Computer Networks-Lab 12

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CL30001 – Computer Networks-Lab

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Department of Computer Science & Software Engineering

Computer Networks - Lab 12

OBJECTIVES

After these Lab students shall be able to perform

- **Practical Implementation Subnetting in Cisco Packet Tracer**
  - **Class A Subnetting**
  - **Class B Subnetting**
  - **Class C Subnetting**

PRE-LAB READING ASSIGNMENT

Remember the delivered lecture carefully.

Table of Contents

Understand IP Addresses

An IP address is an address used in order to uniquely identify a device on an IP network. The address is made up of 32 binary bits, which can be divisible into a network portion and host portion with the help of a subnet mask. The 32 binary bits are broken into four octets (1 octet = 8 bits). Each octet is converted to decimal and separated by a period (dot). For this reason, an IP address is said to be expressed in dotted decimal format (for example, 172.16.81.100). The value in each octet ranges from 0 to 255 decimal, or 00000000 - 11111111 binary.

Here is how binary octets convert to decimal: The right most bit, or least significant bit, of an octet holds a value of 2^0. The bit just to the left of that holds a value of 2^1. This continues until the left-most bit, or most significant bit, which holds a value of 2^7. So if all binary bits are a one, the decimal equivalent would be 255 as shown here:

```
  1  1  1  1 1 1 1 1
128 64 32 16 8 4 2 1 (128+64+32+16+8+4+2+1=255)
```

Here is a sample octet conversion when not all of the bits are set to 1.

```
0  1 0 0 0 0 0 1
0 64 0 0 0 0 0 1 (0+64+0+0+0+0+0+1=65)
```

And this sample shows an IP address represented in both binary and decimal.

```
      10.       1.      23.      19 (decimal)
00001010.00000001.00010111.00010011 (binary)
```

These octets are broken down to provide an addressing scheme that can accommodate large and small networks. There are five different classes of networks, A to E. This document focuses on classes A to C, since classes D and E are reserved and discussion of them is beyond the scope of this document.

Network Masks

A network mask helps you know which portion of the address identifies the network and which portion of the address identifies the node. Class A, B, and C networks have default masks, also known as natural masks, as shown here:

```
Class A: 255.0.0.0
Class B: 255.255.0.0
Class C: 255.255.255.0
```

An IP address on a Class A network that has not been subnetted would have an address/mask pair similar to: 8.20.15.1 255.0.0.0. In order to see how the mask helps you identify the network and node parts of the address, convert the address and mask to binary numbers.

```
8.20.15.1 = 00001000.00010100.00001111.00000001
255.0.0.0 = 11111111.00000000.00000000.00000000
```

Once you have the address and the mask represented in binary, then identification of the network and host ID is easier. Any address bits which have corresponding mask bits set to 1 represent the network ID. Any address bits that have corresponding mask bits set to 0 represent the node ID.

```
8.20.15.1 = 00001000.00010100.00001111.00000001
255.0.0.0 = 11111111.00000000.00000000.00000000
            ---------------------------------
             net id |      host id

netid =  00001000 = 8
hostid = 00010100.00001111.00000001 = 20.15.1
```

Understand Subnetting

Subnetting allows you to create multiple logical networks that exist within a single Class A, B, or C network. If you do not subnet, you are only able to use one network from your Class A, B, or C network, which is unrealistic.

Each data link on a network must have a unique network ID, with every node on that link being a member of the same network. If you break a major network (Class A, B, or C) into smaller subnetworks, it allows you to create a network of interconnecting subnetworks. Each data link on this network would then have a unique network/subnetwork ID. Any device, or gateway, that connects n networks/subnetworks has n distinct IP addresses, one for each network / subnetwork that it interconnects.

In order to subnet a network, extend the natural mask with some of the bits from the host ID portion of the address in order to create a subnetwork ID. For example, given a Class C network of 204.17.5.0 which has a natural mask of 255.255.255.0, you can create subnets in this manner:

```
204.17.5.0 -      11001100.00010001.00000101.00000000
255.255.255.224 - 11111111.11111111.11111111.11100000
                  -------------------------|sub|----
```

By extending the mask to be 255.255.255.224, you have taken three bits (indicated by "sub") from the original host portion of the address and used them to make subnets. With these three bits, it is

possible to create eight subnets. With the remaining five host ID bits, each subnet can have up to 32 host addresses, 30 of which can actually be assigned to a device *since host ids of all zeros or all ones are not allowed* (it is very important to remember this). So, with this in mind, these subnets have been created.

```
204.17.5.0 255.255.255.224     host address range 1 to 30
204.17.5.32 255.255.255.224    host address range 33 to 62
204.17.5.64 255.255.255.224    host address range 65 to 94
204.17.5.96 255.255.255.224    host address range 97 to 126
204.17.5.128 255.255.255.224   host address range 129 to 158
204.17.5.160 255.255.255.224   host address range 161 to 190
204.17.5.192 255.255.255.224   host address range 193 to 222
204.17.5.224 255.255.255.224   host address range 225 to 254
```

