VIETNAM NATIONAL UNIVERSITY HO CHI MINH CITY
HO CHI MINH UNIVERSITY OF TECHNOLOGY

Computer Network 211

ASSIGNMENT 2: NETWORK DESIGN

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1 Introduction

For every big corperation, they need the high security and high speed data transportation to connect locally in the office. Meanwhile, we have to maintain their access to the Internet globally. Based on these demand, we set up a list of requirement, component to show the structure below.

2 Problem Analysis

Assume that we can fulfill the enough equipments, engineer must make sure about the optimization, maintainable network, friendly user interface, satisfy user demands.

2.1 Location:

2.1.1 Headquarter

The infraststructure of BBB building:

- There is 7 floors on total, 1st floor has IT Room and Cabling Central Local
- Component: 100 workstations, 5 servers, 12 network devices

Characteristic:

- Using a combination of licensed and open-source software, office applications, client-server applications, multimedia, and database
- Requirements for high security, robustness when problems occur, easy to upgrade the system

2.2 Connect range:

At the first step, we devide the network into 2 parts: Internet and office connection. From that point, each connection take responsiblity for different usages.

2.2.1 Branch

At Nha Trang and Da Nang, in the smaller scale, we have the buildings with:

- The Networking Support Room and Cabling Central maintain in floor 1 on total 2.
- 50 workstations, 3 servers, 5 or more networking devices

2.2.2 Global connection:

Send and receive data from office to office through the server of Internet,

- What to connect: Computers
- Which to access: transfered data
- The network connects to outside by 2 leased line (for WAN connection) and 1 ADSL (for Internet access) with a load-balancing mechanism

2.2.3 Whole system

The network is organized according to the VLAN structure
Physical wire: 100/1000 Mbps wired and wireless connection
VPN configuration for site-to-site and for a teleworker to connect to LAN
Daily usage:

- Peak hours: 9-11 am, 15-16 pm with 80% capacity
- 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.

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, ..).

2.3 Office survey

2.3.1 Equipment

- Admin computer: the most vulnerarable in each buildings, which has no restrict in access data.
- Staff computer: Access internal data and network to send and receive data.
- Receptionist computer: Query data and create request to the server. This type of PC occupy about 40% of the network load.
- IT computer: Take responsible for server management. This computer need high speed to support the child computer.
- Switch: connect the computer to the office network.

3 Network Structure

3.1 DHCP

The Dynamic Host Configuration Protocol (DHCP) is a network management protocol used on Internet Protocol (IP) networks for automatically assigning IP addresses and other communication parameters to devices connected to the network using a client–server architecture.

Advantages of DHCP:

- Centralized administration of IP configuration: DHCP IP configuration information can be stored in a single location and enables that administrator to centrally manage all IP address configuration information.
- Dynamic host configuration: DHCP automates the host configuration process and eliminates the need to manually configure individual host. When TCP/IP (Transmission control protocol/Internet protocol) is first deployed or when IP infrastructure changes are required.
- Seamless IP host configuration: The use of DHCP ensures that DHCP clients get accurate and timely IP configuration IP configuration parameter such as IP address, subnet mask, default gateway, IP address of DND server and so on without user intervention.
- Flexibility and scalability: allowing the administrator to move easily change IP configuration when the infrastructure changes.

3.2 VLAN structure

Virtual LAN (VLAN) is a concept in which we can divide the devices logically on layer 2 (data link layer). Generally, layer 3 devices divide broadcast domain but broadcast domain can be divided by switches using the concept of VLAN.

A broadcast domain is a network segment in which if a device broadcast a packet then all the devices in the same broadcast domain will receive it. Through VLAN, different small-size sub-networks are created which are comparatively easy to handle when the data comes.

There is 3 types of connections in VLAN based on the connected devices

- Trunk Link: connect VLAN-aware to VLAN-aware
- Access link: connect VLAN-unaware to VLAN-aware

- Hybrid link: any type

Advantages in network:

- Performance: reduce redundancy sending in traffic and lower the bandwidth usage.
- Formation of virtual groups: create group for office, especially department
- Security: restrict the access from outsider, setup firewalls
- Flexibility: we can change the number of host
- Cost reduction: create small size broadcast domains which eliminate the need for expensive routers

3.3 DMZ network

A DMZ Network functions as a sub-network containing an organization's exposed, outward-facing services, it protects the hosts most vulnerable to attack.

