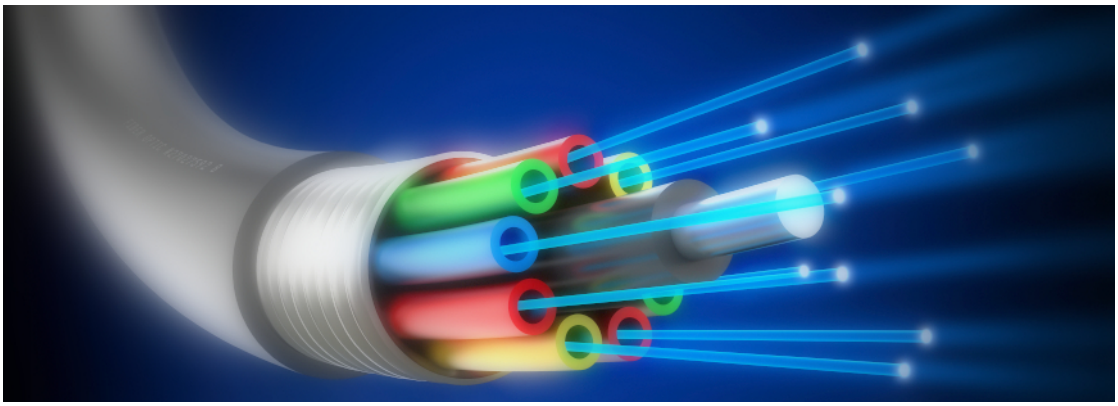
- 4 twisted pairs.
- 100Mbps theoretical speed.
- Only works well at distances under 100m.

2.1.7 Cat 6 Cable



- Affordable, but slightly more expensive than Cat5e
- Maximum frequency of 500MHz
- Maximum cable length is 100metres for slower network speeds (up to 1000Mbps), or 55 metres maximum for higher network speeds
- Less interference than Cat5e
- Top speed of 10Gbps over 55 metres of cable
- RJ45 Connectors

2.1.8 Optical fiber



- Shell: made of PE plastic.
- Coated steel core protects loose pipes.

- Machined steel core.
- Fiber type: Multimode 50/125 um.
- Number of yarns: 4 strands.
- Maximum transmission speed: 1 Gigabit/s.

2.2 IP Diagram

2.2.1 Headquarters

VLAN	Floor	IP Address	Default Gateway	Available IP address
VLAN3	LAN Server	192.168.3.0/24	192.168.3.1	192.168.3.2 - 192.168.3.254
VLAN10	1^{st} Floor	192.168.10.0/24	192.168.10.1	192.168.10.2 - 192.168.10.254
VLAN20	2^{nd} Floor	192.168.20.0/24	192.168.20.1	192.168.20.2 - 192.168.20.254
VLAN30	3^{rd} Floor	192.168.30.0/24	192.168.30.1	192.168.30.2 - 192.168.30.254
VLAN40	4^{th} Floor	192.168.40.0/24	192.168.40.1	192.168.40.2 - 192.168.40.254
VLAN50	5^{th} Floor	192.168.50.0/24	192.168.50.1	192.168.50.2 - 192.168.50.254
VLAN60	6^{th} Floor	192.168.60.0/24	192.168.60.1	192.168.60.2 - 192.168.60.254
VLAN70	7^{th} Floor	192.168.70.0/24	192.168.70.1	192.168.70.2 - 192.168.70.254
VLAN80	WiFi for customer	192.168.80.0/24	192.168.80.1	192.168.80.2 - 192.168.80.254

DHCP Server: VLAN 2
IP Address: 192.168.2.0/24
IP DHCP Server: 192.168.2.10/24

2.2.2 Branches

First branch:

