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April 29, 2022

IFT372 Course Project

Abstract

The purpose of this project is to create three separate networks; a cellular network with two cell towers, three smartphones, a central office server, and gateway router; a wifi system with three access points, five laptops, a server, switch, two smartphones, and a gateway router; and a wired system with a wireless router with three computers, three VoIP phones, a server, wireless router, three laptops, a switch, and a gateway router. The three networks should be interconnected with private and public IPs and should support both data and voice services between networks.

My approach to this project was to create each network at a time, set up DHCP addressing for private IPs, static addressing for public IPs, and to connect each gateway router together through a central router representing an ISP for the internet.

The results of this project included the three functioning networks with public and private addressing and connectivity.

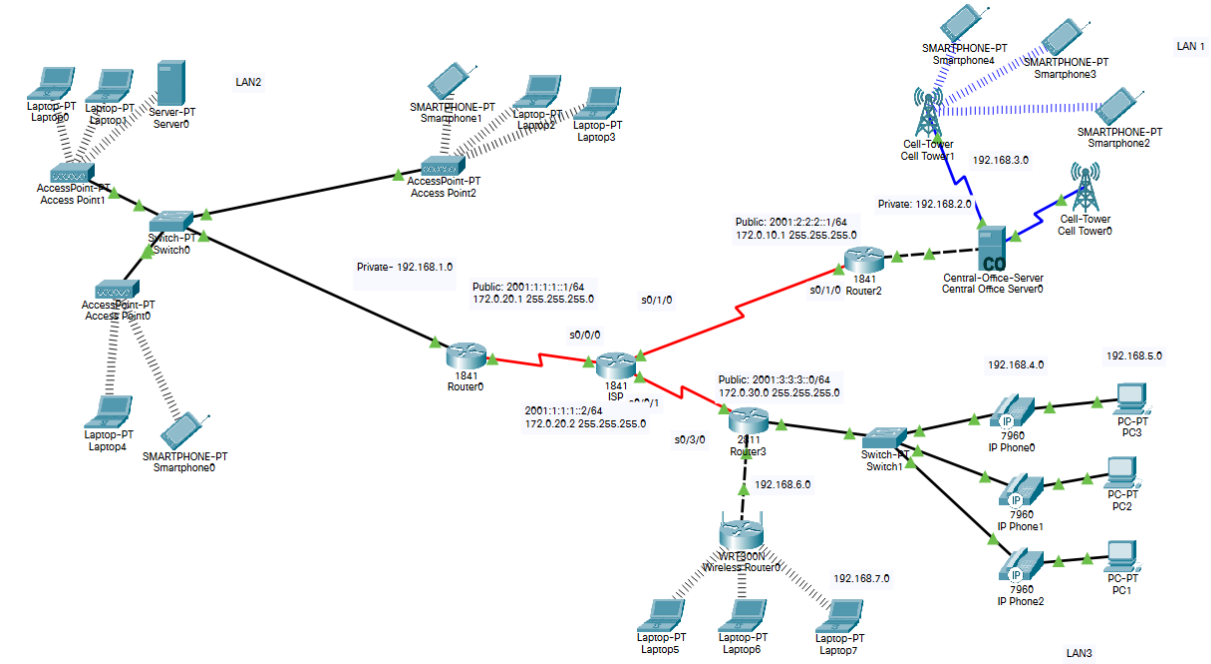
Introduction

The cellular system in this project uses 3G/ 4G architecture to connect mobile devices to the LAN1 network. The air interface is provided by call towers and is managed by the central office server. LAN2 provides a typical WiFi system that uses a switch, router, and wireless access points to provide connectivity. Similarly, the wired/ wireless system in LAN 3 provides wired connectivity through the switch and gateway router. This network also contains a wireless router to provide wireless services. LAN 3 also contains wired IP phones for voice connectivity.