Constructing methods:

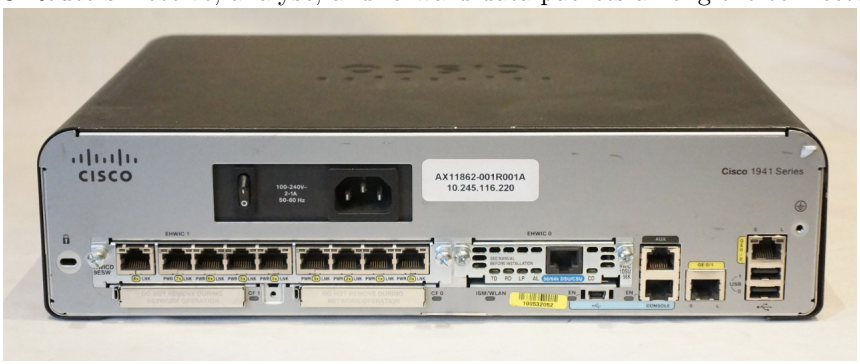
- Single firewall: the DMZ will be placed inside of this firewall. The tier of operations is as follows: the external network device makes the connection from the ISP, the internal network is connected by the second device, and connections within the DMZ is handled by the third network device.
- Dual firewall: The first firewall is configured to only allow traffic destined for the DMZ. The second firewall is only responsible for the traffic that travels from the DMZ to the internal network.

Services: Web server and Mail server

4 Network Design

4.1 List of equipment

- 3 Routers: receive, analyse, and forward data packets among the connected computer networks.



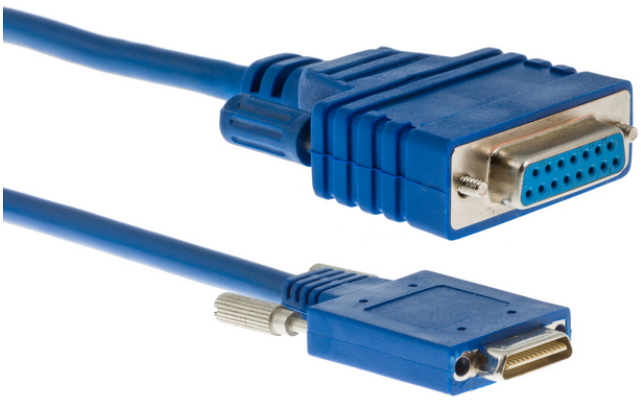
- 12 Switches: connect devices in a network and use packet switching to send, receive or forward data packets or data frames over the network.

- 9 Servers: Network servers are high-powered computers used as a central repository for data and various programs shared by users within a network.

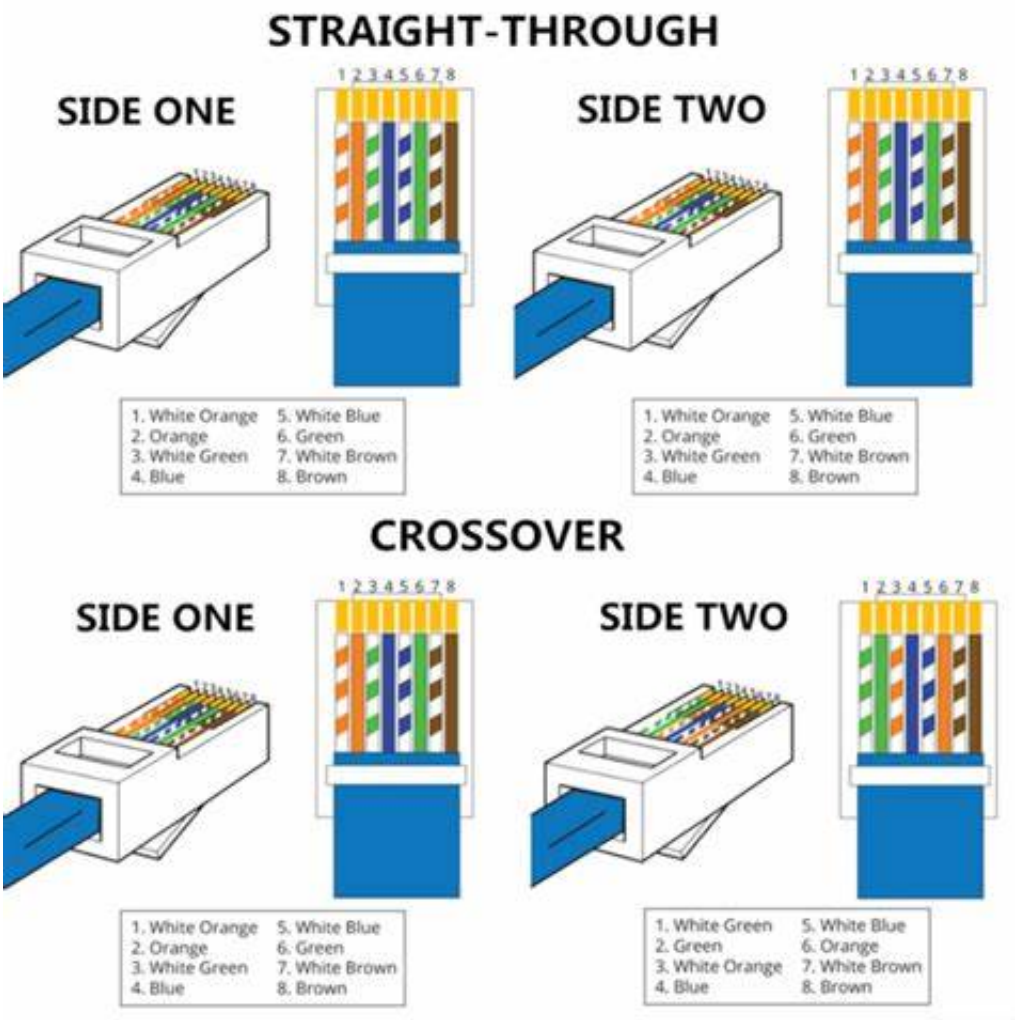
- 3 Access Points: allows other Wi-Fi devices to connect to a wired network.