VLAN	Floor	IP Address	Default Gateway	Available IP Address
VLAN3	LAN Server	172.16.3.0/24	172.16.3.1	172.16.3.2 - 172.16.3.254
VLAN10	1^{st} Floor A	172.16.10.0/24	172.16.10.1	172.16.10.2 - 172.16.10.254
VLAN20	1^{st} Floor B	172.16.20.0/24	172.16.20.1	172.16.20.2 - 172.16.20.254
VLAN30	2^{nd} Floor A	172.16.30.0/24	172.16.30.1	172.16.30.2 - 172.16.30.254
VLAN40	2^{nd} Floor B	172.16.40.0/24	172.16.40.1	172.16.40.2 - 172.16.40.254
VLAN50	WiFi for customer	172.16.50.0/24	172.16.50.1	172.16.50.2 - 172.16.50.254

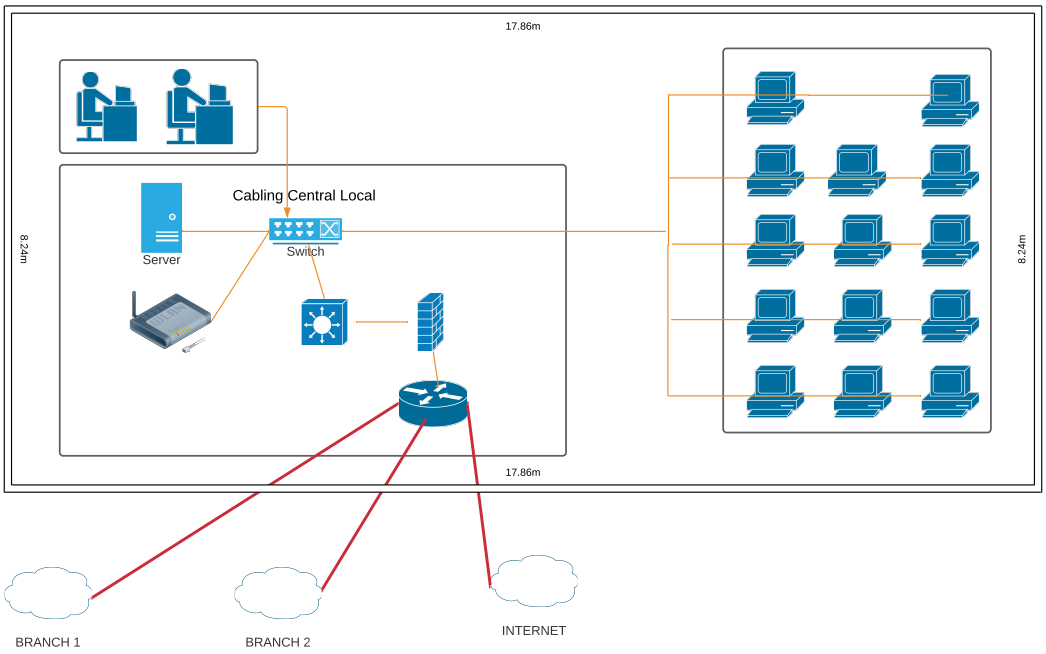
DHCP Server: VLAN 2
IP Address: 172.16.2.0/24
IP DHCP Server: 172.16.2.10/24
Second branch:

VLAN	Floor	IP Address	Default Gateway	Available address
VLAN3	LAN Server	172.17.3.0/24	172.17.3.1	172.17.3.2 - 172.17.3.254
VLAN10	1^{st} Floor A	172.17.10.0/24	172.17.10.1	172.17.10.2 - 172.17.10.254
VLAN20	1^{st} Floor B	172.17.20.0/24	172.17.20.1	172.17.20.2 - 172.17.20.254
VLAN30	2^{nd} Floor A	172.17.30.0/24	172.17.30.1	172.17.30.2 - 172.17.30.254
VLAN40	2^{nd} Floor B	172.17.40.0/24	172.17.40.1	172.17.40.2 - 172.17.40.254
VLAN50	WiFi for customer	172.17.50.0/24	172.17.50.1	172.17.50.2 - 172.16.50.254

