Experiment 05 - IP addressing, Subnet and Subnet Mask

Learning Objective: Set up and configure IP addressing, subnetting, masking a network using CISCO packet tracer.

Tools:MS Word, Cisco Packet Tracer

Theory:

Address - The unique number ID assigned to one host or interface in a network.

Subnet - A portion of a network that shares a particular subnet address.

Subnet mask - A 32-bit combination used to describe which portion of an address refers to the subnet and which part refers to the host.

Interface - A network connection.

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.
- 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
- For the IP addresses from Class A, the first 8 bits (the first decimal number) represent the network part, while the remaining 24 bits represent the host part.
- For Class B, the first 16 bits (the first two numbers) represent the network part, while the remaining 16 bits represent the host part.
- For Class C, the first 24 bits represent the network part, while the remaining 8 bits represent the host part.

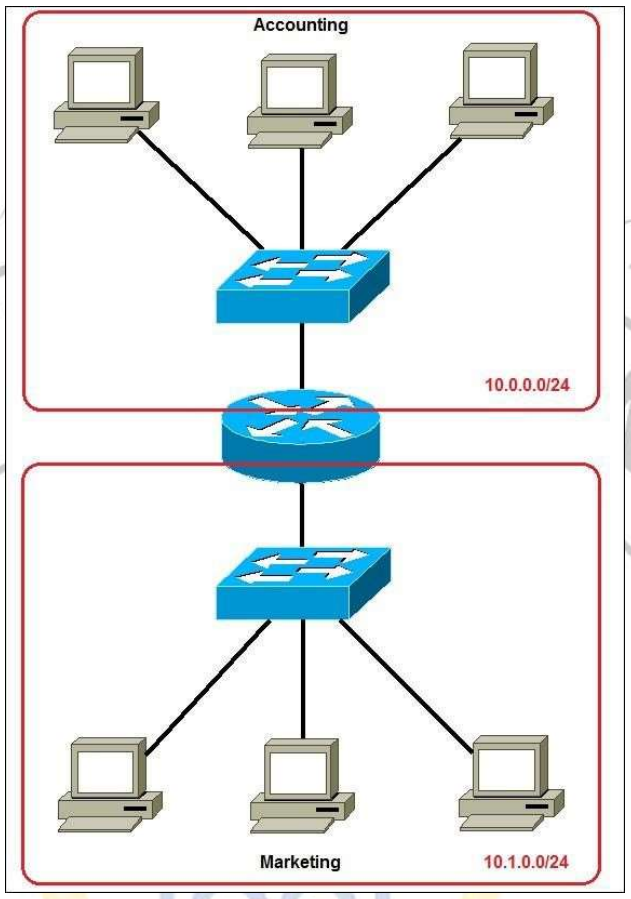
Creation of Subnets:

- There are a couple of ways to create subnets. Letssubnet a class C address **192.168.0.0** that, by default, has **24** subnet bits and **8** host bits.

1. How many subnets do we need?
   2^x = number of subnets.
   x is the number of 1s in the subnet mask.
   With 1 subnet bit, we can have 2^1 or 2 subnets. With 2 bits, 22 or 4 subnets, with 3 bits, 23 or 8 subnets, etc.
2. How many hosts per subnet do we need?
   $2^y – 2$ = number of hosts per subnet. **y** is the number of 0s in the subnet mask.

Subnetting:

- Subnetting is the practice of dividing a network into two or more smaller networks. It increases routing efficiency, enhances the security of the network and reduces the size of the broadcast domain.
- It allows you to create multiple logical networks that exist within a single Class A, B, or C network.
- 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 the above diagram two subnets were created for different departments: 10.0.0.0/24 for Accounting and 10.1.0.0/24 for Marketing. Devices in each subnet are now in a different broadcast domain. This will reduce the amount of traffic flowing on the network and allow us to implement packet filtering on the router.

Subnet Mask:

- An IP address is divided into two parts:
  - Network id and subnet id
  - Host id.
- For example, an IP class A address consists of 8 bits identifying the network and 24 bits identifying the host. This is because the default subnet mask for a class A IP address is 8 bits long. (or, written in dotted decimal notation, 255.0.0.0).
- Like an IP address, a subnet mask also consists of 32 bits. Computers use it to determine the network part and the host part of an address. The 1s in the subnet mask represent a network part, the 0s a host part.
- Computers works only with bits. The math used to determine a network range is binary **AND**.

