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REPUBLIC OF CAMEROON

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MINISTER OF HIGHER EDUCATION

FACULTY OF ENGINEERING AND TECHNOLOGY

***************************UNIVERSITY OF BUEA*************************

DEPARTMENT OF COMPUTER ENGINEERING

CEF 458: Enterprise IP Telephony

Lab 2: IP telephony configuration on 2 branches of a company

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Lab Description and Background Scenario

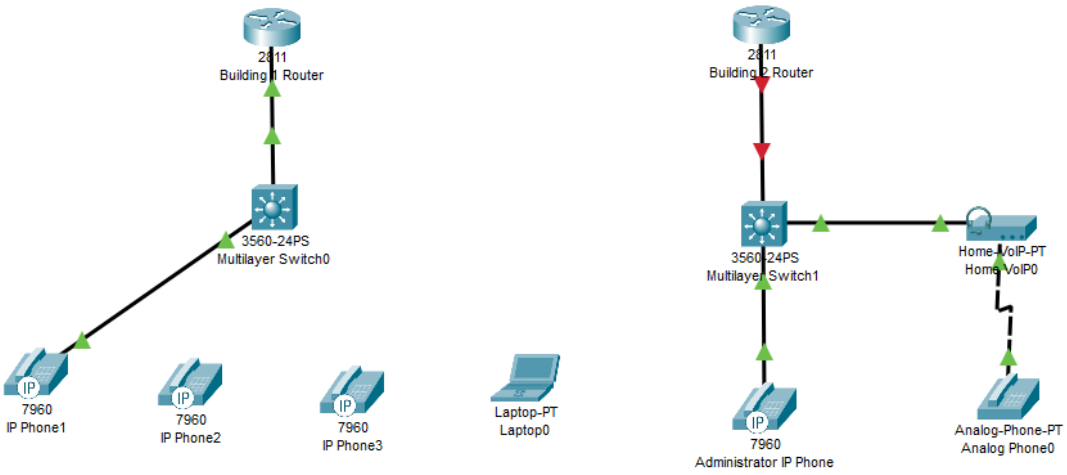
This case study is designed to provide you with an insight into IP Telephony features, where you will be configuring Call Manager Express, setting up dial peers and connecting IP phones as well as analogue phones. This activity is designed to provide you with an insight into what is now possible within Packet Tracer, how to use the various telephony devices, and finally how to apply the configuration. For the purposes of this activity, we will assume that Company ABC has two remote buildings. Each building contains a router configured with DHCP, CME, & other telephony features. It also contains a Multilayer Switch configured to handle voice packets, and finally there are several telephone devices. The telephone devices vary, in some cases; the phones located within the buildings are IP Phones, or IP Communicators, or Analogue Phones. All phone devices must be able to call one another internally within a building as well as being able to call phones located within other buildings. You will need to work through the steps provided within this document, completing the configuration, and inserting the various devices where needed.

Objectives:

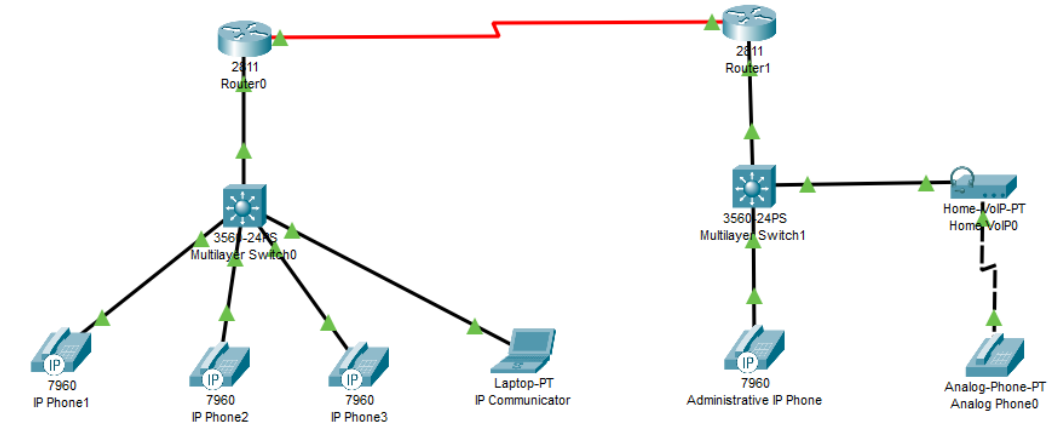
- Configure basic router and switch functions
- Configure DHCP, Call Manager Express, Dial Peers and Telephony Features