- Computer: Personal computer or PC that serves staff and customer purposes.

- Serial DCE cable: One side of the link (DCE), has to transmit the clock signal, which controls the data rate, and the other side (DTE) receives the clock signal.



- Copper straight through cable: a type of twisted pair copper wire cable for local area network (LAN) use for which the RJ-45 connectors at each end have the same pinout
- Copper cross over cable: a type of twisted pair copper wire cable for LANs (local area network) in which the wires on the cable are crossed over so that the receive signal pins on the RJ-45 connector on one end are connected to the transmit signal pins on the RJ-45 connector on the other end



- Checkpoint: Authentication computer and component of network to access resources.

4.2 Overall design

There is 3 main blocks we have to implement: Headquarter, Danang Branch, Nhatrang Branch

4.3 Network component of a building

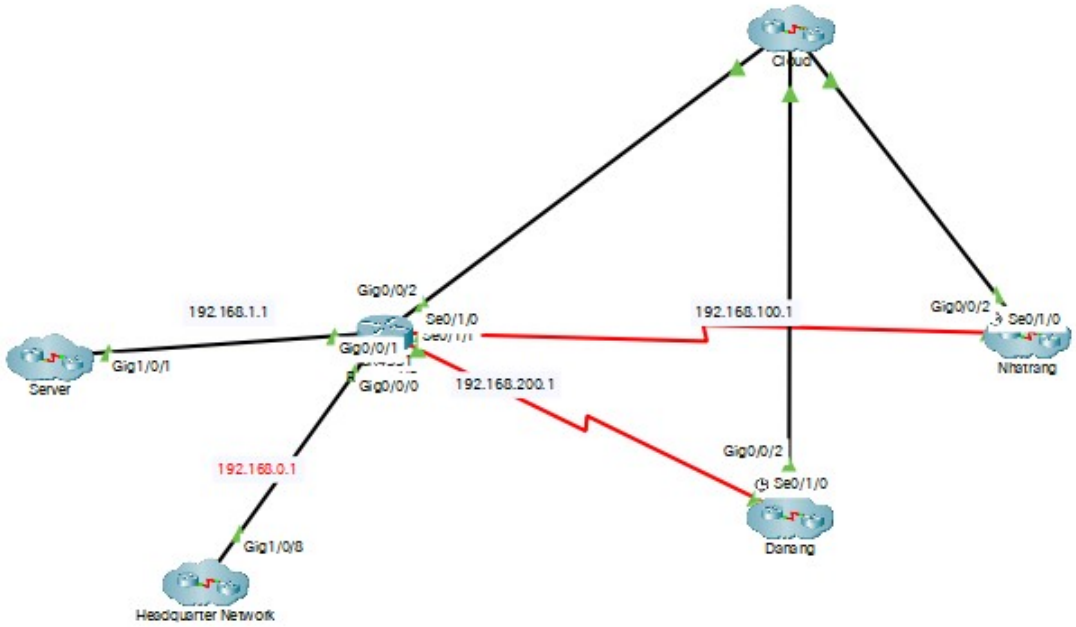
These buildings has the structure as follow:

- 1 main router
- 1 multi-layer switch
- Switches
- Server
- Computer

In addition, the server has to connect through a DMZ switch (PIX51)to prevent the attack from outsider.

4.4 Wiring connect

- From branch to branch: we use Serial DCE cable to track the clock signal and data rate. 2 branches need to connect with the headquarter. They are prevented from connect to each other directly.
- From router to multi-layer switch: using copper straight through cable to maintain pinout
- From multi-layer switch to switch: use copper cross over cable to connect the same type devices