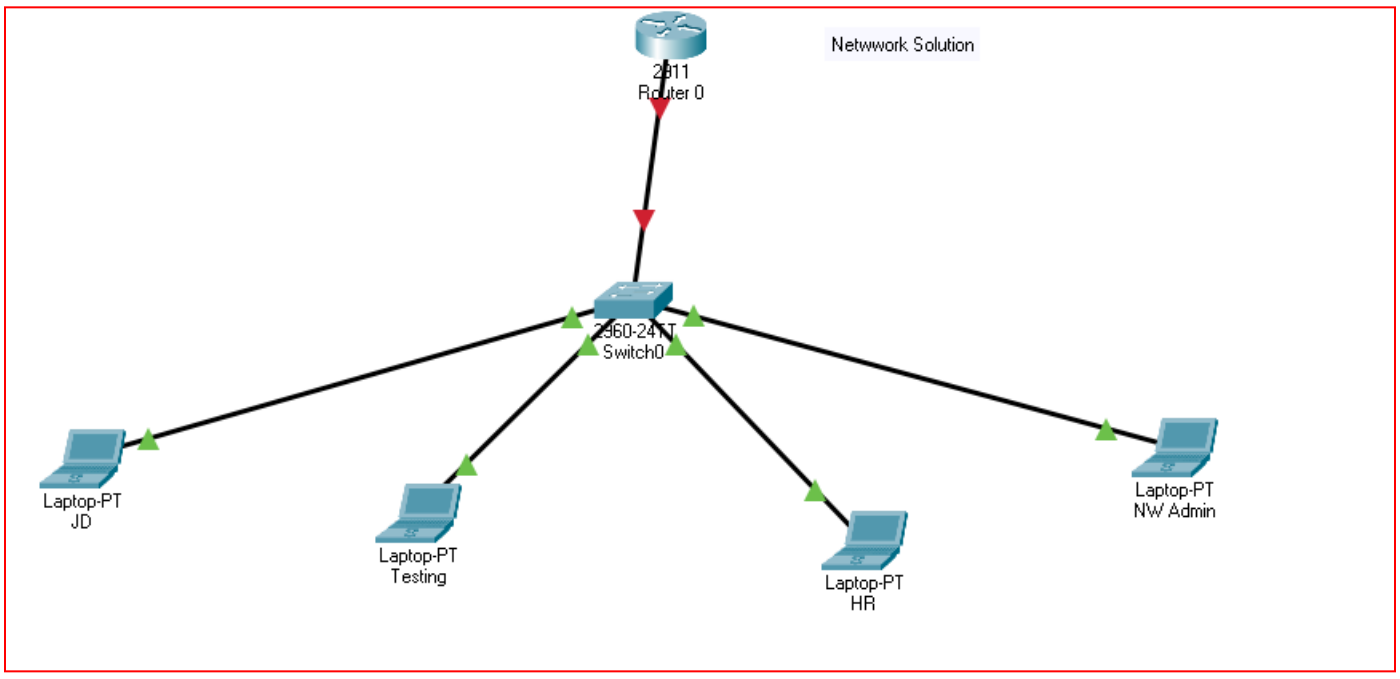
SUBNETTING A NETWORK

A sub network or subnet is a logical subdivision of an IP network. The practice of dividing a network into two or more networks is called sub netting.

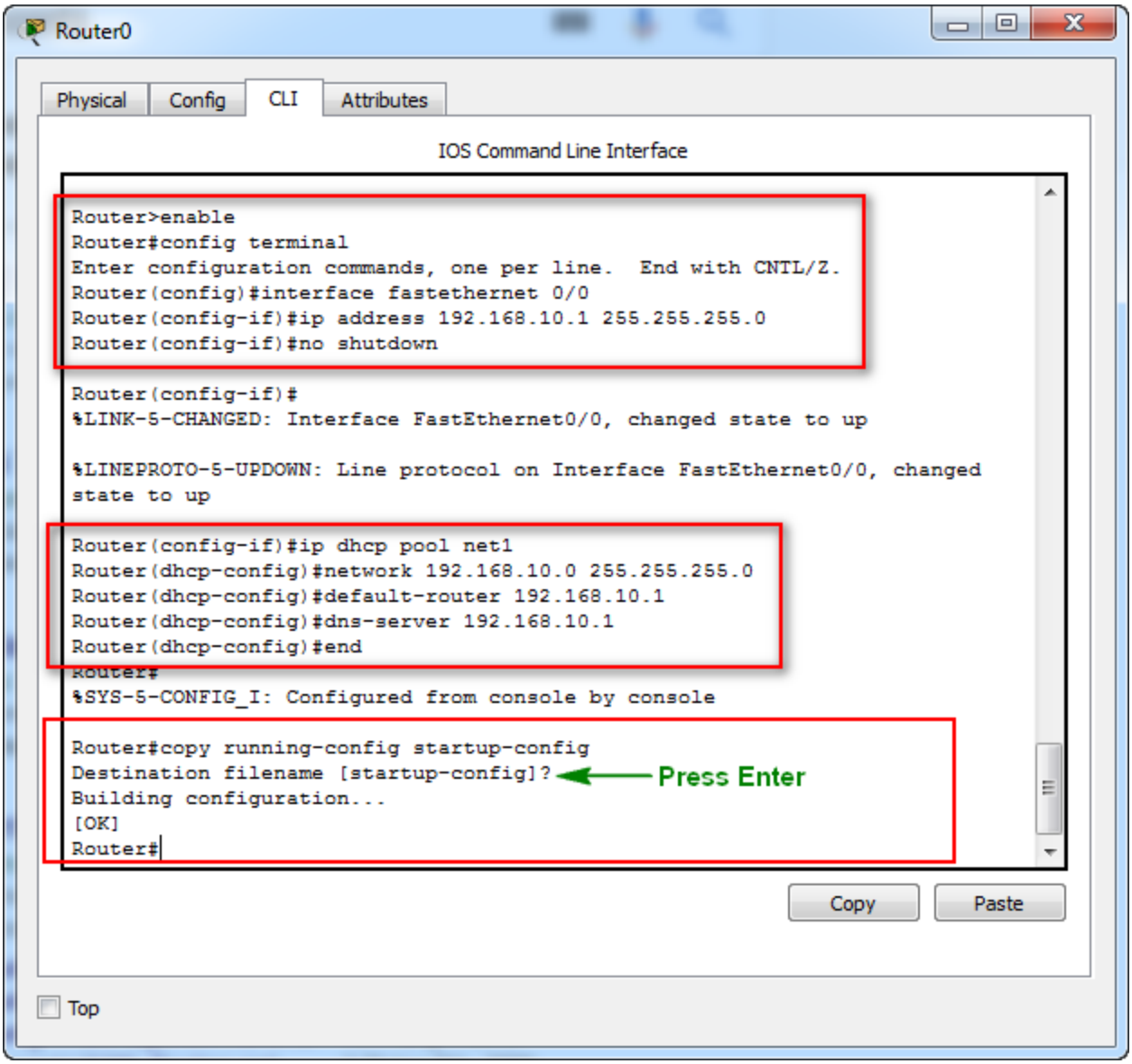
1. ***Sub netting offers many advantages. Some of them are.***
    1. It provides security to the network.
    2. Speeds up the network thus improving the performance of the network.
    3. It allows for better organization of the resources.