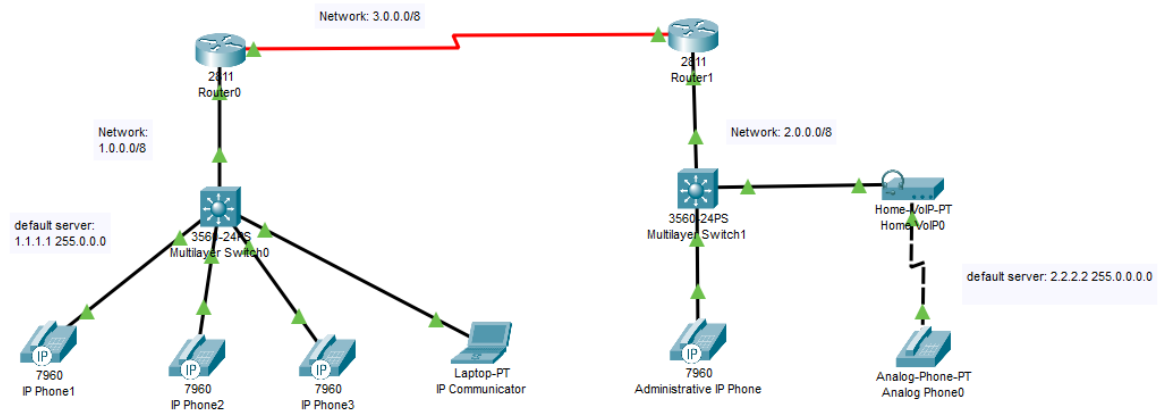
Topology Diagrams:

- Start of configurations:



- After configurations:





Tasks:

Step 1: DHCP config and TFTP server discovery

'Building_1_Router' needs to be configured for DHCP to provide addressing for each IP Phone to be connected. Once DHCP is configured, you will need to configure the FastEthernet0/0 interface and ensure that the IP Phone connected to the multilayer switch receives an IP Address (option 150).

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#ip dhcp pool VOICE
Router(dhcp-config)#network 1.0.0.0 255.0.0.0
Router(dhcp-config)#default-router 1.1.1.1
Router(dhcp-config)#option 150 ip 1.1.1.1
Router(dhcp-config)#exit
Router(config)#hostname Building_1_Router
Building_1_Router(config)#interface f0/0
Building_1_Router(config-if)#ip address 1.1.1.1 255.0.0.0
Building_1_Router(config-if)#no shutdown

Building_1_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

Building_1_Router(config-if)#exit
Building_1_Router(config)#exit
Building_1_Router#
%SYS-5-CONFIG_I: Configured from console by console

Building_1_Router#copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
Building_1_Router#
```

Explanations:

Building_1_Router(config)#***ip dhcp pool CATC*** #Sets the DHCP pool name: VOICE#

Building_1_Router(dhcp-config)#***network 1.0.0.0 255.0.0.0*** #DHCP network 1.0.0.0 with /8 mask#

Building_1_Router(dhcp-config)#***default-router 1.1.1.1*** #Specifying the default router#

Building_1_Router(dhcp-config)#***option 150 ip 1.1.1.1*** #Supports Cisco IP Phone requirement for DHCP#

Building_1_Router(config)#***interface FastEthernet0/0*** #Selects the Fa0/0 interface for configuration#

Building_1_Router(config-if)#***ip address 1.1.1.1 255.0.0.0*** #Applying the IP address#

Building_1_Router(config-if)#***no shutdown*** #Activating the interface#

Verify that 'IP Phone 1' has received an IP address (How do you verify that?).

Answer:

Verify that 'IP Phone 1' has received an IP address by placing your cursor over the phone until a configuration summary appears. (This usually takes some time).

```
Device Name: IP Phone1
Device Model: 7960

Port     Link   IP Address          MAC Address
Vlan1    Up     1.0.0.1/8           0001.C739.B152
Switch   Up     <not set>           00D0.FF95.C701
PC       Down   <not set>           00D0.FF95.C702

Gateway: 1.1.1.1
Line Number: 1101

Physical Location: Intercity > Home City > Corporate Office > IP Phone1
```

DHCP config and TFTP server discovery for building 2

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#hostname Building_2_Router
Building_2_Router(config)#ip dhcp pool VOICE
Building_2_Router(dhcp-config)#network 2.0.0.0 255.0.0.0
Building_2_Router(dhcp-config)#default-router 2.2.2.2
Building_2_Router(dhcp-config)#option 150 ip 2.2.2.2
Building_2_Router(dhcp-config)#exit
Building_2_Router(config)#int f0/0
Building_2_Router(config-if)#ip address 2.2.2.2 255.0.0.0
Building_2_Router(config-if)#no shutdown

Building_2_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

Building_2_Router(config-if)#
```

Step 2: Call Manager Express configuration

You must now configure the Call Manager Express telephony service on 'Building_one_Router' (Why?).

Answer to the why:

A call express manager for telephony service should be configured to provide advanced call routing and handling features, such as call queuing, auto-attendant, and call forwarding. It allows businesses to efficiently manage incoming calls and improve customer service by directing callers to the appropriate department or agent. Additionally, it can help reduce costs by automating certain tasks and freeing up staff to focus on other important tasks.