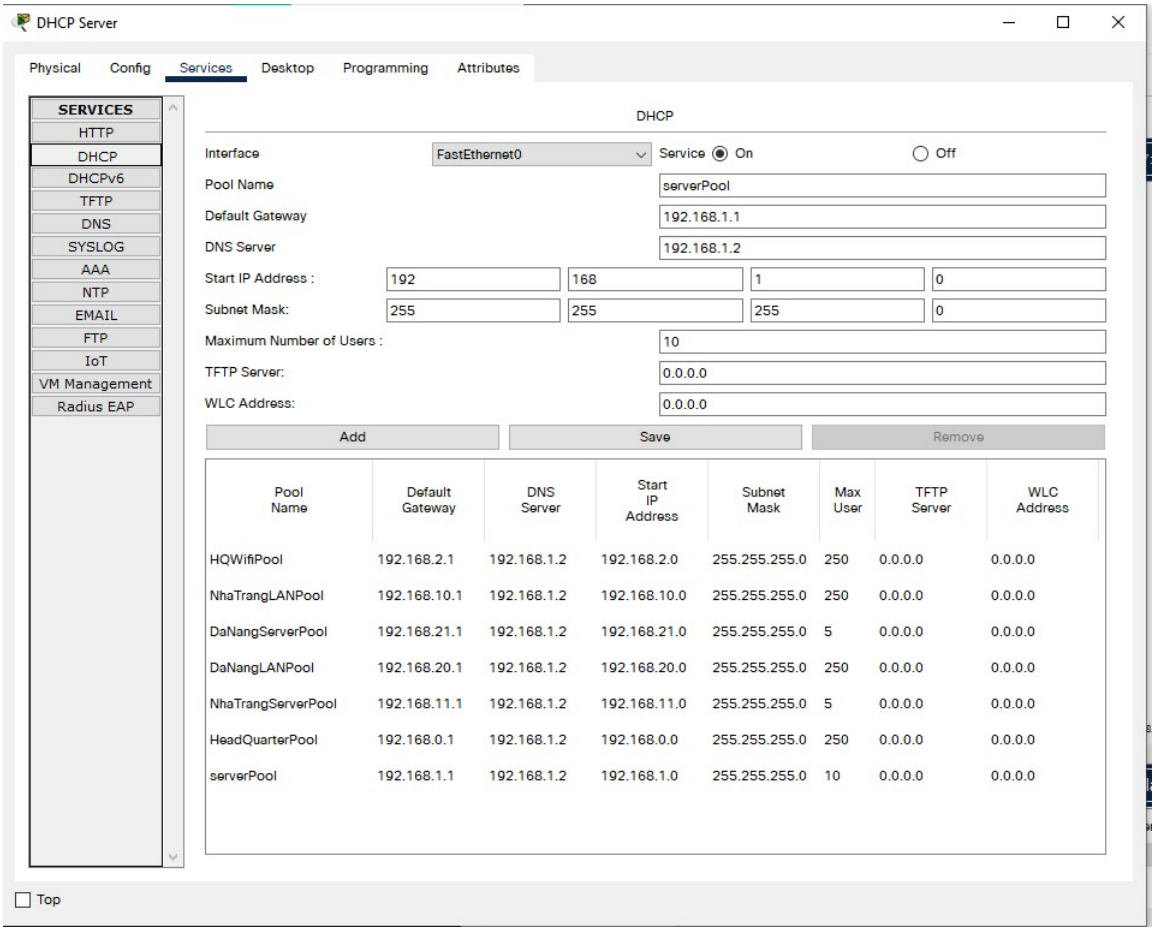


4.5 VLAN structure

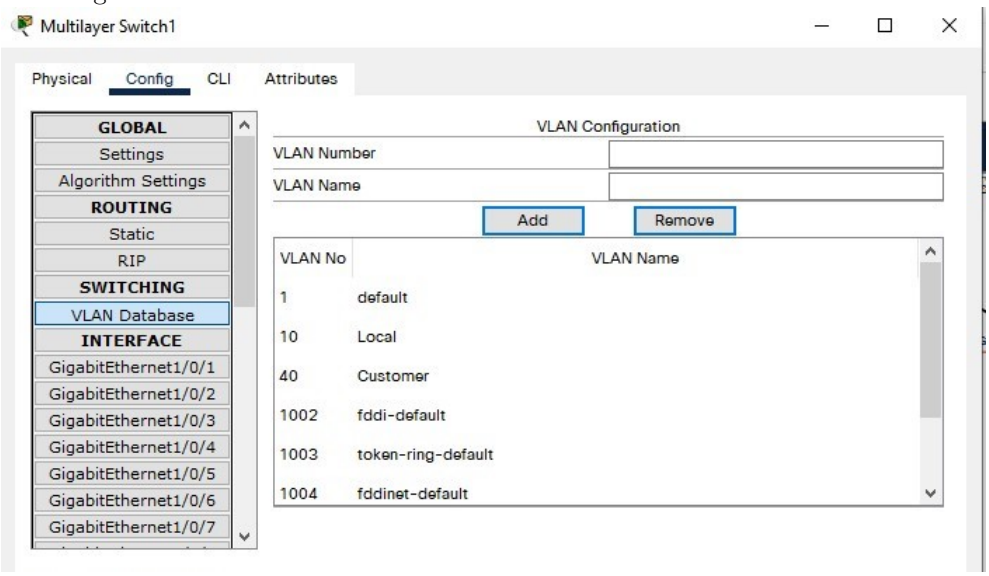
When consider Access Point as the customer, we prevent the computer get access to our LAN network of the system.

From building to building, staff PC can connect each other and create, send file, information...
In 1 building, ping action would be successful if the source is a server and the other one is computer.