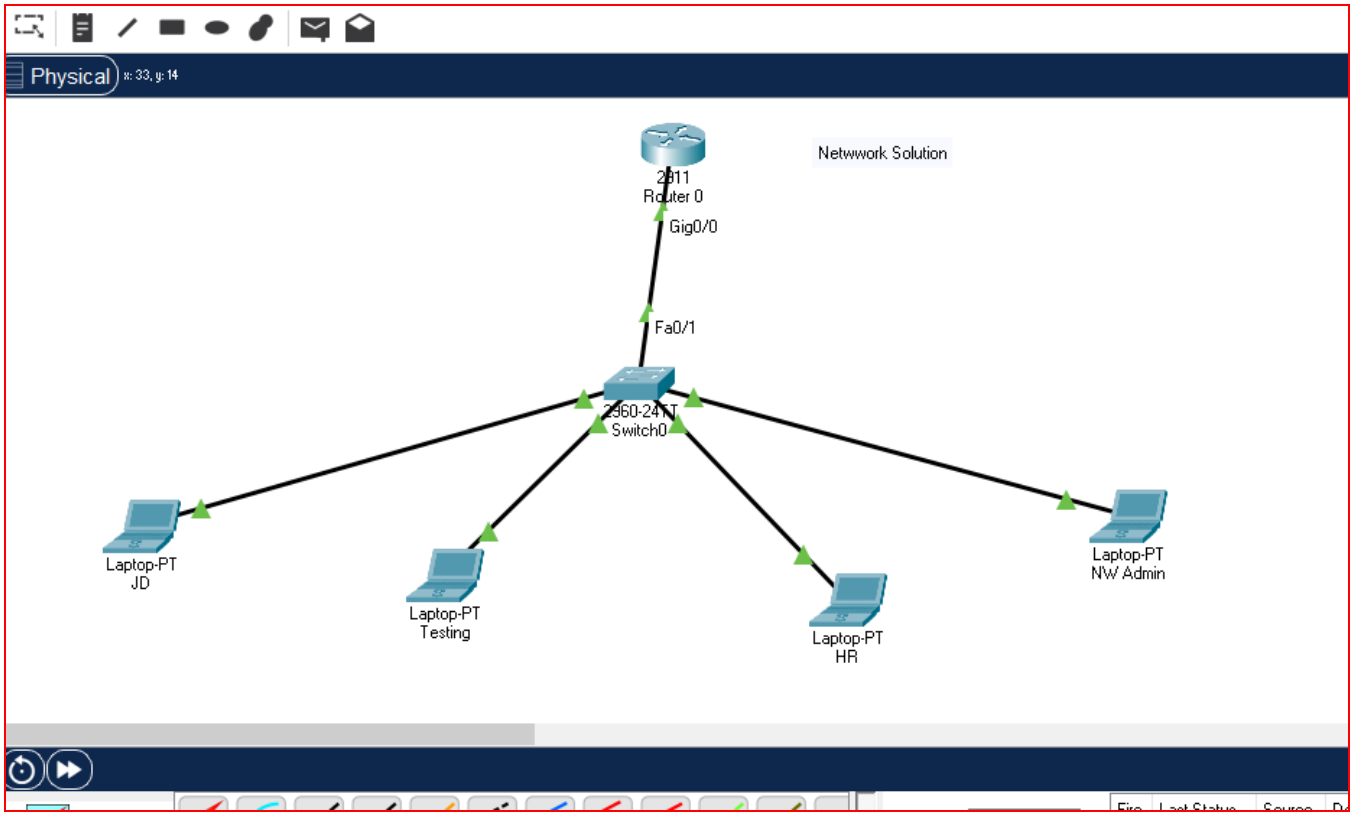
Understanding sub netting is very important not only for those preparing for CCNA exam but also network administrators. Today, Let us see how to create a subnet in a network.

Imagine I formed a small software company named Network Solution whose network looks like below. I hired one Java Developer (JD), one software tester, one HR and one network administrator. I have been assigned the IP address range from 192.168.10.1 to 192.168.10.255.