You will also need to specify the maximum number of phones (05) that the router will support and dial numbers (05). For this Configuration, take the default router ip address as the source address and 2000 as the port (PS: Ip source address are used by phones to register in the CME). Don't forget to automatically assign tags to phones as they register in the system.

```
Building_1_Router#
Building_1_Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Building_1_Router(config)#telephony-service
Building_1_Router(config-telephony)#max-ephones 5
Building_1_Router(config-telephony)#max-dn 5
Building_1_Router(config-telephony)#ip source-address 1.1.1.1 port 2000
Building_1_Router(config-telephony)#auto assign 4 to 6
Building_1_Router(config-telephony)#auto assign 1 to 5
Building_1_Router(config-telephony)#exit
Building_1_Router(config)#exit
Building_1_Router#
%SYS-5-CONFIG_I: Configured from console by console

Building_1_Router#copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
Building_1_Router#
```

Explanation:

Building_1_Router(config)#***telephony-service*** #Configuring the router for telephony services#

Building_1_Router(config-telephony)#***max-ephones 5*** #Setting the number of phones#

Building_1_Router(config-telephony)#***max-dn 5*** #Setting the number of directory numbers#

Building_1_Router(config-telephony)#***ip source-address 1.1.1.1 port 2000*** #IP Address source#

Building_1_Router(config-telephony)#***auto assign 4 to 6*** #Automatically assigning ext numbers to buttons#

Building_1_Router(config-telephony)#***auto assign 1 to 5*** #Automatically assigning ext numbers to buttons#

Call Manager Express configuration for building 2

```
Building_2_Router(config)#telephony-service
Building_2_Router(config-telephony)#max-ephones 5
Building_2_Router(config-telephony)#max-dn 5
Building_2_Router(config-telephony)#ip source-address 2.2.2.2 port 2000
Building_2_Router(config-telephony)#auto assign 4 to 6
Building_2_Router(config-telephony)#auto assign 1 to 5
Building_2_Router(config-telephony)#exit
Building_2_Router(config)#exit
Building_2_Router#
%SYS-5-CONFIG_I: Configured from console by console

Building_2_Router#copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
Building_2_Router#
```

Step 3: switch configuration (QoS management):

On 'Building_One_Switch', set Switchport's Fa0/1 – 5 to 'voice' to handle voice packets belonging to VLAN 1.

```
Switch>enable
Switch#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#hostname Building_1_Switch
Building_1_Switch(config)#interface range fa0/1-5
Building_1_Switch(config-if-range)#switchport voice vlan 1
Building_1_Switch(config-if-range)#exit
Building_1_Switch(config)#exit
Building_1_Switch#
%SYS-5-CONFIG_I: Configured from console by console

Building_1_Switch#copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
Building_1_Switch#
```

Explanations:

Building_1_Switch(config)#***interface range fa0/1 – 5*** #Configuring interface range#
Building_1_Switch(config-if-range)#***switchport voice vlan 1*** #Setting switchport's to handle voice packets#

switch configuration (QoS management) for building 2:

```
Switch>enable
Switch#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#interface range fa0/1-5
Switch(config-if-range)#switchport voice vlan 1
Switch(config-if-range)#exit
Switch(config)#exit
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
Switch#
```

Step 4: dn and dial numbers configuration

Configure ‘IP Phone 1’ Phone on the first directory entry with dial number 1101: Ensure that this IP Phone receives an ‘IP Address’ from the DHCP server configured on ‘Building_One_Router’ and a ‘Line Number’.

```
Building_1_Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Building_1_Router(config)#ephone-dn 1
Building_1_Router(config-ephone-dn)#%LINK-3-UPDOWN: Interface ephone_dsp DN 1.1, changed
state to up

Building_1_Router(config-ephone-dn)#number 1101
Building_1_Router(config-ephone-dn)#
%IPPHONE-6-REGISTER: ephone-1 IP:1.0.0.1 Socket:2 DeviceType:Phone has registered.

Building_1_Router(config-ephone-dn)#
```

Explanation:
Building _1_Router(config)#***ephone-dn 1*** #Defining IP Phone directory number#
Building_1_Router(config-ephone-dn)#***number 1101*** #Assigning the number#

Adding IP Phone 2

Place an IP Phone into the physical workspace within Packet Tracer and name it ‘IP Phone 2’. Connect the switchport of the IP Phone to port Fa0/3 of ‘Building_One_Switch’. Now on ‘Building_One_Router’ configure IP Phone 2 on the second directory number with dial number 1201:
After a short while, the IP Phone will be configured with an ‘IP Address’ and also a ‘Line Number’ should appear within its configuration. Verify that this has occurred.

```
Building_1_Router(config)#ephone-dn 2
Building_1_Router(config-ephone-dn)#%LINK-3-UPDOWN: Interface ephone_dsp DN 2.1, changed
state to up

Building_1_Router(config-ephone-dn)#number 1201
Building_1_Router(config-ephone-dn)#
%IPPHONE-6-REGISTER: ephone-2 IP:1.0.0.2 Socket:2 DeviceType:Phone has registered.

Building_1_Router(config-ephone-dn)#exit
Building_1_Router(config)#
```

```
Device Name: IP Phone2
Device Model: 7960

Port     Link   IP Address          MAC Address
Vlan1    Up     1.0.0.2/8           0009.7C22.1061
Switch   Up     <not set>           0003.E4EB.B501
PC       Down   <not set>           0003.E4EB.B502

Gateway: 1.1.1.1
Line Number: 1201

Physical Location: Intercity > Home City > Corporate Office > IP Phone2
```

Explanations:
Building _1_Router(config)#***ephone-dn 2*** #Defining IP Phone directory number#
Building_1_Router(config-ephone-dn)#***number 1201*** #Assigning the number#

Adding IP Phone 3

Place an IP Phone into the physical workspace within Packet Tracer and name it 'IP Phone 3'. Connect the switchport of the IP Phone to port Fa0/4 of 'Building_One_Switch'. Now on 'Building_One_Router' configure ip phone 3 on the 3rd directory number with dial number 1301:

After a short while, the IP Phone will be configured with an 'IP Address' and also a 'Line Number' should appear within its configuration. Verify that this has occurred.

```
Building_1_Router(config)#ephone-dn 3
Building_1_Router(config-ephone-dn)#%LINK-3-UPDOWN: Interface ephone_dsp DN 3.1, changed
state to up

Building_1_Router(config-ephone-dn)#number 1301
Building_1_Router(config-ephone-dn)#
%IPPHONE-6-REGISTER: ephone-3 IP:1.0.0.3 Socket:2 DeviceType:Phone has registered.

Building_1_Router(config-ephone-dn)#exit
Building_1_Router(config)#
```

```
Device Name: IP Phone3
Device Model: 7960

Port    Link    IP Address          MAC Address
Vlan1   Up      1.0.0.3/8           0001.C966.7E11
Switch  Up      <not set>           000A.41C9.D801
PC      Down    <not set>           000A.41C9.D802

Gateway: 1.1.1.1
Line Number: 1301

Physical Location: Intercity > Home City > Corporate Office > IP Phone3
```

Explanations:

Building _1_Router(config)#***ephone-dn 3*** #Defining IP Phone directory number#
Building_1_Router(config-ephone-dn)#***number 1301*** #Assigning the number#

Adding the IP Communicator

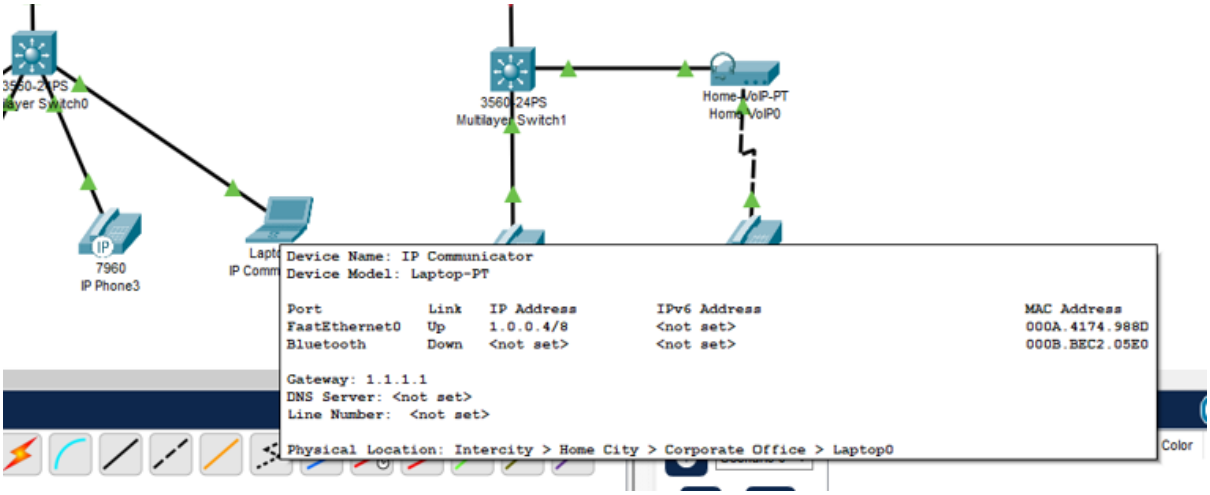
Repeat the above process, however, this time add a 'Laptop' instead of an IP Phone to Packet Tracer. Here you will use the 'IP Communicator' in place of a physical IP Phone. Connect the Ethernet port of the laptop to port Fa0/5 of 'Building_1_Switch'. Ensure that the laptop has been set to receive an IP Address via DHCP! Now on 'Building_1_Router', configure the PC on the 4th directory number, with dial number 1401:

After a short while, the laptop will be configured with an 'IP Address' and a 'Line Number' should also appear within its IP Communicator configuration. Verify that this has occurred.

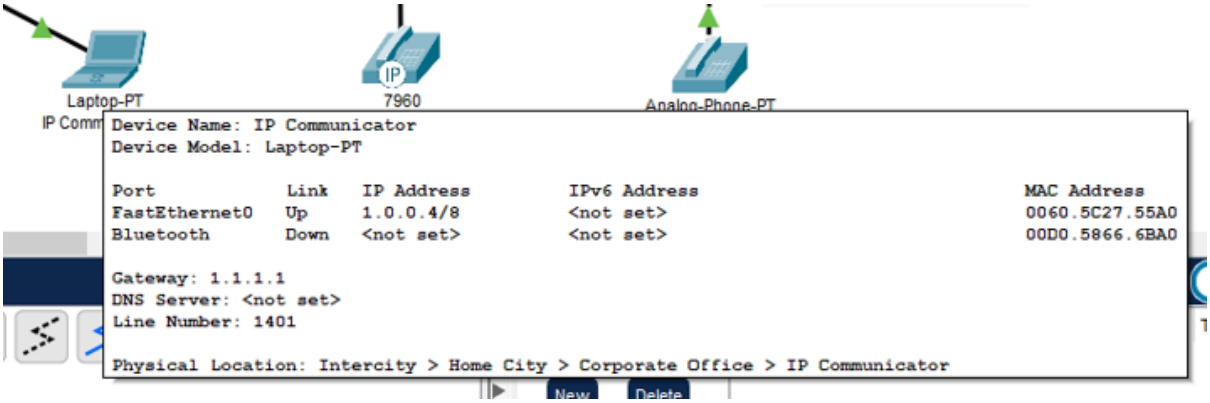
```
Building_1_Router(config)#ephone-dn 4
Building_1_Router(config-ephone-dn)#%LINK-3-UPDOWN: Interface ephone_dsp DN 4.1, changed
state to up

Building_1_Router(config-ephone-dn)#number 1401
Building_1_Router(config-ephone-dn)#
%IPPHONE-6-REGISTER: ephone-4 IP:1.0.0.4 Socket:2 DeviceType:Phone has registered.

Building_1_Router(config-ephone-dn)#
```