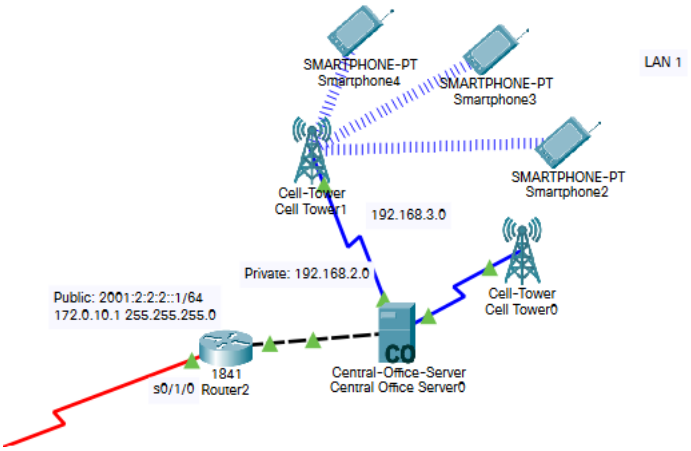
The purpose of this project is to use the CISCO Packet Tracer application to connect these three different architectures and provide data and voice exchange functionality.

Design and Development

Network Diagram



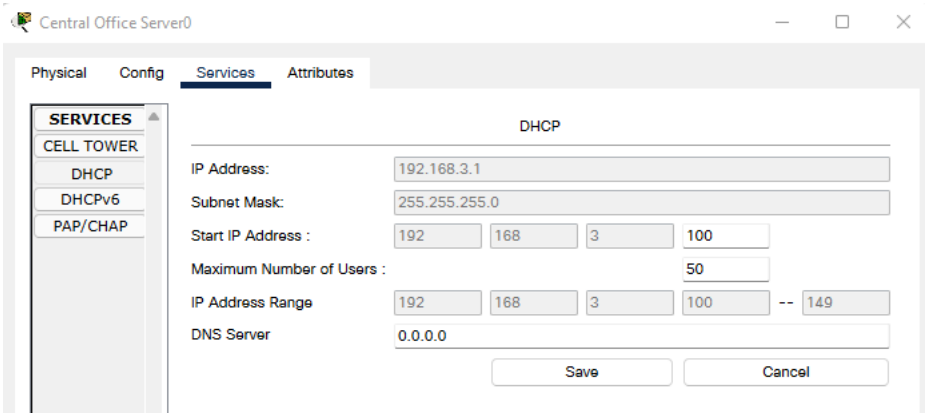
The LAN 1 network contains a central office server that will configure two cell towers. There will be three smartphones that will connect to the cell towers for service.



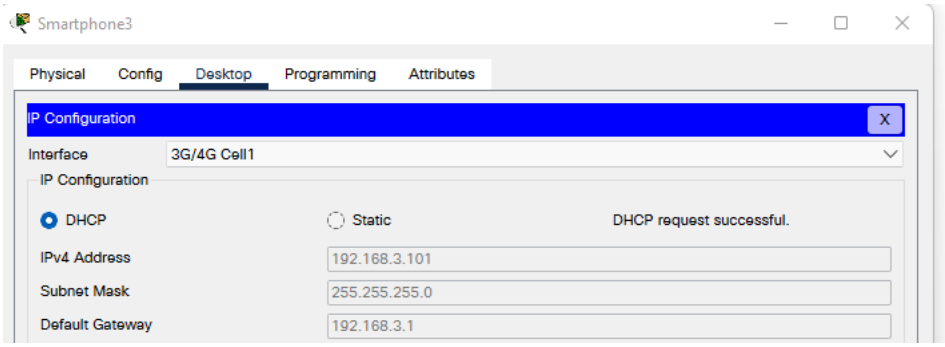
Set Up DHCP in LAN1 network

```
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#int fa0/0
Router(config-if)#ip address 192.168.2.1
% Incomplete command.
Router(config-if)#ip address 192.168.2.1 255.255.255.0
Router(config-if)#no shut

Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

Router(config-if)#exit
Router(config)#ip dhcp pool LAN1
Router(dhcp-config)#network 192.168.2.0 255.255.255.0
Router(dhcp-config)#default-router 192.168.2.1
Router(dhcp-config)#exit
Router(config)#
```