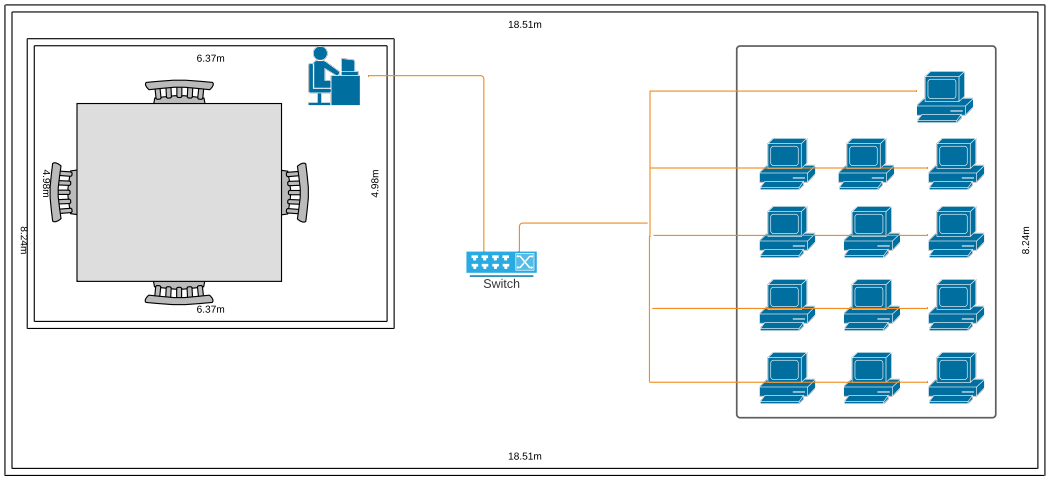
DHCP Server: VLAN 2
IP address: 172.17.2.0/24
IP DHCP Server: 172.17.2.10/24