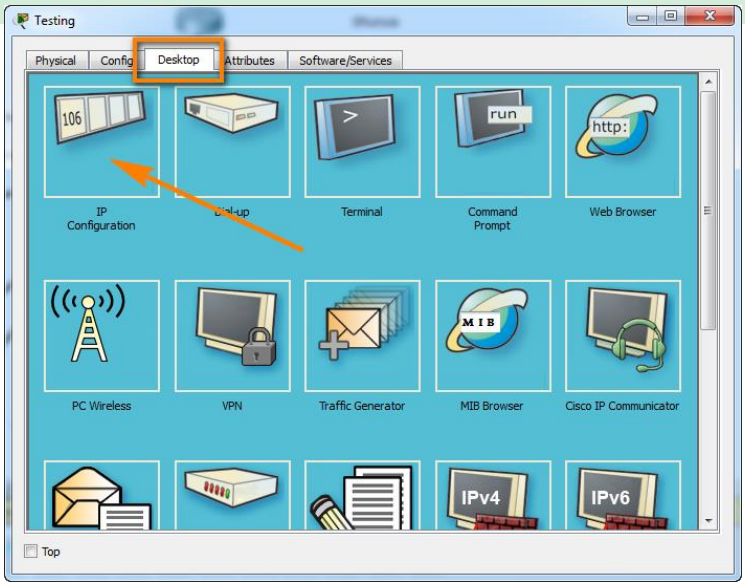


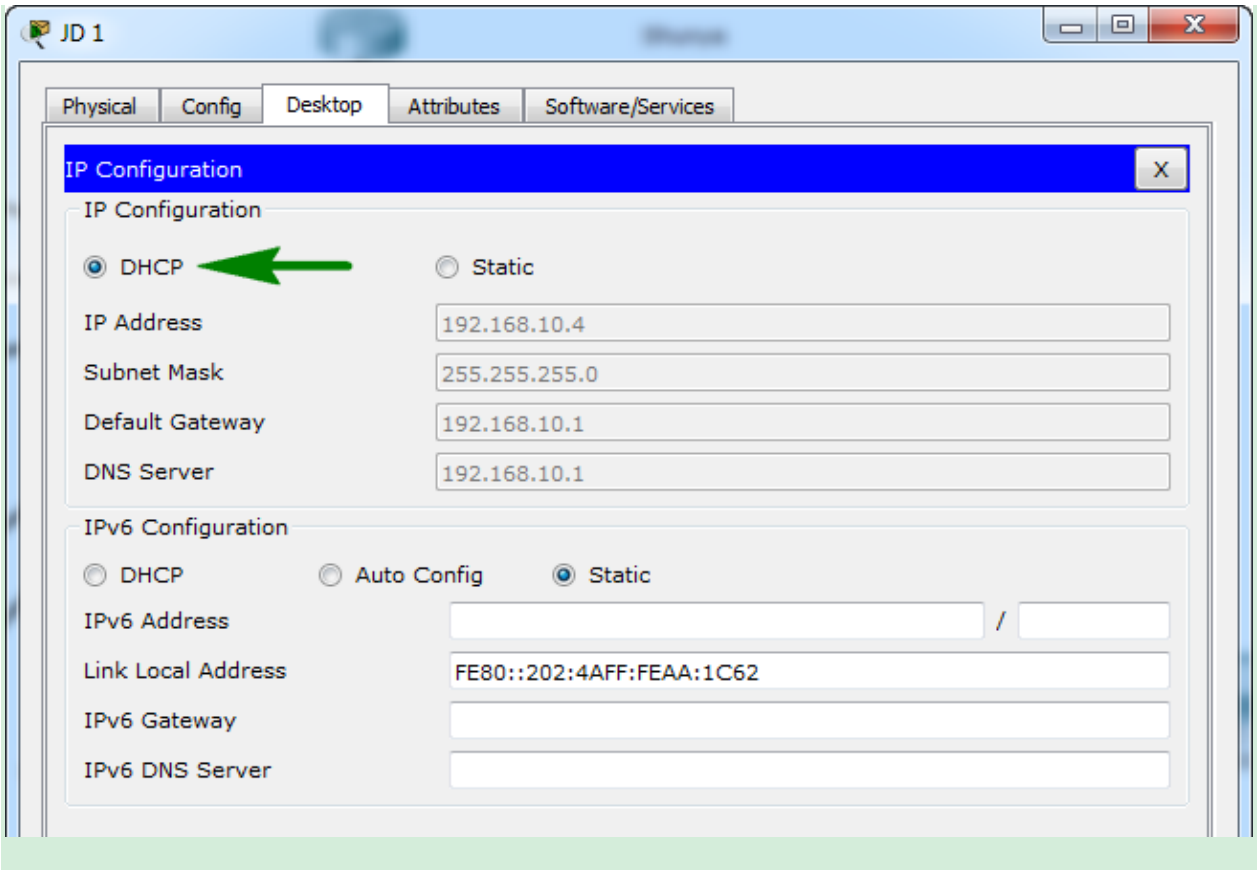
I have enabled DHCP on my router as below.


Router0
Physical
Config
CLI
Attributes
IOS Command Line Interface
Router>enable
Router#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface fastethernet 0/0
Router(config-if)#ip address 192.168.10.1 255.255.255.0
Router(config-if)#no shutdown
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
Router(config-if)#ip dhcp pool net1
Router(dhcp-config)#network 192.168.10.0 255.255.255.0
Router(dhcp-config)#default-router 192.168.10.1
Router(dhcp-config)#dns-server 192.168.10.1
Router(dhcp-config)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console
Router#copy running-config startup-config
Destination filename [startup-config]?
Press Enter
Building configuration...
[OK]
Router#
Copy
Paste
Top