INPUT 1	INPUT 2	OUTPUT
0	0	0
0	1	0
1	0	0
1	1	1

Fig1. AND Truth Table

- Let's say that we have the IP address of 10.0.0.1 with the default subnet mask of 8 bits (255.0.0.0).
  First, we need to convert the IP address to binary:
  IP address: 10.0.0.1 = 00001010.00000000.00000000.00000001
  Subnet mask: 255.0.0.0 = 11111111.00000000.00000000.00000000
- Computers then use the AND operation to determine the network number:

```
00001010.00000000.00000000.00000001 = 10.0.0.1
11111111.00000000.00000000.00000000 = 255.0.0.0
-----------------------------------------------
00001010.00000000.00000000.00000000 = 10.0.0.0
```

Fig2. Network Number

- The computer can then determine the size of the network. Only IP addresses that begin with 10 will be in the same network. So, in this case, the range of addresses in this network is 10.0.0.0 – 10.255.255.255.

Subnetting Example:

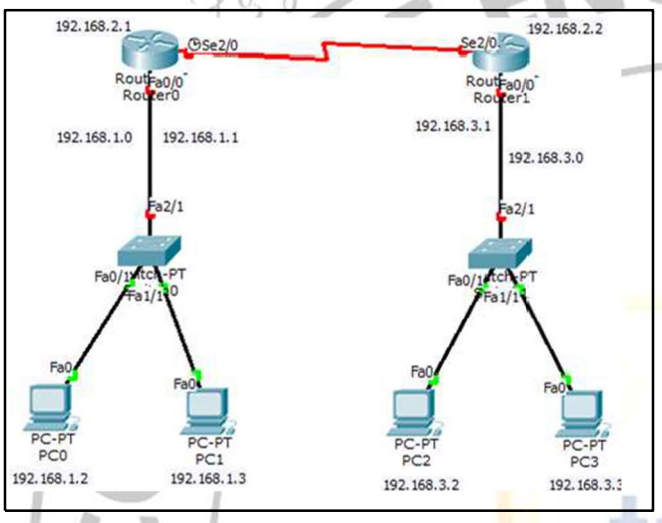
- Let's say that we need to subnet a class C address **192.168.0.0/24**. We need two subnets with **50 hosts** per subnet. Here is our calculation:

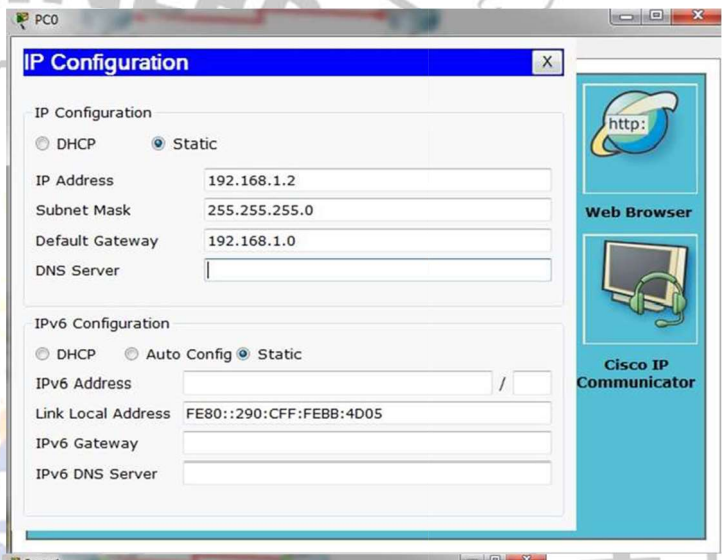
1. Since we need only two subnets, we need 21 subnet bits. In our case, this means that we will take one bit from the host part. Calculation is shown below:
   First, we have a class C address 192.168.0.0 with the subnet mask of 24. Let's convert them to binary:
   192.168.0.0 = 11000000.10101000.00000000.00000000
   255.255.255.0 = 11111111.11111111.11111111.00000000
   We need to covert a single zero from the host part of the subnet mask. Here is our new subnet mask:
   255.255.255.128 = 11111111.11111111.11111111.10000000
   Remember, the ones in the subnet mask represent the network.