2.2.3 Schematic physical setup of the system

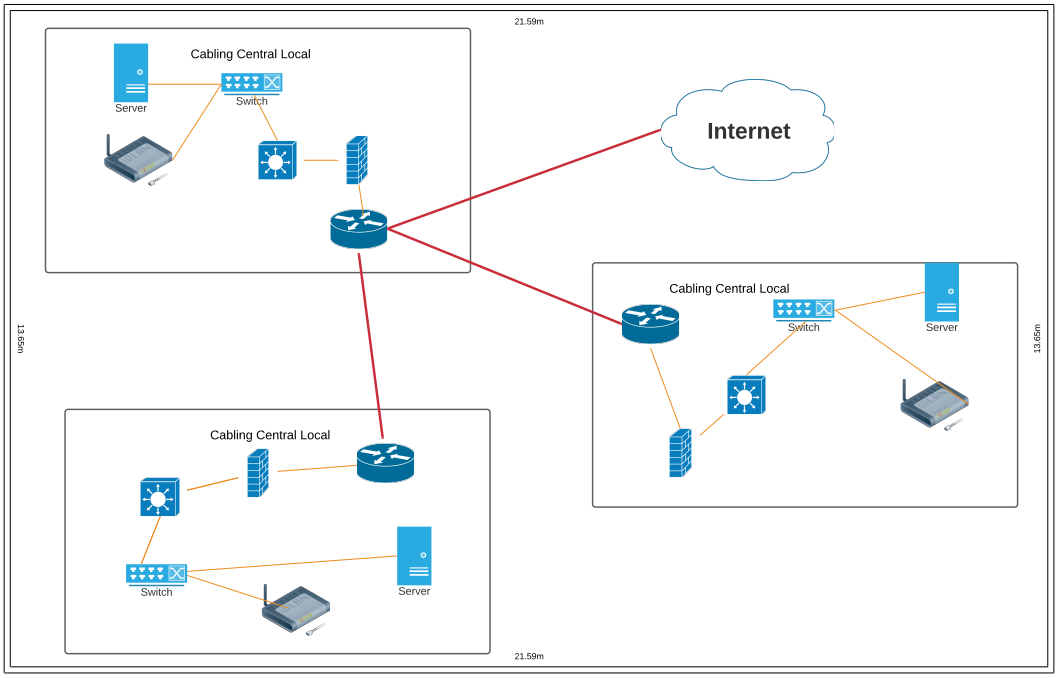
First floor



Other floors



2.3 WAN connection diagram between Headquarters and Branches (using OSPF protocol)



3 Throughput, bandwidth, and safety parameters

The flows and load parameters of the system (about 80% at peak hours 9g-11g and 15g-16g) can be shared for **Head Office** and **Branch** as follows:

- Servers for updates, web access, database access, ... The total upload and download capacity is about 500 MB/day.
- Each workstation is used for Web browsing, document downloads, customer transactions, ... The total upload and download capacity is about 100 MB/-day.
- WiFi-connected laptop for customers to access about 50 MB/day.

3.1 Headquarter

- At first floor, there are 5 servers. The total upload and download capacity is about 500 MB/day.

$$Throughput = 5 \times 500 \times \frac{1}{8 \times 3600} = 0.087MBps.$$

$$Bandwidth = 5 \times 500 \times \frac{0.8}{3 \times 3600} = 0.185MBps.$$

- There are total 100 workstations. The total upload and download capacity is about 100 MB/day:

$$Throughput = 100 \times 100 \times \frac{1}{8 \times 3600} = 0.347MBps$$

$$Bandwidth = 100 \times 100 \times \frac{0.8}{3 \times 3600} = 0.741MBps$$

- We have 100 laptop connecting to wifi, each access 50mb/day.

$$Throughput = 100 \times 50 \times \frac{1}{8 \times 3600} = 0.174MBps$$

$$Bandwidth = 100 \times 50 \times \frac{0.8}{3 \times 3600} = 0.370MBps$$

$\Rightarrow$ The total throughput and bandwidth when all network systems work concurrently is:

$$Throughput = 0.087 + 0.347 + 0.174 = 0.608MBps = 4.864Mbps$$

$$Bandwidth = 0.185 + 0.741 + 0.370 = 1.296MBps = 10.368Mbps$$

To ensure the system works stably when there are more developments in the next 5 years, we extend 20%:

$$\textbf{Throughput} = 4.864Mbps \times 120\% = 5.8368Mbps$$
$$\textbf{Bandwidth} = 10.368Mbps \times 120\% = 12.4416Mbps$$

3.2 Branch

- There are 3 Servers on the 1^{st} floor. Upload and download capacity is about 500MB/day. We calculate Throughput at the time of using the highest transmission line (Concentrated 80%) in 3 hours:

$$Throughput = 3 \times 500 \times \frac{1}{8 \times 3600} = 0.052MBps.$$
$$Bandwidth = 3 \times 500 \times \frac{0.8}{3 \times 3600} = 0.111MBps$$

- There are a total of 50 workstations. Total upload and download capacity is about 100MB/day. We calculate the Throughput at the time of using the highest transmission line:

$$Throughput = 50 \times 100 \times \frac{1}{8 \times 3600} = 0.174MBps$$
$$Bandwidth = 50 \times 100 \times \frac{0.8}{3 \times 3600} = 0.370MBps$$

- We install WiFi to provide network for about 50 laptops, each laptop can access about 50MB/day. We can calculate Throughput when using the highest transmission line:

$$Throughput = 50 \times 50 \times \frac{1}{8 \times 3600} = 0.087MBps$$
$$Bandwidth = 50 \times 50 \times \frac{0.8}{3 \times 3600} = 0.148MBps$$