I set up DHCP in the router for LAN1, although the only device this DHCP pool affects is the Central office server. The real DHCP addressing takes place through the central office server which will assign IP addresses to mobile devices connecting to the cell towers. The picture below shows the DHCP configuration details of the server:



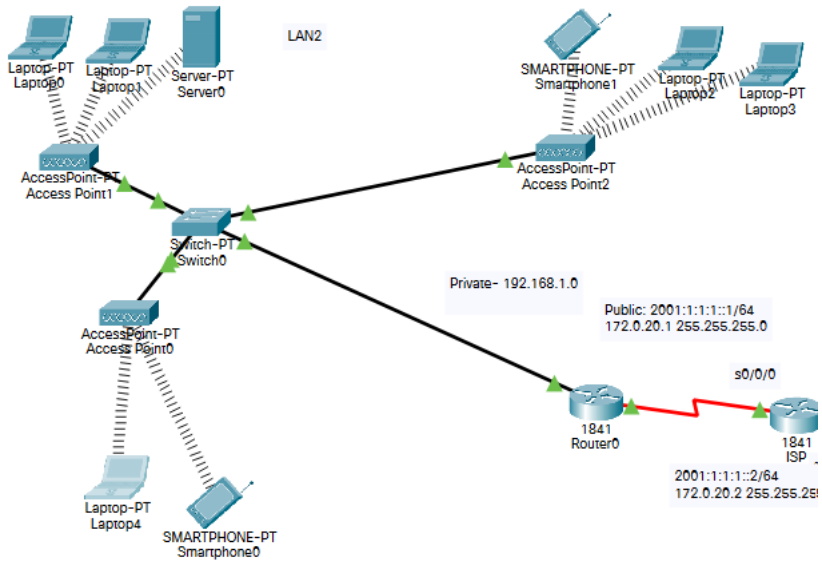
We also can see the DHCP request is successful in the 3G/4G interface of the smartphones:



The private network between the router and the central office server is 192.168.2.0 255.255.255.0, while the private network between the central office server, cell towers and smartphones is 192.068.3.0 255.255.255.0. Public addressing uses the default gateway of 172.0.10.1 with an IPv6 address of 2001:2:2:2::1.

LAN2

The LAN2 network is a WiFi network with five laptops, two smartphones, a server, a switch, and three access points.