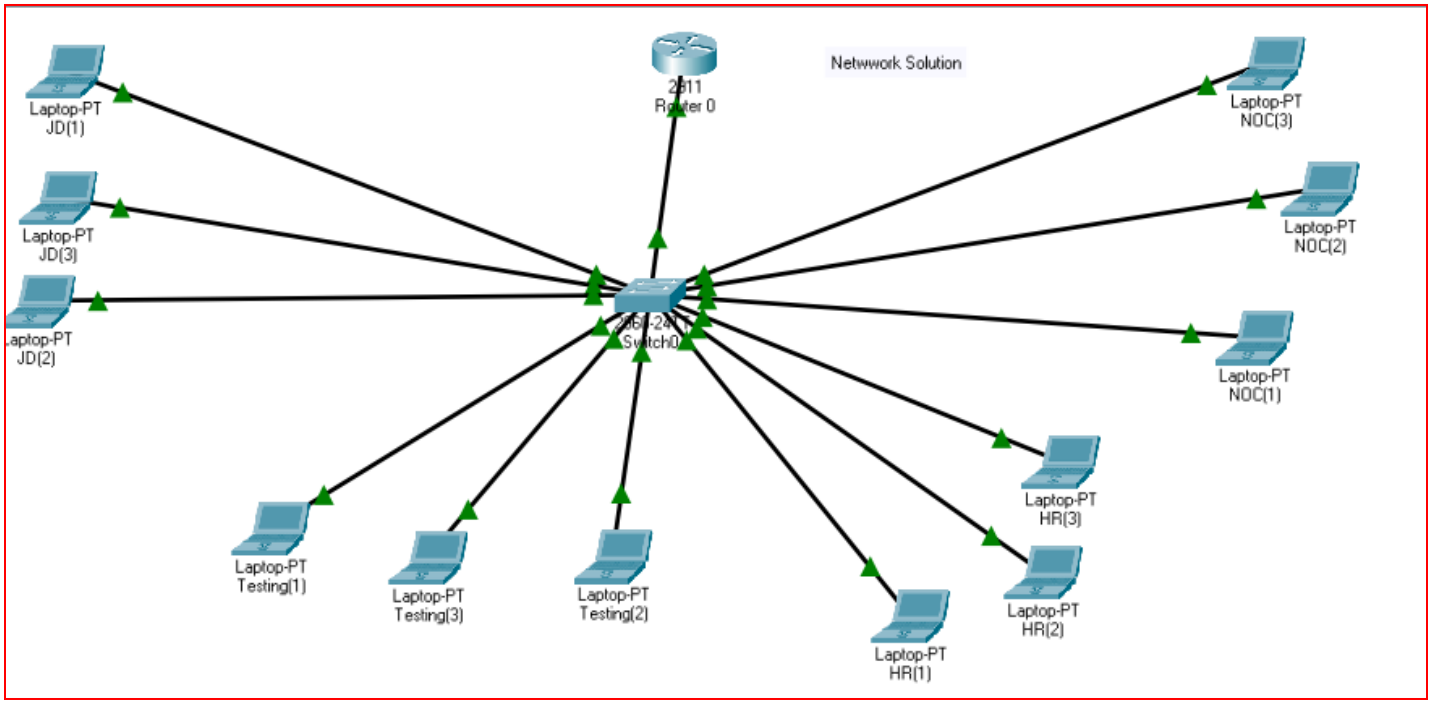


Enable DHCP on all PCs:

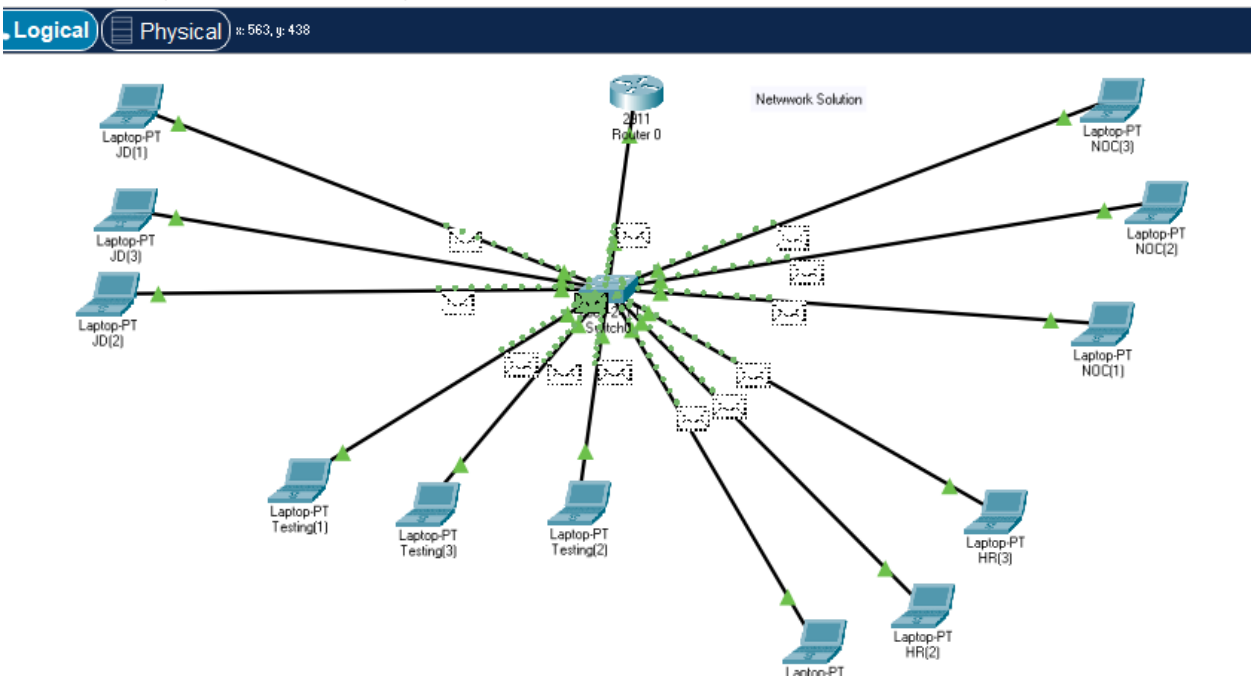




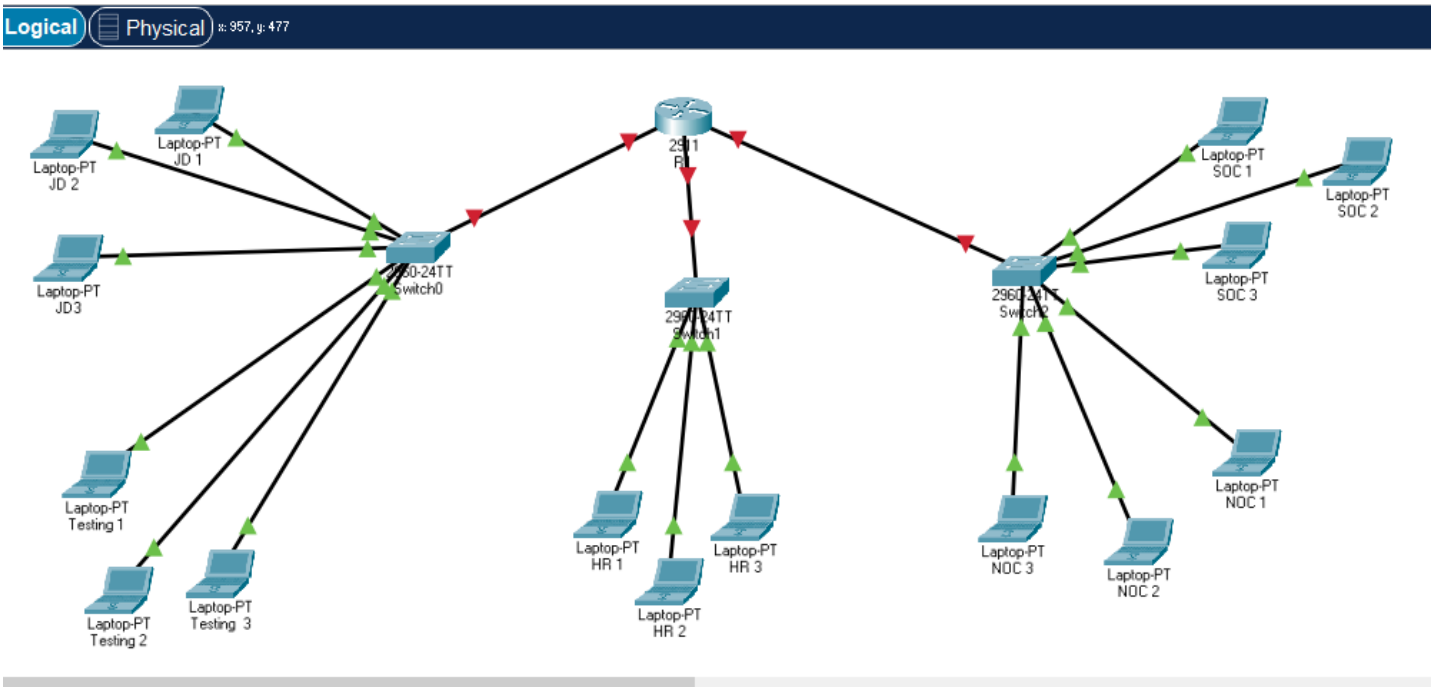
After one year, imagine my company has received blessings from GOD and has seen rapid growth. Now the company has three Java Developers, three software testers and a dedicated HR team. Not only that, my company now has moved into Remote Infrastructure Management(RIM) and has a Network Operation Center (NOC) and Security Operation Center (SOC). Totally I have 15 computers in my network which looks like below.



Now see the image below. Here the machine **"JD1"** sends a packet to machine **"Testing3"**. We can see here that for communication between machines **"JD1:** and **"Testing3"** other machines have also been disturbed. See, this affects the performance of the network.



So for this reason, I decided to subnet the network. I decide to divide the network into three subnets as shown below each for HR, Java Development and OC departments.



Add more FastEthernet 1/0 port for Router 0

To create a subnet, first we need to have proper planning as to how many subnets we need and how many we may need in the future. Presently, I need three subnets. The number of subnets should always be calculated in the powers of 2.

2 to the power of 1 = 2

This doesn't satisfy our requirement as we need three subnets.

2 to the power of 2 = 4

This satisfies our requirement. So we need to take two bits from the host portion of the IP address. 192.168.10.1 to 192.168.10.255 is the address range available to us with subnet mask 255.255.255.0, Writing the subnet mask in the binary notation, it is

11111111 11111111 11111111 00000000

255 255 255 0

The first 24 bits are network bits and the last eight bits are host bits. To create three subnets, we need to take two bits from the host portion of the address as explained above.

11111111 111111111 11111111 11000000

255 255 255 192

Four subnets which can be created from the above subnet mask are,

- **192.168.10.0 to 192.168.10.63 (with host bits 00000000)**
- **192.168.10.64 to 192.168.10.127 (with host bits 01000000)**
- **192.168.10.128 to 192.168.10.191 (with host bits 10000000)**
- **192.168.10.192 to 192.168.10.255 (with host bits 11000000)**

Subnet for Java Developers and Software testers

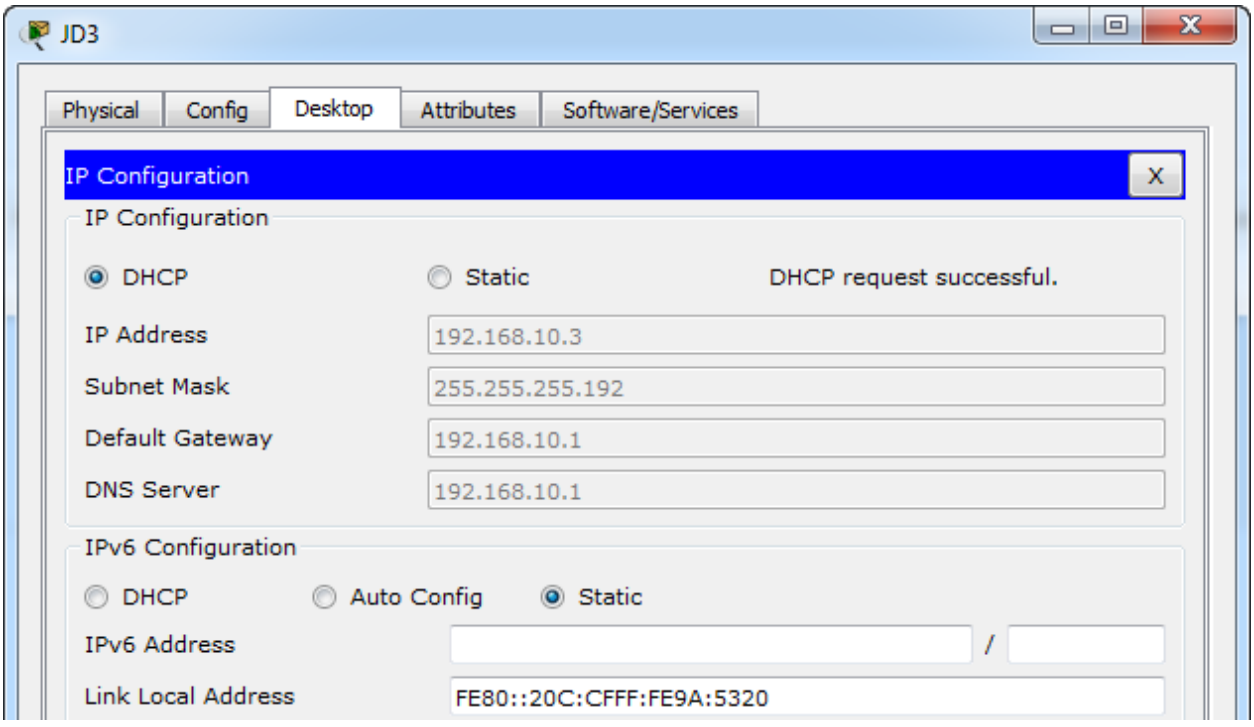
Since we require only three subnets, we will create the first three subnets. The first subnet (192.168.10.1 to 192.168.10.63) comprises of Java Developers and Software testers. The commands are as shown below on the interface.

```
Router>en
Router#conf ter
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R1
R1(config)#int g0/0
R1(config-if)#ip add 192.168.10.1 255.255.255.192
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#ip dhcp pool net1
```

```
Router>en
Router#conf ter
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#hostname R1
R1(config)#int g0/0
R1(config-if)#ip add 192.168.10.1 255.255.255.192
R1(config-if)#no shut

R1(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up

R1(config-if)#ex
R1(config)#ip dhcp pool net1



R1(dhcp-config)#network 192.168.10.0 255.255.255.192
R1(dhcp-config)#dns-server 192.168.10.1
R1(dhcp-config)#default-router 192.168.10.1
R1(dhcp-config)#ex
R1(config)#
```