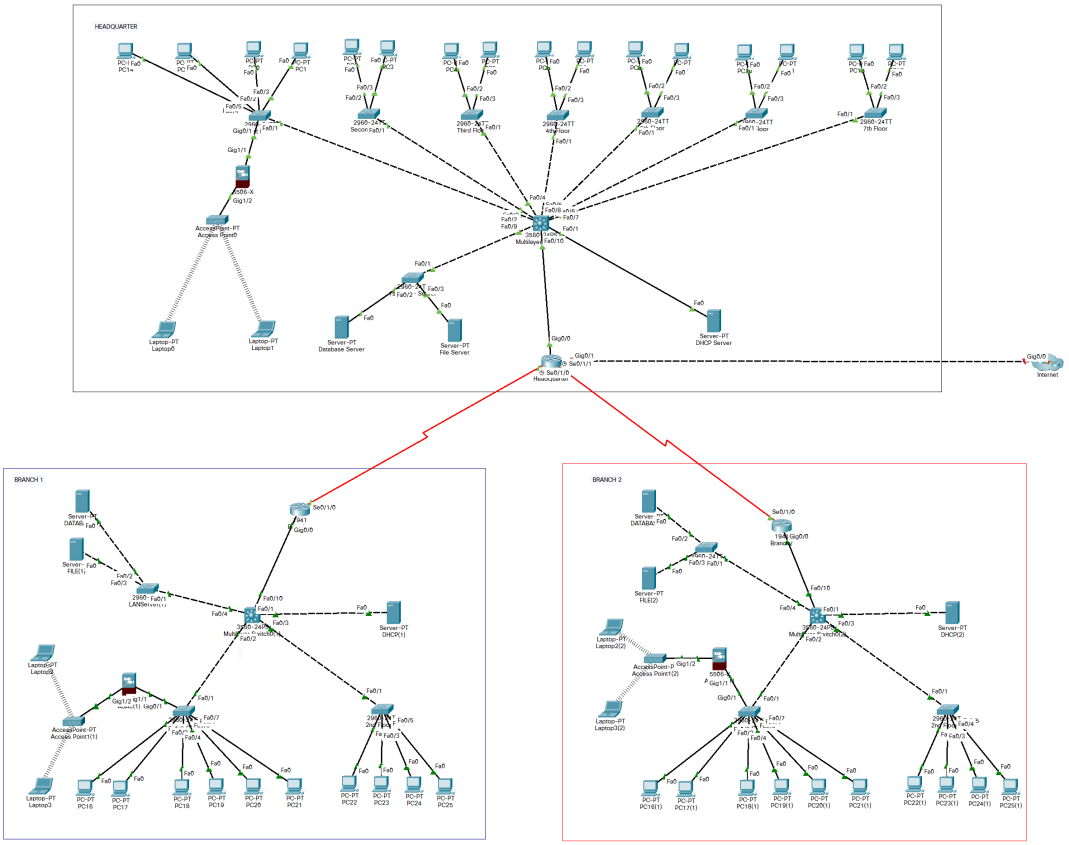
$\Rightarrow$ The total throughput and bandwidth when all network systems work concurrently is:

$$Throughput = 0.052 + 0.174 + 0.087 = 0.313MBps = 2.504Mbps$$
$$Bandwidth = 0.111 + 0.370 + 0.148 = 0.629MBps = 5.032Mbps$$

To ensure the system works stably when there are more developments in the next 5 years, we extend 20%:

$$\textbf{Throughput} = 2.504 * 120\% = 3.0048Mbps$$
$$\textbf{Bandwidth} = 5.032 * 120\% = 6.0384Mbps$$