Because we have route to connect across the VLAN, the computer in different VLANs can connect (checked by ping).

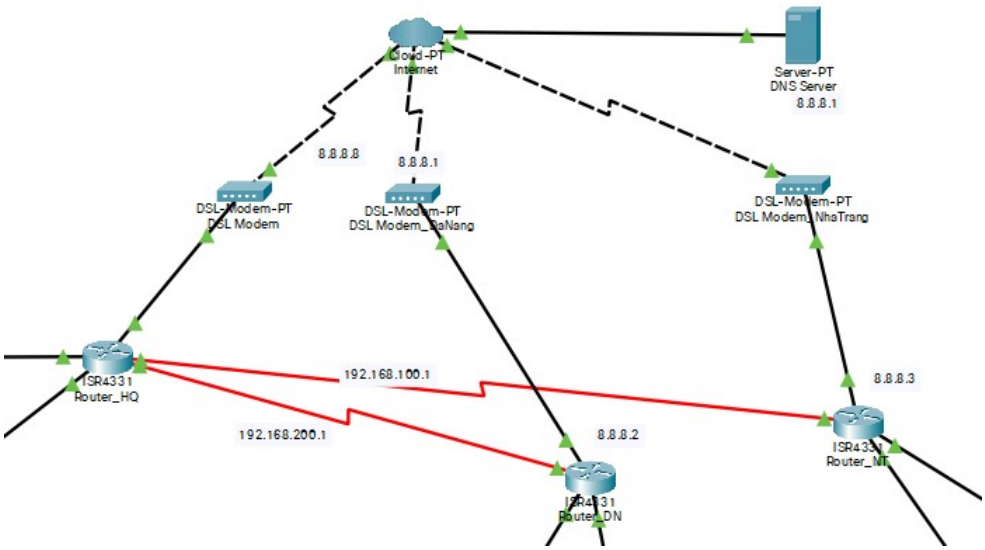


There is 1 other structure can be applied to this problem, the VLAN structure for department. For example, 3 departments will have 3 separated VLANs: 10(Financial), 20(Manager), 30(Receptionist),... The architecture we implement above hasn't consider about restrict staff from access resources. To migrate the structure, we can split the local network of the building as Local-Customer and then assign Fast Ethernet Port to them. Later, we have to setup the remain VLANs to give more accurate right for accessing data.