IP Communicator now set with a line number



Explanations:

Building _1_Router(config)#***ephone-dn 4*** #Defining IP Phone directory number#

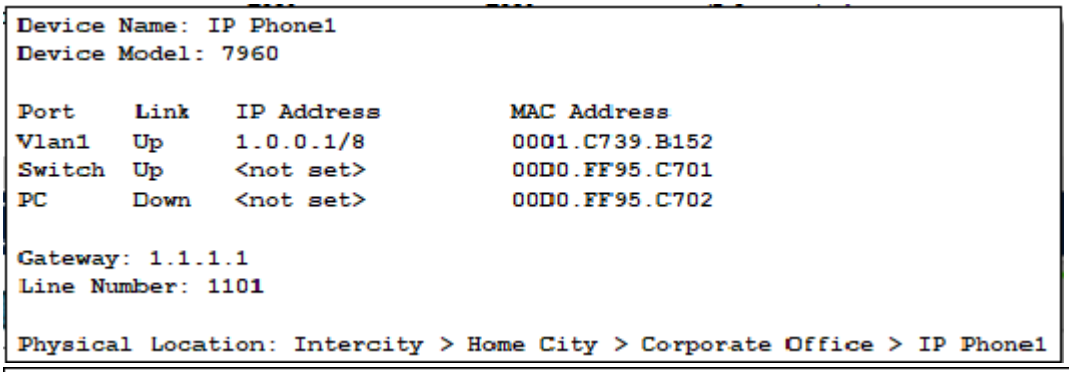
Building_1_Router(config-ephone-dn)#***number 1401*** #Assigning the number#

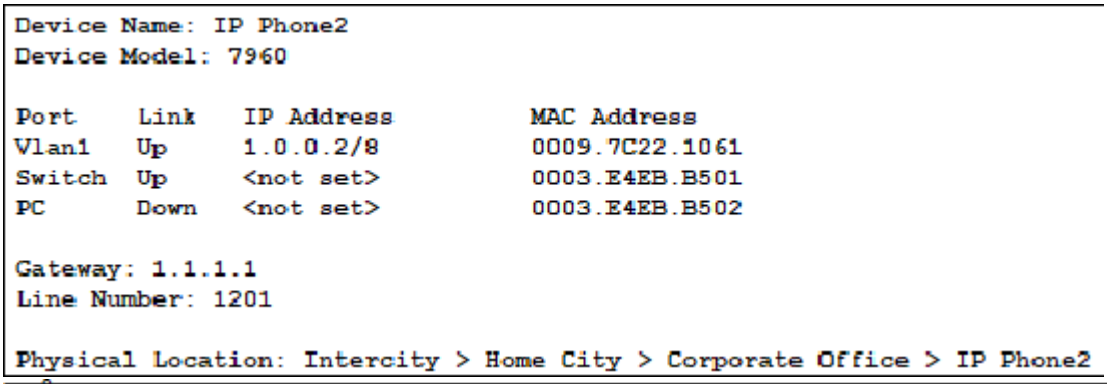
Step 5: Testing & Verification.

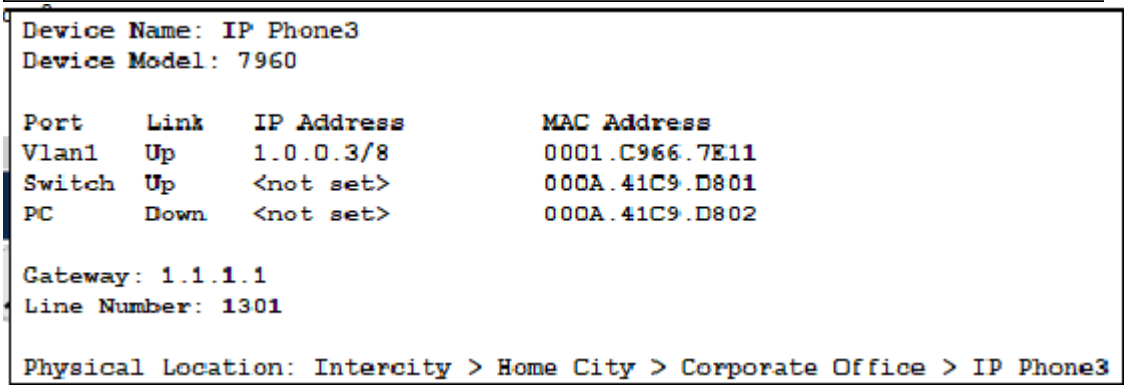
The information shown in the below table should be similar to your IP Configuration & Line Numbers. Please verify that you have similar results:

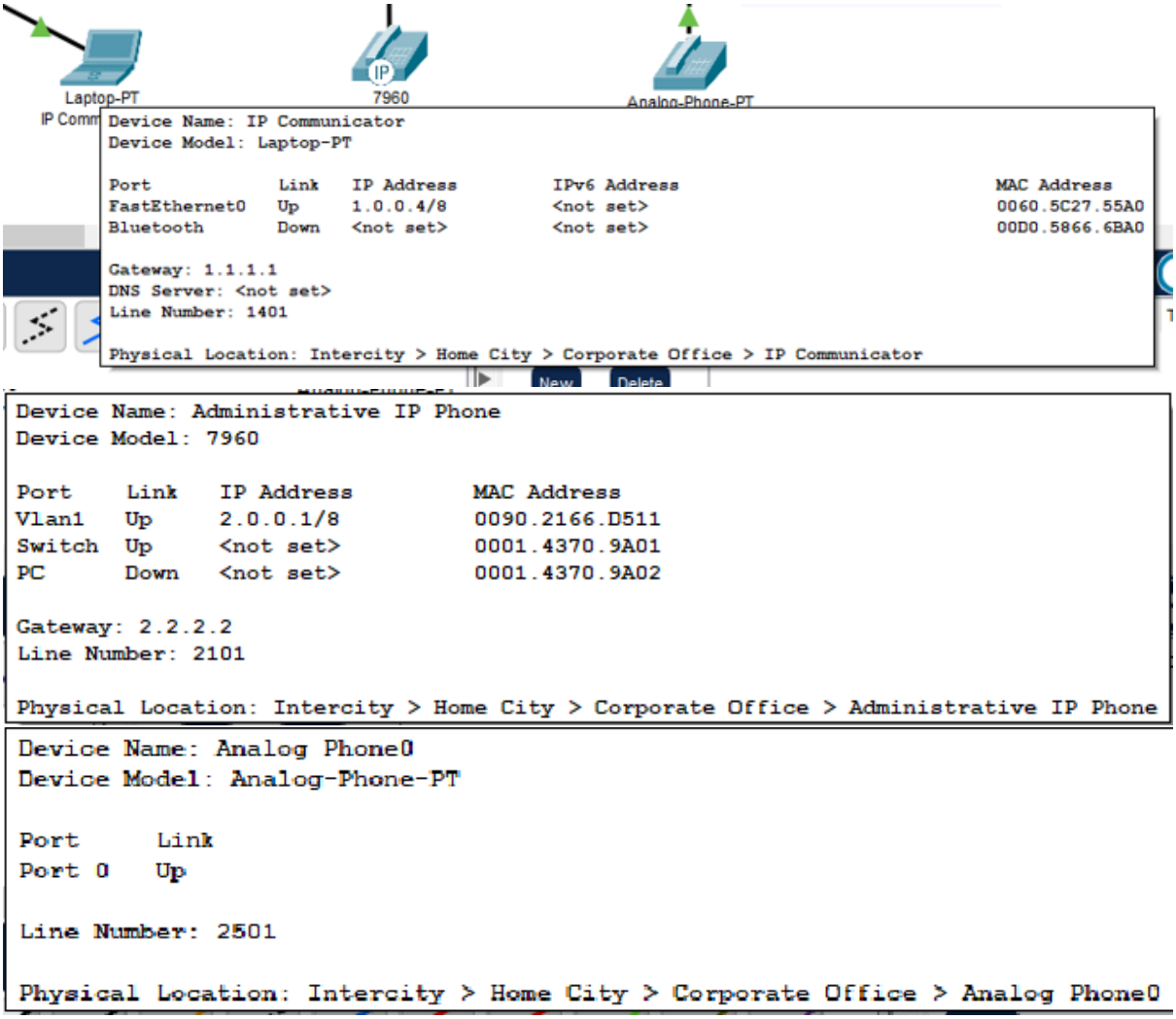
Building	Phone	IP Address	Line Number
Building 1	IP Phone 1	1.0.0.1	1101
	IP Phone 2	1.0.0.2	1201
	IP Phone 3	1.0.0.3	1301
	IP Communicator	1.0.0.4	1401
Building 2	Administrative IP Phone	2.0.0.1	2101
	Analogue Phone	-	2501

Screenshots verifying the table:








Laptop-PT
7960
Analog-Phone-PT
Device Name: IP Communicator
Device Model: Laptop-PT
Port Link IP Address IPv6 Address MAC Address
FastEthernet0 Up 1.0.0.4/8 <not set> 0060.5C27.55A0
Bluetooth Down <not set> <not set> 00D0.5866.6BA0
Gateway: 1.1.1.1
DNS Server: <not set>
Line Number: 1401
Physical Location: Intercity > Home City > Corporate Office > IP Communicator
New
Delete
Device Name: Administrative IP Phone
Device Model: 7960
Port Link IP Address MAC Address
Vlan1 Up 2.0.0.1/8 0090.2166.D511
Switch Up <not set> 0001.4370.9A01
PC Down <not set> 0001.4370.9A02
Gateway: 2.2.2.2
Line Number: 2101
Physical Location: Intercity > Home City > Corporate Office > Administrative IP Phone
Device Name: Analog Phone0
Device Model: Analog-Phone-PT
Port Link
Port 0 Up
Line Number: 2501
Physical Location: Intercity > Home City > Corporate Office > Analog Phone0

Within each building check to see if you can call between IP Phones, for example, select IP Phone 1 (take the receiver off the phone) and dial IP Phones 2, 3, or the IP Communicator.