4 Design the network map using Packet Tracer



5 Test the system

5.1 PCs Connection in same VLAN

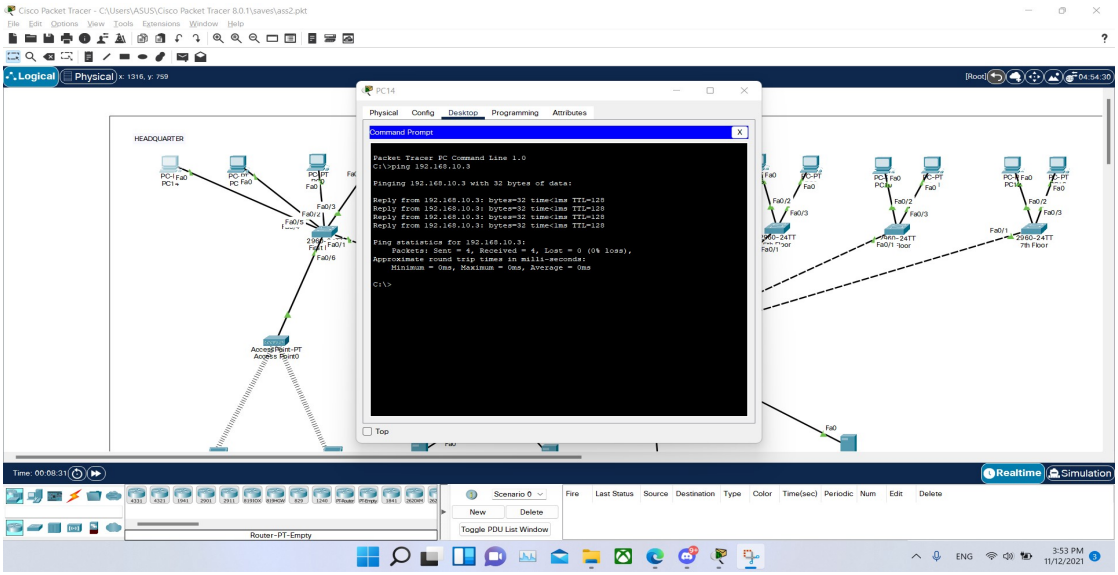


Figure 1: Connection between PC14(in VLAN10) and PC15(in VLAN10)

5.2 PCs Connection between different VLANs

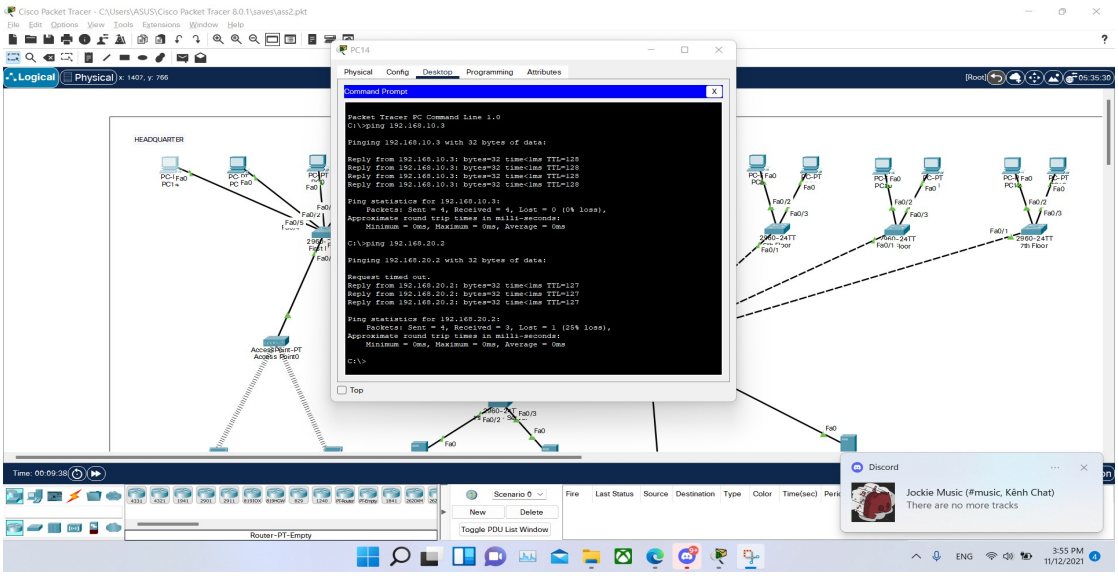


Figure 2: Connection between PC14 (in VLAN10) and PC2(in VLAN20)