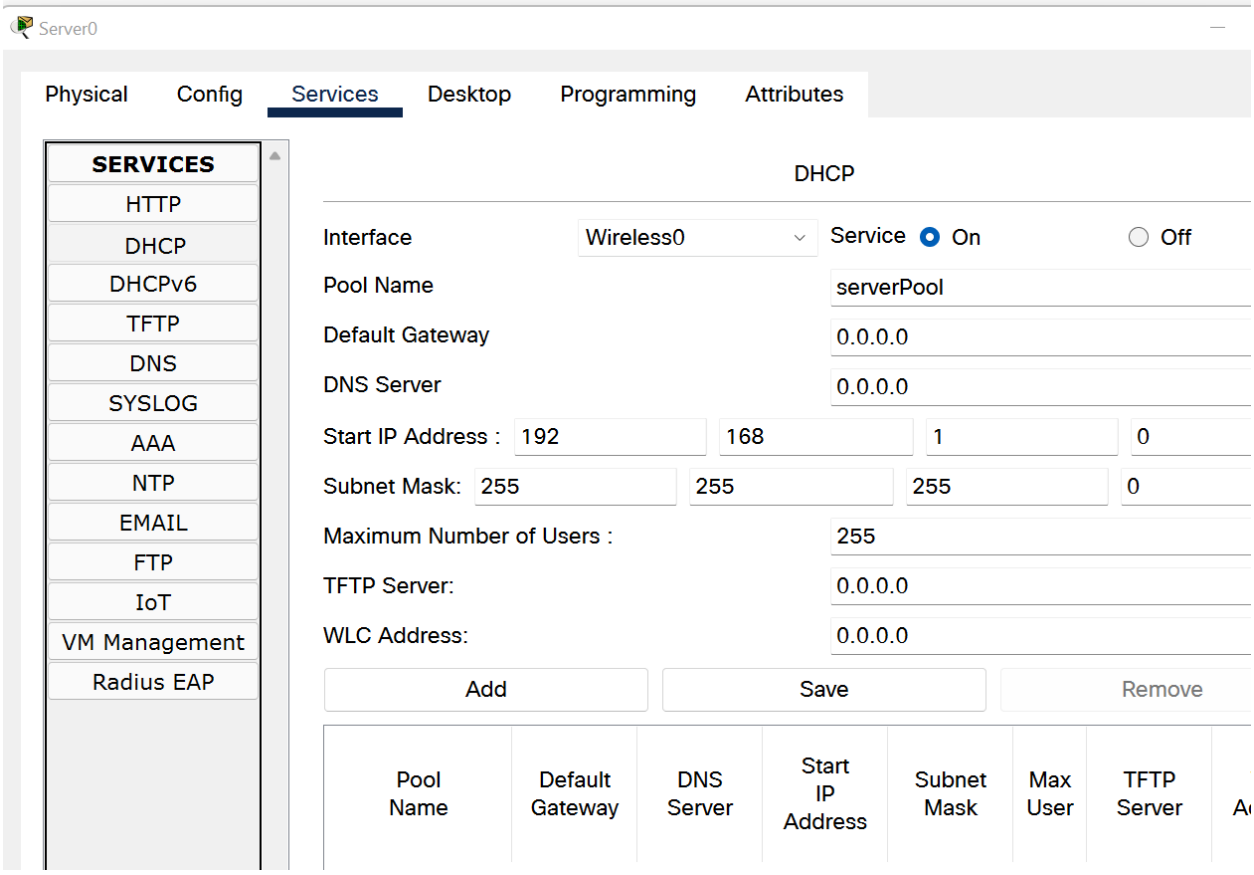
To enable network address translation in the LAN2 network, I have set up dynamic NAT. This allows the network to learn how to route traffic based on the traffic it sees. Using dynamic NAT is great for a service set architecture because for traffic to be successfully routed, the connection has to be initiated from inside the network. This helps with network security because the devices cannot be contacted with their local IP, only through the public IP of the router. Packets won't be sent to a device unless the router has a NAT record of a communication initiated from within the network to this outside device. Below are the steps I took to configure the LAN2 router:

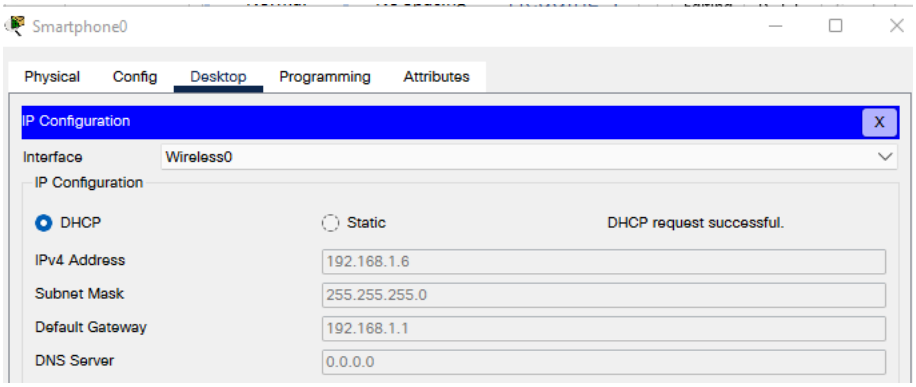
```
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#access-list 1 permit 192.168.1.0 0.0.0.255

Router(config)#ip nat inside source list 1 interface s0/0/0 overload
Router(config)#int s0/0/0
Router(config-if)#ip nat outside
Router(config-if)#int fa0/0
Router(config-if)#ip nat inside
Router(config-if)#
```