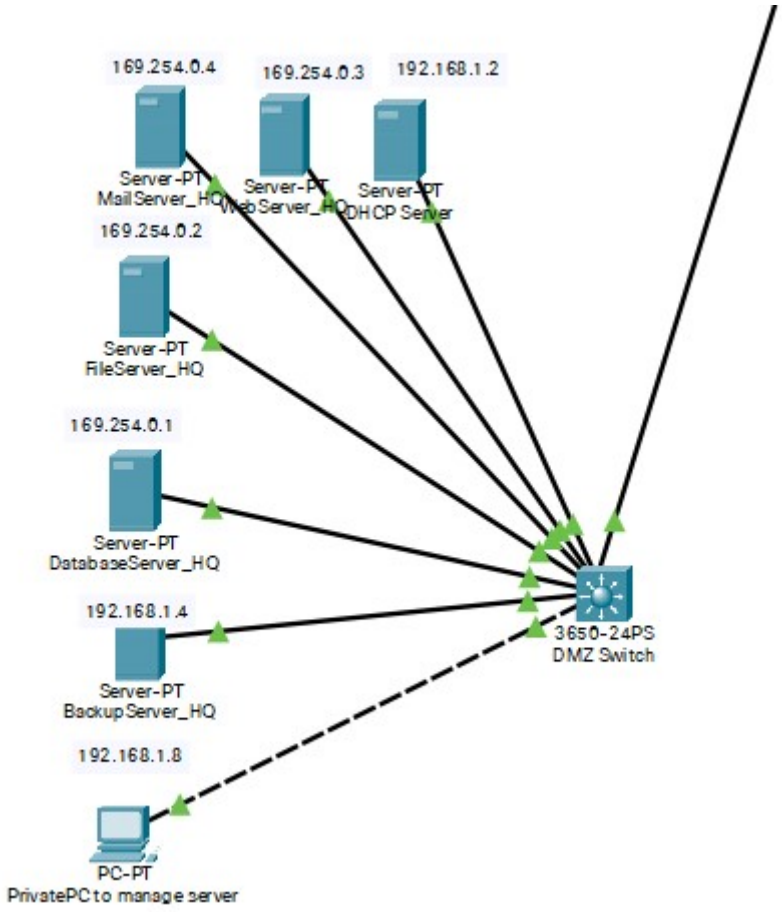


4.6 Packet Tracer Design

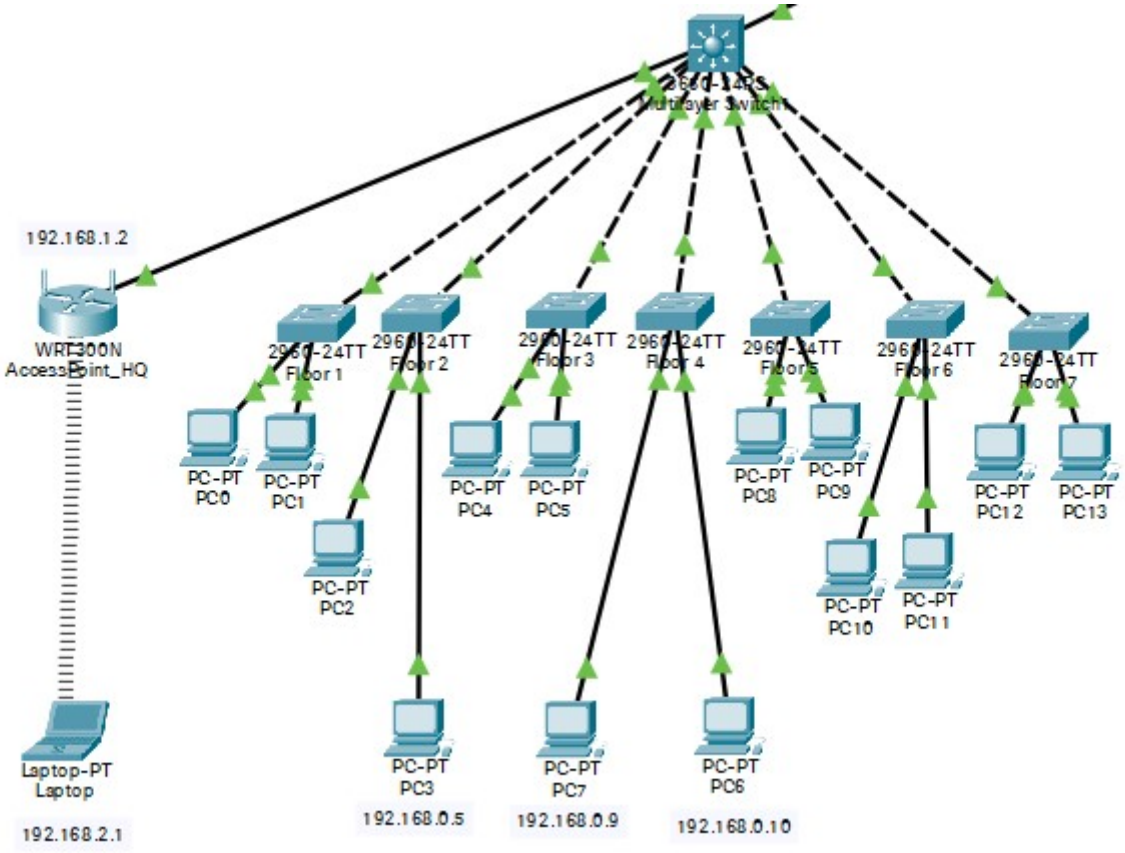
4.6.1 Internet connection / DNS



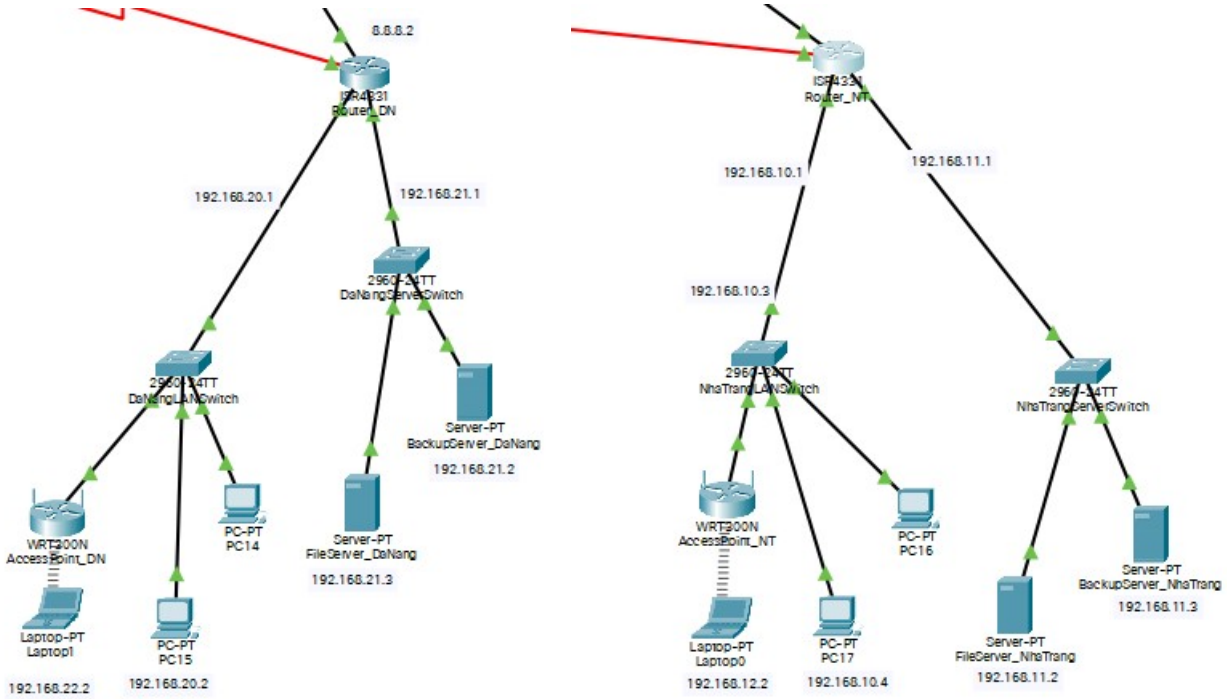
4.6.2 Headquarter server



4.6.3 Headquarter design



4.6.4 Danang and Nhatrang branch



5 Network Evaluation

5.1 Estimate parameter

Total workstations: $100 + 50 \times 2 = 200$
Total servers: $5 + 3 \times 2 = 11$
The total upload and download capacity for a server is 500 MB.
The total upload and download capacity for a workstations is 100 MB.
We use one WiFi for Head Office and each Branch. Total upload and download capacity of each WiFi is 50 MB.
The total upload and download capacity of the entire bank is:

$$11 \times 500 + 200 \times 100 + 3 \times 50 = 25650 \text{ MB}$$

Total capacity used during peak hours (accounting for 80% of total capacity):

$$25650 \times 80\% = 20520 \text{ MB}$$

Throughput needed for bank at peak hours (for 3 hours from 9am to 11am and 3pm to 4pm):

$$20520/(3 \times 3600) = 1.9 \text{ MB/s} = 15.2 \text{ Mbps}$$

To increase to 20% of capacity in 5 years: $15.2 \times 120\% = 18.24$ Mbps
We can rent a transmission line with high stability, with a bandwidth of 19 Mbps (safe) for the building in within 5 years. The calculation of throughput and bandwidth is based on peak hours, so the network speed will still ensure good operation in all cases, including peak hours.

5.2 Ping result

5.2.1 Requirement:

Because we have to maintain the internet access of every computer, we connect 3 main routers to the cloud of Google with IP 8.8.8.8. In case the bank want to limit the internet access or make a default landing page, IP of cloud would be changed according to the homepage.
For the Server:

- Headquarter Server can get information from every computer in network. However, in the opposite direction, PC cannot ping to the servers.
- Server can get access to the Internet as part of the network

For the computer in buildings:

- The PCs in the whole network can connect to each other, regardless: Location, IP, floor, hardware types,...