5.3 PCs Connection between Headquarter and Branches

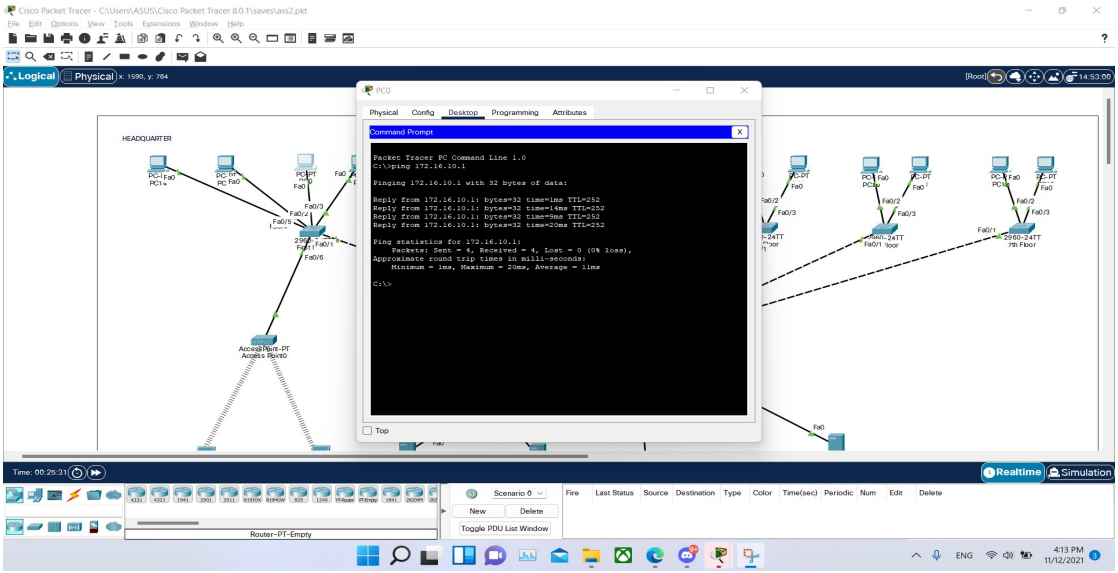


Figure 3: Connection between PC0 (in HQ) and PC16(in Branch1)