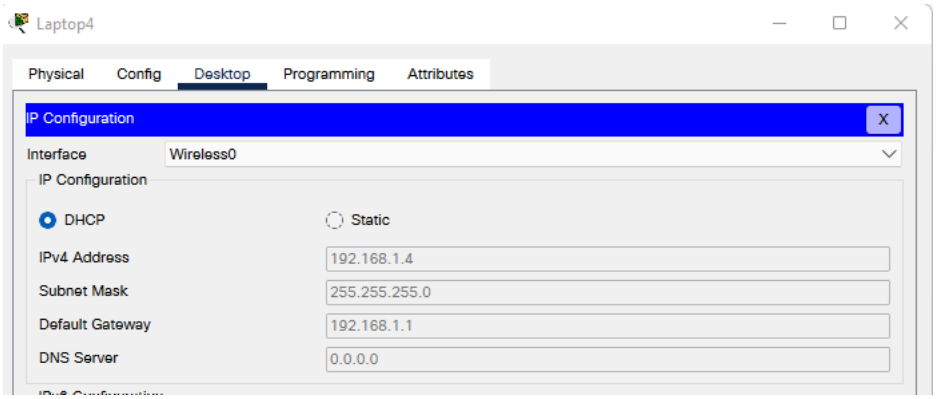
I set the public LAN2 router IPv6 address to 2001:1:1:1::1/64:

```
Router(config)#int s0/0/0
Router(config-if)#ipv6 enable
Router(config-if)#ipv6 address 2001:1:1:1::1/64
```

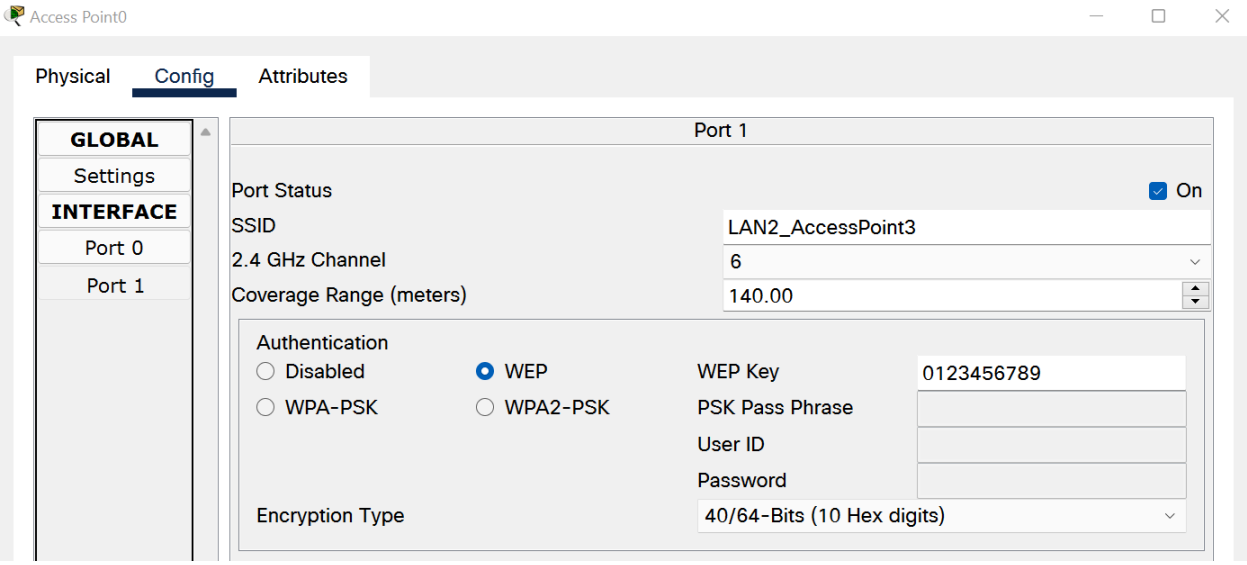
For LAN2, I set the server machine to provide DHCP services, and all the devices have been assigned an IP address:


Server0
Physical
Config
Services
Desktop
Programming
Attributes
SERVICES
HTTP
DHCP
DHCPv6
TFTP
DNS
SYSLOG
AAA
NTP
EMAIL
FTP
IoT
VM Management
Radius EAP
DHCP
Interface
Wireless0
Service
On
Off
Pool Name
serverPool
Default Gateway
0.0.0.0
DNS Server
0.0.0.0
Start IP Address :
192
168
1
0
Subnet Mask:
255
255
255
0
Maximum Number of Users :
255
TFTP Server:
0.0.0.0
WLC Address:
0.0.0.0
Add
Save
Remove
Pool Name
Default Gateway
DNS Server
Start IP Address
Subnet Mask
Max User
TFTP Server


Smartphone0
Physical
Config
Desktop
Programming
Attributes
IP Configuration
X
Interface
Wireless0
IP Configuration
DHCP
Static
DHCP request successful.
IPv4 Address
192.168.1.6
Subnet Mask
255.255.255.0
Default Gateway
192.168.1.1
DNS Server
0.0.0.0


Laptop4
Physical
Config
Desktop
Programming
Attributes
IP Configuration
X
Interface
Wireless0
IP Configuration
DHCP
Static
IPv4 Address
192.168.1.4
Subnet Mask
255.255.255.0
Default Gateway
192.168.1.1
DNS Server
0.0.0.0

I also implemented WEP security on the LAN2 network to both secure and control which access point each device was using. This is also helpful because there will be wireless devices within each network, so setting network security will help to ensure only the LAN2 wireless devices are connecting to this network.

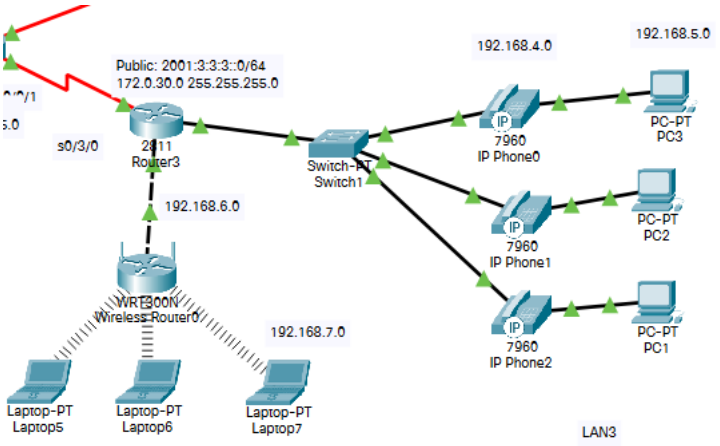


The smartphones want to automatically connect to the cellular services available in LAN1. I went into the 3G/ 4G settings in each smart device and turned off that service. For the purposes of this lab, the smartphones in the LAN2 network are only accessing the wireless services of that network.

The entire LAN2 network is on the private 192.168.1.0 network. As stated previously, DHCP services for this network has been configured using the server device. The public IP for this network is 172.0.20.1 and its IPv6 address is 2001:1:1:1::1.

LAN3

The LAN3 network is a wired and wireless network with a switch, three PCs (with one IP phone apiece), a wireless router, and three laptops.