- Computer is not allow to ping to higher security layer of connection (servers)

For the laptop:

- Laptop can ping to the Access Point to connect Internet
- This type of access is separated from PCs, servers, network...

From HCM PC to HCM PC

```
C:\>ping 192.168.0.9

Pinging 192.168.0.9 with 32 bytes of data:

Reply from 192.168.0.9: bytes=32 time<1ms TTL=128
Reply from 192.168.0.9: bytes=32 time=1ms TTL=128
Reply from 192.168.0.9: bytes=32 time<1ms TTL=128
Reply from 192.168.0.9: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.0.9:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

From HCM PC to Danang PC

```
C:\>ping 192.168.20.2

Pinging 192.168.20.2 with 32 bytes of data:

Reply from 192.168.20.2: bytes=32 time=1ms TTL=126
Reply from 192.168.20.2: bytes=32 time=1ms TTL=126
Reply from 192.168.20.2: bytes=32 time=1ms TTL=126
Reply from 192.168.20.2: bytes=32 time=11ms TTL=126

Ping statistics for 192.168.20.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 11ms, Average = 3ms
```

From HCM PC to HCM Server

```
C:\>ping 192.168.1.4

Pinging 192.168.1.4 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.1.4:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

From HCM PC to Internet

```
C:\>ping 8.8.8.8

Pinging 8.8.8.8 with 32 bytes of data:

Reply from 8.8.8.8: bytes=32 time=60ms TTL=127
Reply from 8.8.8.8: bytes=32 time=45ms TTL=127
Reply from 8.8.8.8: bytes=32 time=66ms TTL=127
Reply from 8.8.8.8: bytes=32 time=42ms TTL=127

Ping statistics for 8.8.8.8:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 42ms, Maximum = 66ms, Average = 53ms
```

From HCM Server to HCM PC

```
Packet Tracer SERVER Command Line 1.0
C:\>ping 192.168.0.10

Pinging 192.168.0.10 with 32 bytes of data:

Reply from 192.168.0.10: bytes=32 time<1ms TTL=127
Reply from 192.168.0.10: bytes=32 time<1ms TTL=127
Reply from 192.168.0.10: bytes=32 time<1ms TTL=127
Reply from 192.168.0.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.0.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

From HCM Server to HCM laptop