5.4 Connections from Customers devices (Laptop) to PCs on the LAN

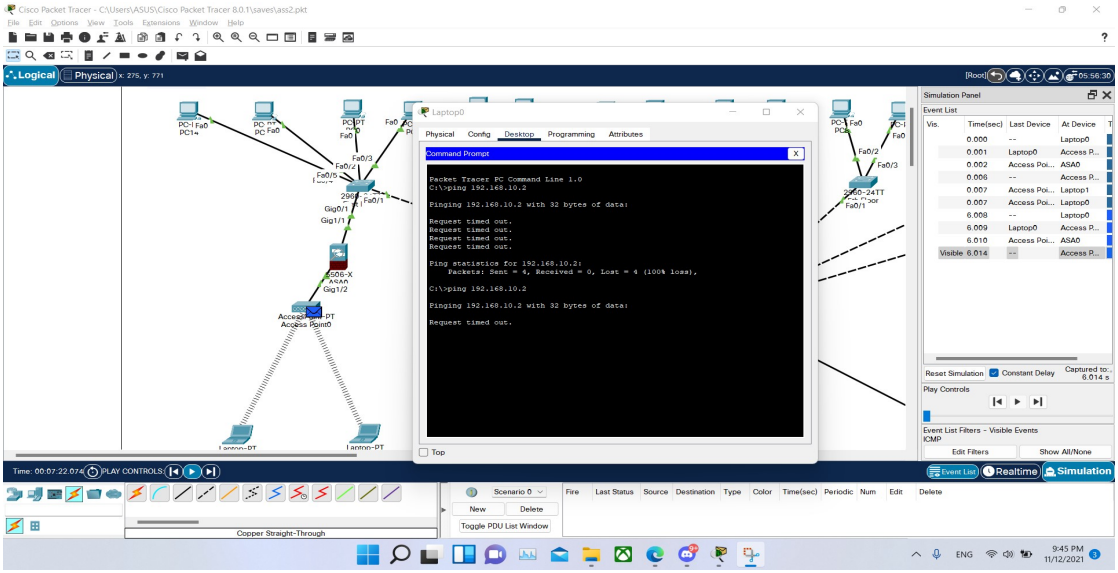


Figure 4: Connection between Laptop0 to PC14

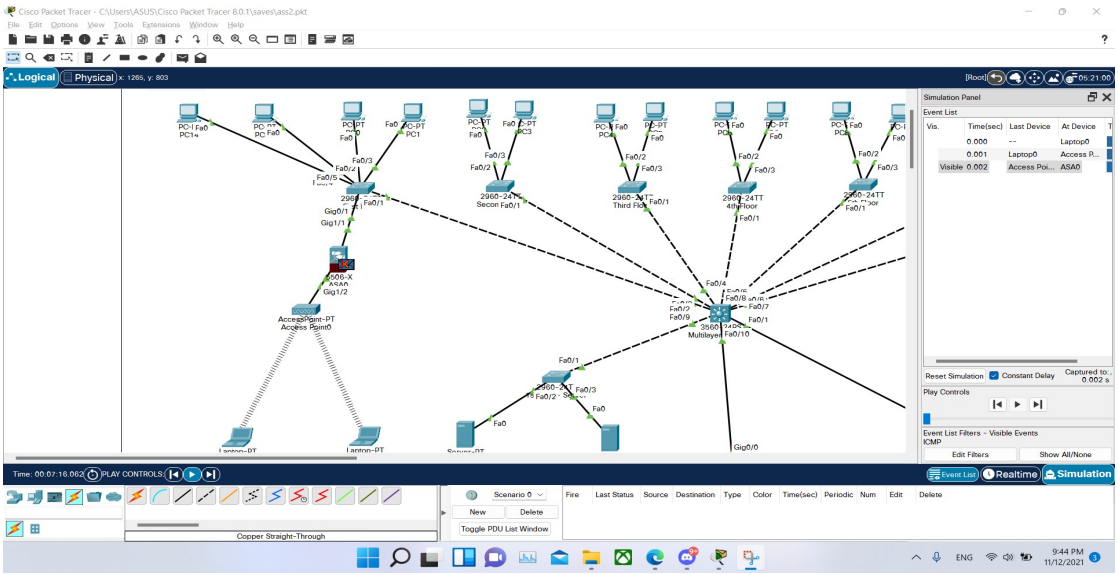


Figure 5: Simulation screen between Laptop0 to PC14

6 Re-evaluate the designed network system

✓For this large exercise, the group organized the network system according to the VLAN structure to help minimize bandwidth for the network, enhance security between departments (VLANs), high flexibility when moving departments, and more. computer in the office.

✓About the improvement problem, the departments can be easily expanded by adding more switches.

✓Regarding supporting software, currently, supporting software can be applied to a wide variety of banking systems, including Licensed or Open source, such as operating systems (Windown, Linux), office software (Microsoft Office, Open). Office,..), web browser (IE, Mozilla Firefox,..),..
✓However:

- Currently, the connection from the Head Office to the Internet is only through an ADSL connection, there is no backup connection in the event of a problem or overload.
- The network design also does not have a firewall to improve security and ensure access to the LAN.
- There is no Backup Server to backup data regularly to prevent data loss.