The LAN3 network will make use of vlans to separate the IP phones service and the data service for the PCs. I have created vlan 4 with the name VOICE to service the 192.168.4.0 network that the IP phones will use, and vlan 5 named DATA that will service the 192.168.5.0 network in use by the PCs.

```
Switch>en
Switch#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#vlan 4
Switch(config-vlan)#name VOICE
Switch(config-vlan)#vlan 5
Switch(config-vlan)#name DATA
Switch(config-vlan)#exit
Switch(config)#
```

The fa0/1 interface will be set to serve as the trunk interface on the switch since this is the interface that connects to the router.

```
Switch(config)#int fa 0/1
Switch(config-if)#sw
% Incomplete command.
Switch(config-if)#switchport mode trunk
Switch(config-if)#
```

I configured the DATA vlan and its respective interfaces along with the VOICE vlan.

```
Switch(config)#int range fa 1/1, fa 2/1, fa 3/1
Switch(config-if-range)#switchport mode access
Switch(config-if-range)#switchport access vlan 5
```

```
Switch(config)#int range fa 1/1, fa 2/1, fa 3/1
Switch(config-if-range)#switchport voice vlan 5
```

As a security measure, I manually disabled the remaining ports. This ensures an unauthorized party cannot access the wired network by simply plugging in to an unused port.

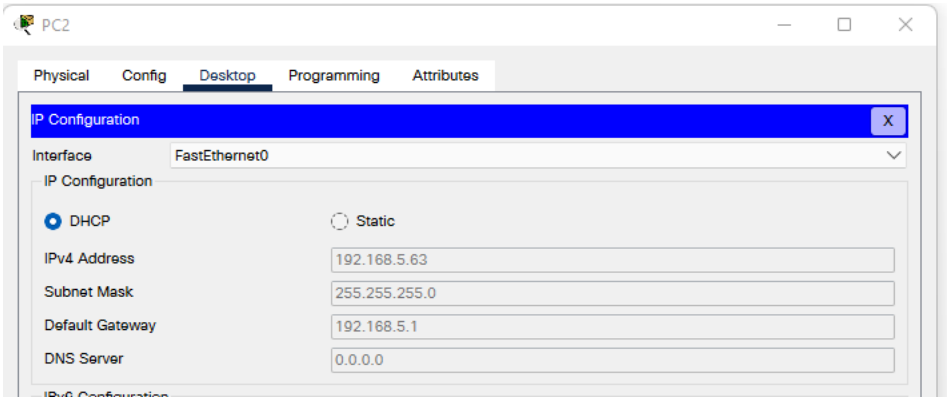
```
Switch>sh vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa4/1, Fa5/1
4    VOICE                            active
5    DATA                             active    Fa1/1, Fa2/1, Fa3/1
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active
Switch>sh ip int brief
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/1        unassigned      YES manual up                    up
FastEthernet1/1        unassigned      YES manual up                    up
FastEthernet2/1        unassigned      YES manual up                    up
FastEthernet3/1        unassigned      YES manual up                    up
FastEthernet4/1        unassigned      YES manual administratively down down
FastEthernet5/1        unassigned      YES manual administratively down down
Vlan1                  unassigned      YES manual administratively down down
Switch>
```

To create the different IP schemes for the IP phones and the PCs, I will configure subinterfaces for voice and data channels in LAN3. fa 0/0.4 will be used for the 192.168.4.0 VOICE network, and fa 0/0.5 sill be used for the 192.168.5.0 data network.

```
Router(config)#int fa 0/0.4
Router(config-subif)#encapsulation dot1Q 4
Router(config-subif)#ip address 192.168.4.1 255.255.255.0
Router(config-subif)#exit
Router(config)#fa 0/0.5
               ^
% Invalid input detected at '^' marker.

Router(config)#int fa 0/0.5
Router(config-subif)#encapsulation dot1Q 5
Router(config-subif)#ip address 192.168.5.1 255.255.255.0
Router(config-subif)#exit
Router(config)#int fa 0/0
Router(config-if)#no shut

Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up

%LINK-5-CHANGED: Interface FastEthernet0/0.4, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.4, changed state to up

%LINK-5-CHANGED: Interface FastEthernet0/0.5, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.5, changed state to up
```