```
C:\>ping 192.168.2.2

Pinging 192.168.2.2 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.2.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>
```

From HCM Server to Danang server

```
C:\>ping 192.168.21.2

Pinging 192.168.21.2 with 32 bytes of data:

Reply from 192.168.21.2: bytes=32 time=19ms TTL=126
Reply from 192.168.21.2: bytes=32 time=10ms TTL=126
Reply from 192.168.21.2: bytes=32 time=10ms TTL=126
Reply from 192.168.21.2: bytes=32 time=12ms TTL=126

Ping statistics for 192.168.21.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 10ms, Maximum = 19ms, Average = 12ms
```

From HCM Server to Internet

```
C:\>ping 8.8.8.8

Pinging 8.8.8.8 with 32 bytes of data:

Request timed out.
Reply from 8.8.8.8: bytes=32 time=63ms TTL=127
Reply from 8.8.8.8: bytes=32 time=66ms TTL=127
Reply from 8.8.8.8: bytes=32 time=50ms TTL=127

Ping statistics for 8.8.8.8:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 50ms, Maximum = 66ms, Average = 59ms
```

From HCM laptop to HCM PC

```
C:\>ping 192.168.0.10

Pinging 192.168.0.10 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.0.10:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

From HCM laptop to HCM Server

```
C:\>ping 192.168.1.4

Pinging 192.168.1.4 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.1.4:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>
```

From HCM laptop to Danang laptop

```
C:\>ping 192.168.22.2

Pinging 192.168.22.2 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.22.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

From HCM laptop to Danang Server

```
C:\>ping 192.168.22.2

Pinging 192.168.22.2 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.22.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

From Danang PC to HCM PC

```
Packet Tracer PC Command Line 1.0
C:\>ping 192.168.0.10

Pinging 192.168.0.10 with 32 bytes of data:

Reply from 192.168.0.10: bytes=32 time=2ms TTL=126
Reply from 192.168.0.10: bytes=32 time=2ms TTL=126
Reply from 192.168.0.10: bytes=32 time=10ms TTL=126
Reply from 192.168.0.10: bytes=32 time=1ms TTL=126

Ping statistics for 192.168.0.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 10ms, Average = 3ms

C:\>
```

From Danang PC to HCM Server

```
C:\>ping 192.168.1.4

Pinging 192.168.1.4 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.1.4:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

From Danang PC to Danang PC

```
C:\>ping 192.168.20.4

Pinging 192.168.20.4 with 32 bytes of data:

Reply from 192.168.20.4: bytes=32 time=1ms TTL=128
Reply from 192.168.20.4: bytes=32 time=1ms TTL=128
Reply from 192.168.20.4: bytes=32 time<1ms TTL=128
Reply from 192.168.20.4: bytes=32 time=1ms TTL=128

Ping statistics for 192.168.20.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

From Danang PC to Nhatrang PC

```
Packet Tracer PC Command Line 1.0
C:\>ping 192.168.10.4

Pinging 192.168.10.4 with 32 bytes of data:

Request timed out.
Reply from 192.168.10.4: bytes=32 time=5ms TTL=125
Reply from 192.168.10.4: bytes=32 time=20ms TTL=125
Reply from 192.168.10.4: bytes=32 time=2ms TTL=125

Ping statistics for 192.168.10.4:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum = 20ms, Average = 9ms
```

5.3 Usage feature

- Complexity: The structure follows these rule: each PC is wired to switch,(then the multilayer switch) and the router.

  If a laptop connect to network by Access Point, they are external computer at the bottom layer of structure.

- Maintainable: Because the bank has many transaction and sending receiving action, network congestion may happen. This problem need at least 1 staff take the responsible.

- : Flexibility: Computer and PC in the network can easily move, re-arrange location but still have access as before.

- Upgradable: The system was design follow the demand of BBB for the next 5 years. For short terms, there is no need to upgrade the bandwidth and throughput. However, we should consider adding more Access Point to the buildings.

- Security: With only 1 private computer, this network doesn't support firewall to secure the system. We only make sure that the private computer in headquarter is not allowed to in the same VLAN as the others.
- Speed: Speed and other parameter is in the acceptable range and full-fills the requirements. In case the system scale become larger, BBB network speed will be slow down. The solution for this are upgrade cable, switch, re-arrange,...

5.4 More in future

For the next 5 years, the number of computer as well as the number of higher requirement will increase dramatically. The purpose of this analysis is to make a short work-list for future.

5.4.1 Remain problem

- Low security to be maintain and preserved sensitive data
- Limit the right of staff in data access by split a lower VLAN structure
- Let the branches connect directly to avoid network congestion in headquarter.
- Calculated the cost for the network and future maintenance

5.4.2 Development orientation

- Firewall and other secure network is necessary to have prevent data problem.
- Upgrade network speed for Internet access
- Real implement to test connection and estimated parameter
- Testing the performance in peak hours
- Synchronize the device type in network to make the synchronization

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