Screenshot of the answer: As it is seen in the screenshots below, we are able to place calls within each block of the buildings.

Also testing the building 2 to check if the phones can call each other:

Step 6: Establishing WAN communication.

For the moment 'Building_One_Router' and 'Building_Two_Router' are not connected. You will need to establish a WAN serial connection between the two routers by connecting both S0/3/0 interfaces. You will then need to define a static route on each of the two routers, notifying them of route information to each network. First of all, place a serial connection between interfaces S0/3/0 of each router. Note that 'Building_One_Router' should be designated as the DCE.

```
Building_1_Router(config)#interface serial 0/3/0
Building_1_Router(config-if)#ip address 3.0.0.1 255.0.0.0
Building_1_Router(config-if)#clockrate 56000
```

Commands used:

Building _1_Router(config)#***interface serial 0/3/0***
Building_1_Router(config-if)#***ip address 3.0.0.1 255.0.0.0***
Building_1_Router(config-if)#***clock rate 56000***
Building_1_Router(config-if)#***no shutdown***

```
Building_2_Router(config)#int s0/3/0
Building_2_Router(config-if)#ip address 3.0.0.2 255.0.0.0
Building_2_Router(config-if)#no shutdown

Building_2_Router(config-if)#
%LINK-5-CHANGED: Interface Serial0/3/0, changed state to up

Building_2_Router(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/3/0, changed state to up
```

Commands used:

Building _2_Router(config)#***interface serial 0/3/0***
Building_2_Router(config-if)#***ip address 3.0.0.2 255.0.0.0***
Building_2_Router(config-if)#***no shutdown***

Step 7: Configuring routing protocol

Now that the interfaces have been configured, you will need to configure Static Routes on each router so that traffic can be routed from network 1.0.0.0/8 through to 2.0.0.0/8 via network 3.0.0.0/8.

Configuring static route on building one:

```
Building_1_Router(config)#ip route 1.0.0.0 255.0.0.0 3.0.0.2
Building_1_Router(config)#exit
Building_1_Router#
%SYS-5-CONFIG_I: Configured from console by console
```

Configuring static route on building two:

```
Building_2_Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Building_2_Router(config)#ip route 2.0.0.0 255.0.0.0 3.0.0.1
Building_2_Router(config)#exit
Building_2_Router#
%SYS-5-CONFIG_I: Configured from console by console
```

Step 8: Enabling WAN voice communication with Dial Peer Mapping

Finally, now that you have connectivity between all phone devices within each Local Area Network, and that you have established a WAN connection between both routers defining static routes; you are now ready to configure the 'Dial Peer Mapping' so that an IP Phone belonging within one LAN can call across the WAN to another IP Phone. In order to do this you we need to configure dial peer information on

Building 1 router:

```
Building_1_Router(config)#dial-peer voice 1 voip
Building_1_Router(config-dial-peer)#destination-pattern 2...
Building_1_Router(config-dial-peer)#session target ipv4:3.0.0.2
Building_1_Router(config-dial-peer)#exit
Building_1_Router(config)#exit
```

Building 2 router:

```
Building_2_Router(config)#dial-peer voice 1 voip
Building_2_Router(config-dial-peer)#destination-pattern 1...
Building_2_Router(config-dial-peer)#session target ipv4:3.0.0.1
Building_2_Router(config-dial-peer)#exit
Building_2_Router(config)#exit
```

Commands used:

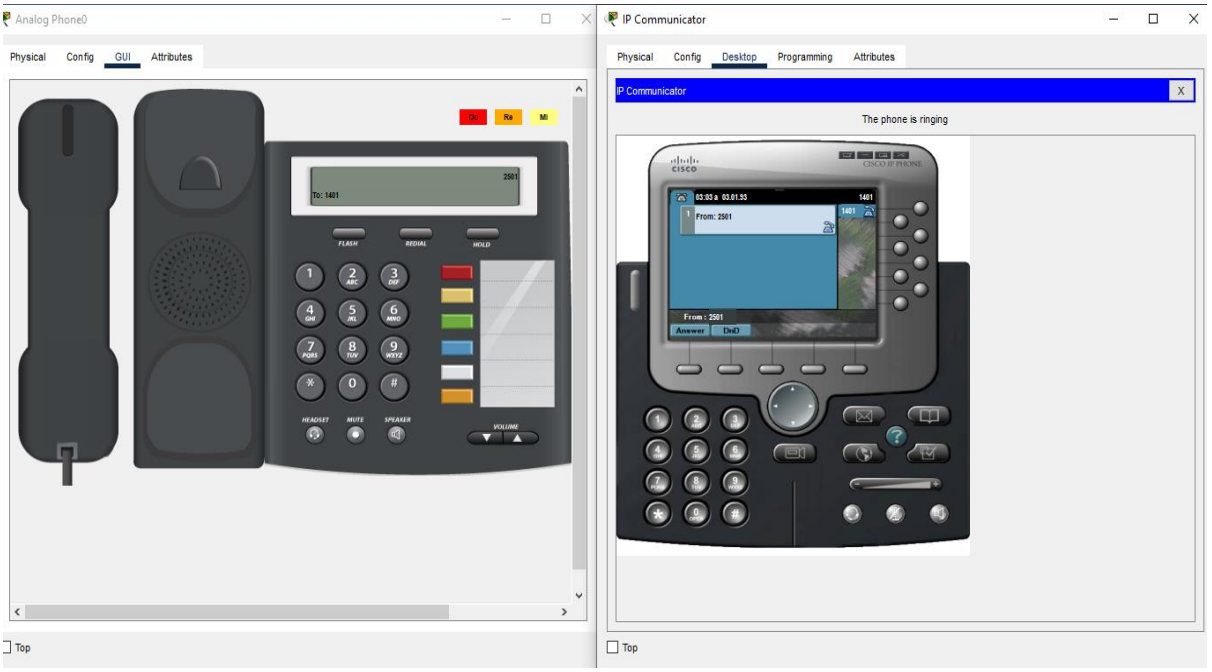
Building _1_Router(config)#***dial-peer voice 1 voip*** #Assigning the dial-peer#
Building_1_Router(config-dial-peer)#***destination-pattern 2…*** #Destination dial pattern begins with n.o.2#
Building_1_Router(config-dial-peer)#***session target ipv4:3.0.0.***2 #Gateway to Building_2_Router#

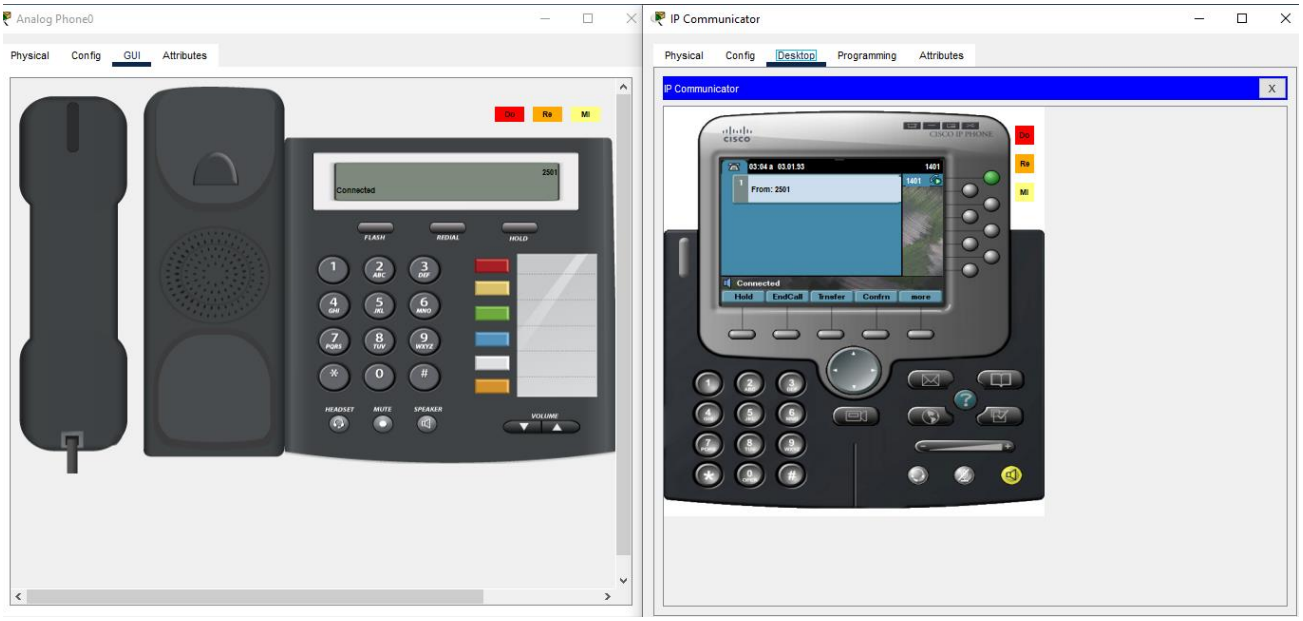
Step 9: Testing & Verification.

Please complete the following tests to ensure that you have end-to-end connectivity between all telephone devices. Note, to make a call: first select a phone with your mouse cursor; looking at the GUI, click on the receiver to dismount it from the telephone; then finally dial the destination telephone number.

1. Test that you can call from ‘IP Phone 1’ through the WAN to the ‘Administrators IP Phone’.
   As shown below, it is seen that the IP Phone 1 successfully made a call with the Administrative IP Phone via the WAN that was created.

2. Test that you can call from the ‘Analogue Phone’ to the ‘IP Communicator’. From the screenshots, it is shown that we were able to make a call between the LANs via the WAN that was created. And as we can see below, the call between the Analogue phone from building 2 and the IP Communicator from building 1 was successfully established.





Conclusion:

To conclude, we successfully created an IP telephony network between 2 branches of a company, and these branches were able to call each other as required by the lab exercises.