I will now use the router to provide DHCP services for the VoIP devices and the PCs. The VOICE4 DHCP pool will provide addresses for the 192.168.4.0 network phones, and the DATA5 DHCP pool will provide addresses for the 192.168.5.0 PCs.

```
Router(config)#ip dhcp pool DATA5
Router(dhcp-config)#network 192.168.5.0 255.255.255.0
Router(dhcp-config)#default-router 192.168.5.1%DHCPD-4-PING_CONFLICT: DHCP address conflict:
server pinged 192.168.5.1.
%DHCPD-4-PING_CONFLICT: DHCP address conflict:  server pinged 192.168.5.2.
%DHCPD-4-PING_CONFLICT: DHCP address conflict:  server pinged 192.168.5.3.
%DHCPD-4-PING_CONFLICT: DHCP address conflict:  server pinged 192.168.5.4.

Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#ip dhcp pool DATA5
Router(dhcp-config)#network 192.168.5.0
% Incomplete command.
Router(dhcp-config)#network 192.168.5.0 255.255.255.0
Router(dhcp-config)#default-router%DHCPD-4-PING_CONFLICT: DHCP address conflict:  server pinged
192.168.5.1.
%DHCPD-4-PING_CONFLICT: DHCP address conflict:  server pinged 192.168.5.4.
%DHCPD-4-PING_CONFLICT: DHCP address conflict:  server pinged 192.168.5.2.
%DHCPD-4-PING_CONFLICT: DHCP address conflict:  server pinged
Router(dhcp-config)#default-router 192.168.5.1
Router(dhcp-config)#exit
Router(config)#ip dhcp pool VOICE4
Router(dhcp-config)#network 192.168.4.0 255255.255.0
                                        ^
% Invalid input detected at '^' marker.

Router(dhcp-config)#network 192.168.4.0 255.255.255.0
Router(dhcp-config)#default-router 192.168.4.1
Router(dhcp-config)#exit
Router(config)#
```



Additional configuration is required on the gateway router for the IP phones service. option 150 will allow the phones to register through the 192.168.4.1 port on the router. I will also give each phone an extension number.

```
Router(config)#ip dhcp pool VOICE4
Router(dhcp-config)#option 150 ip 192.68.4.1
Router(dhcp-config)#exit
Router(config)#telephony-service
Router(config-telephony)#max-dn 3
Router(config-telephony)#max-ephones 3
Router(config-telephony)#ip source-address 192.168.4.1 port 2000
Router(config-telephony)#ephone-dn 1
Router(config-ephone-dn)#%LINK-3-UPDOWN: Interface ephone_dsp DN 1.1, changed state to up

Router(config-ephone-dn)#number 1010
Router(config-ephone-dn)#ephone-dn 2
Router(config-ephone-dn)#%LINK-3-UPDOWN: Interface ephone_dsp DN 2.1, changed state to up

Router(config-ephone-dn)#number 1020
Router(config-ephone-dn)#ephone-dn 3
Router(config-ephone-dn)#%LINK-3-UPDOWN: Interface ephone_dsp DN 3.1, changed state to up

Router(config-ephone-dn)#number 1030
Router(config-ephone-dn)#exit
```

To provide wireless services, we are also including in the LAN3 network a wireless router. I have chosen to connect this router directly to the gateway router via a crossover cable. The network between these two routers is 192.168.6.0, and the wireless router broadcasts the 192.168.7.0 network to the three laptop devices in this network.

I created IP routes between all networks to enable them to communicate together.

Testing and Results

I am able to open a device on any network and ping a device on another network. All of my connections are set up and configured in packet tracer. I did encounter difficulty however in establishing voice connectivity specifically with the LAN3 network. My phones are not making it past the registration phase, and will not receive an IP address from the router's DHCP service.

Summary and Conclusions

In other networking courses, I have set up wired and wireless networks, DHCP, and vlans, but this was my first exposure to central office servers, cell towers, smart devices connecting through 3G/ 4G, and IP phones. I had to do research to learn how to set up these different devices on the network. I was especially surprised how easy it was to set up the cell towers in Packet Tracer.