Ctrl+F6 to exit CLI focus Copy Paste

If you go to any machine on this subnet and look at its IP address, it will be like below.

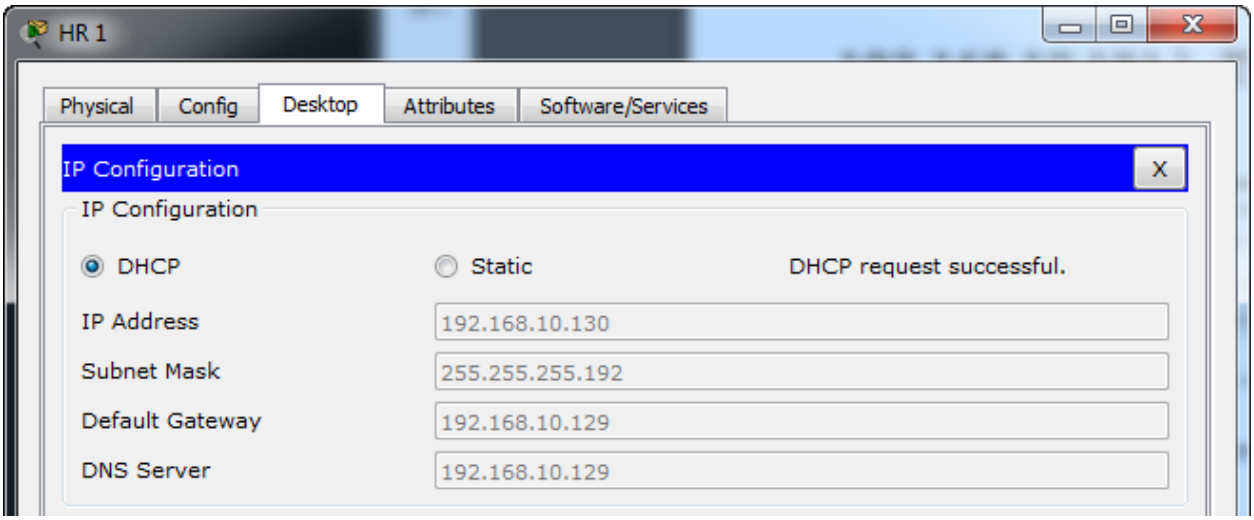


Subnet for the Human Resource Department

Now the subnet for the Human Resource Department (192.168.10.64 to 192.168.10.127) . This will be like below

```
R1(config)#int g0/1
R1(config-if)#ip add 192.168.10.65 255.255.255.192
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#ip dhcp pool net2
R1(dhcp-config)#network 192.168.10.64 255.255.255.192
R1(dhcp-config)#dns-server 192.168.10.65
```

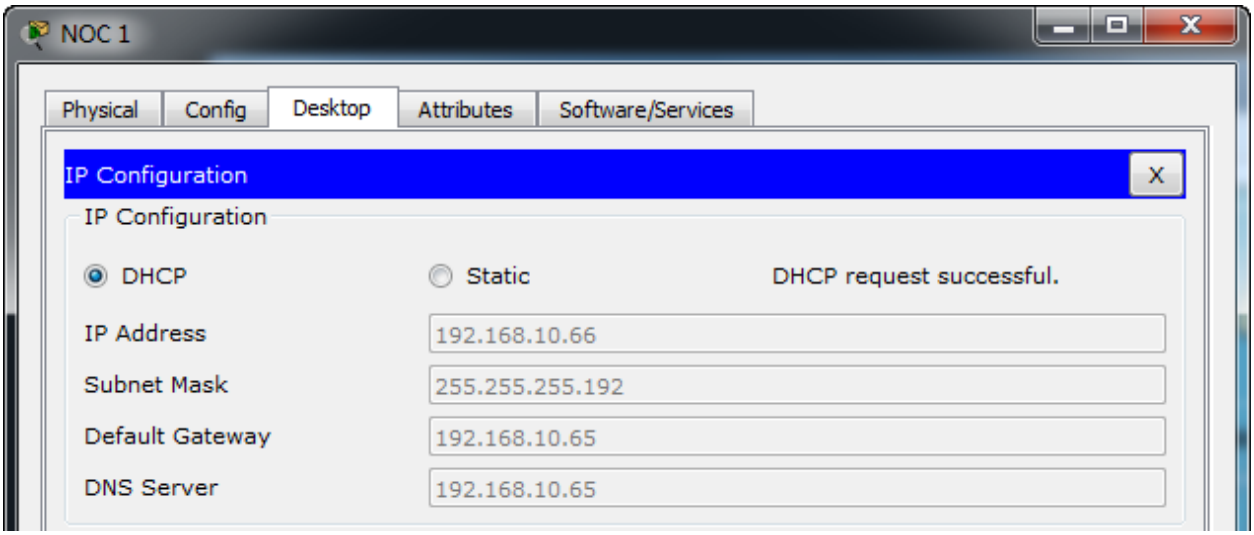
```
R1(config-if)#int g0/1
R1(config-if)#ip add 192.168.10.65 255.255.255.192
R1(config-if)#no shut

R1(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state to up

R1(config-if)#ex
R1(config)#ip dhcp pool net2
R1(dhcp-config)#network 192.168.10.64 255.255.255.192
R1(dhcp-config)#dns-server 192.168.10.65
R1(dhcp-config)#default-router 192.168.10.65
R1(dhcp-config)#ex
R1(config)#
```



Subnet for the Human Resource Department

The third subnet (192.168.10.128 to 192.168.10.191) comprises of NOC and SOC.

```
R1(config)#int g0/2
R1(config-if)#ip add 192.168.10.129 255.255.255.192
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#ip dhcp pool net3
R1(dhcp-config)#network 192.168.10.128 255.255.255.192
R1(dhcp-config)#default-router 192.168.10.129
R1(dhcp-config)#dns-server 192.168.10.129
```



Now our network has been successfully subnetted into three subnets and we still have another subnet to use for future use.

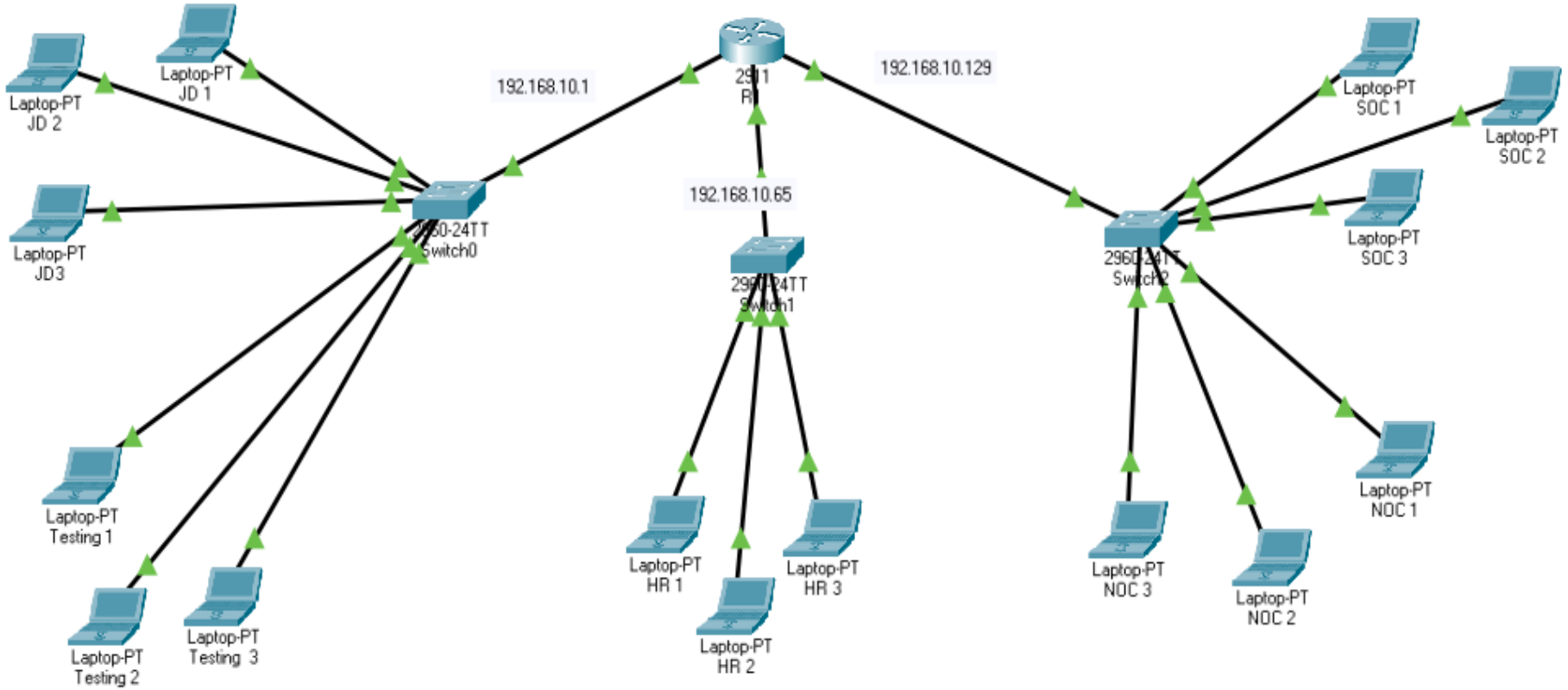


Figure 1 Final Topology

IP 197.10.10.0/27

- Sub Network 1
  - Network ID: 197.10.10.0 /27
  - Broadcast ID 197.10.10.31/27
  - Subnet Mask: 255.255.255.224
- Sub Network 2
  - Network ID: 197.10.10.32 /27
  - Broadcast ID 197.10.10.63/27
  - Subnet Mask: 255.255.255.224
- Sub Network 3
  - Network ID: 197.10.10.64 /27
  - Broadcast ID 197.10.10.95/27
  - Subnet Mask: 255.255.255.224
- Sub Network 4
  - Network ID: 197.10.10.96 /27
  - Broadcast ID 197.10.10.127/27
  - Subnet Mask: 255.255.255.224
- Sub Network 5
  - Network ID: 197.10.10.128 /27
  - Broadcast ID 197.10.10.159/27
  - Subnet Mask: 255.255.255.224