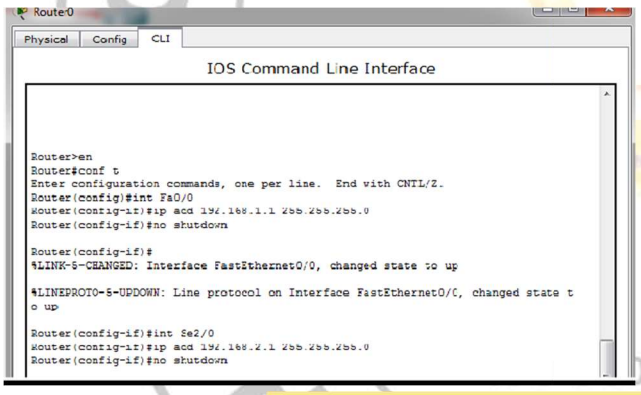
2. We need 50 hosts per subnet. Since we took one bit from the host part, we are left with seven bits for the hosts. Is it enough for 50 hosts? The formula to calculate the number of hosts is $2^y - 2$, with y representing the number of host bits. Since $2^7 - 2$ is 126, we have more than enough bits for our hosts.

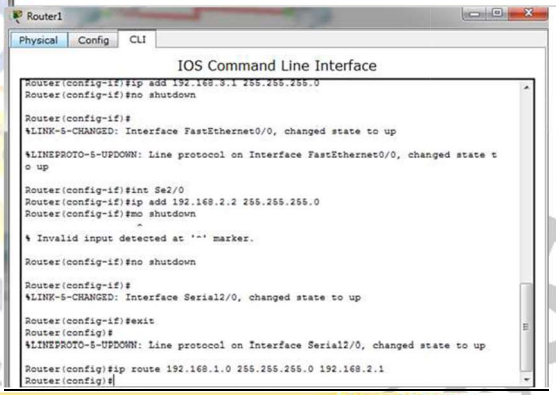
3. Our network will look like this:
   192.168.0.0/25 – the first subnet has the subnet number of **192.168.0.0**. The range of IP addresses in this subnet is **192.168.0.0 – 192.168.0.127**.
   192.168.0.128/25 – the second subnet has the subnet number of **192.168.0.128**. The range of IP addresses in this subnet is **192.168.0.128 – 192.168.0.255**.

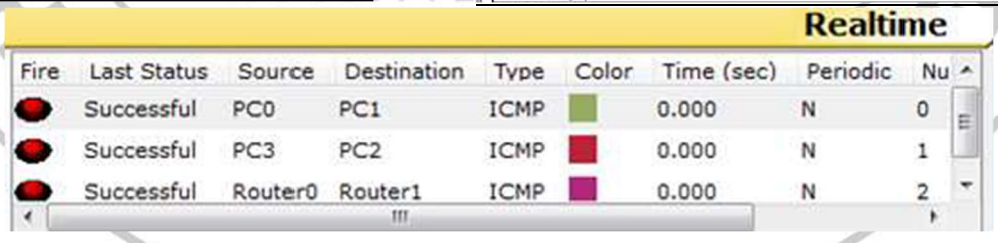
Implementation:



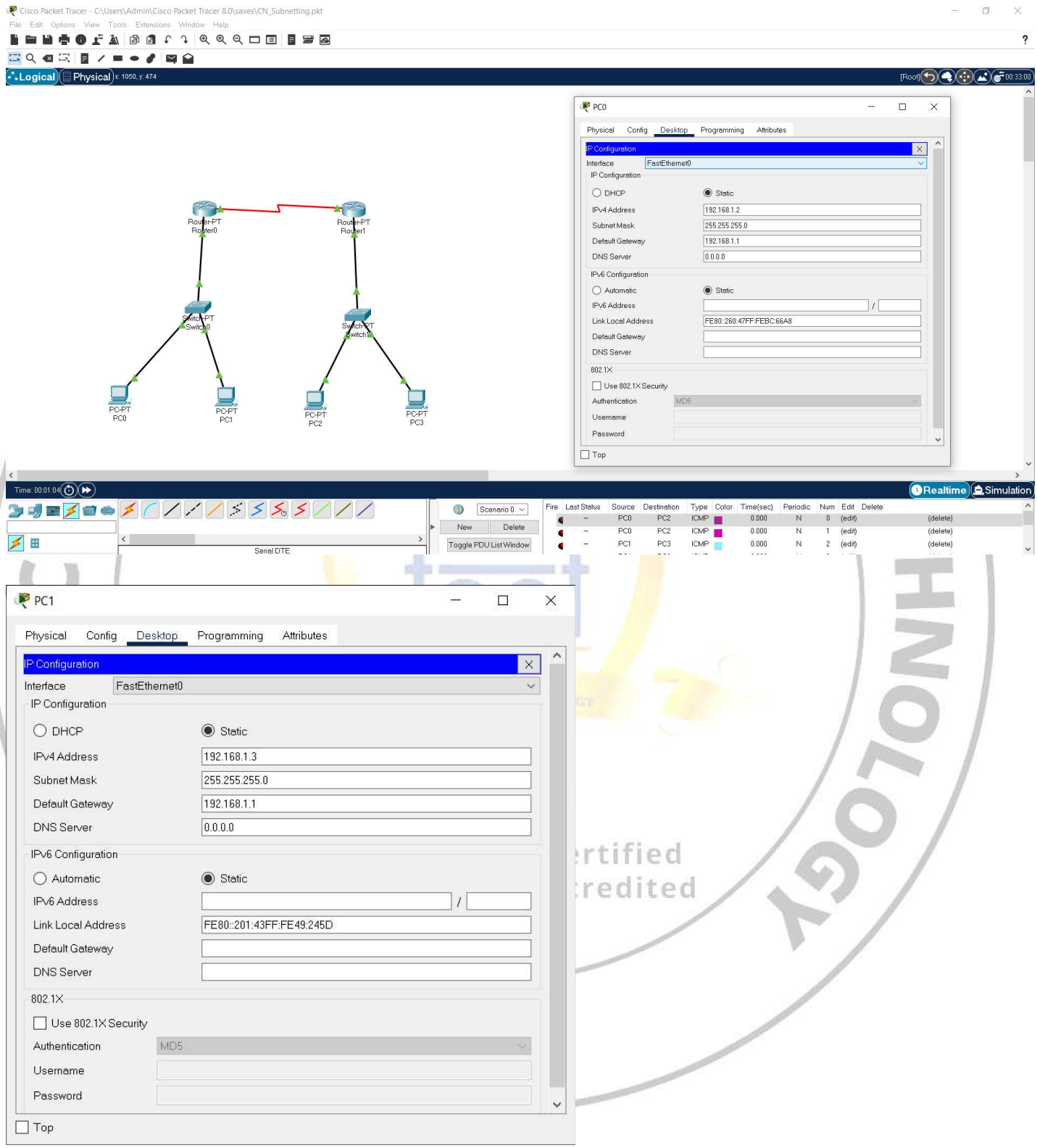


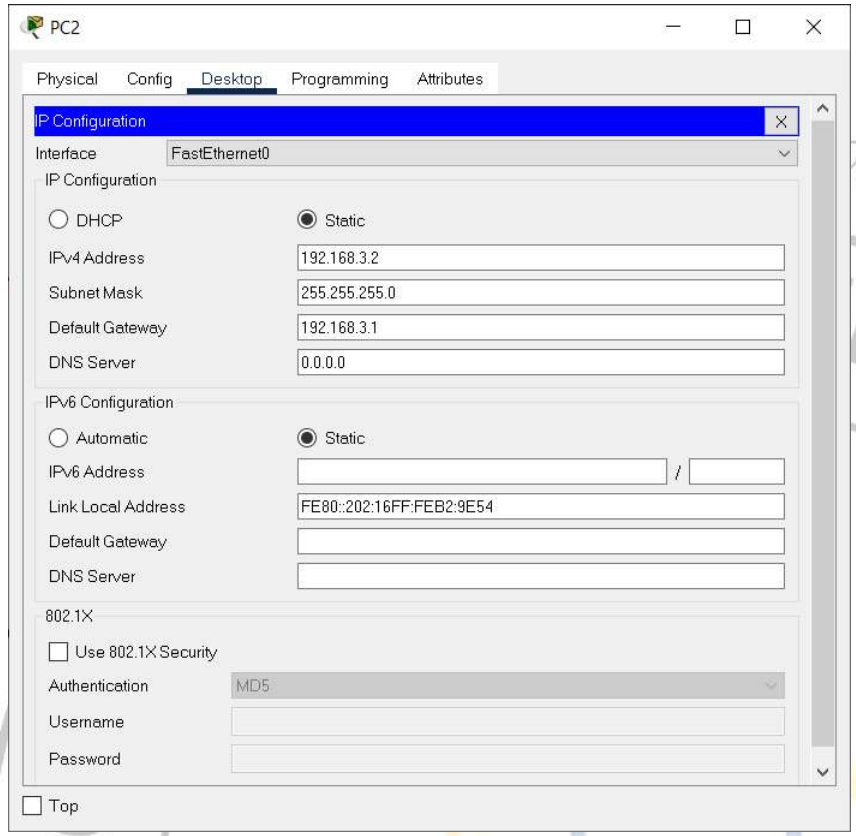


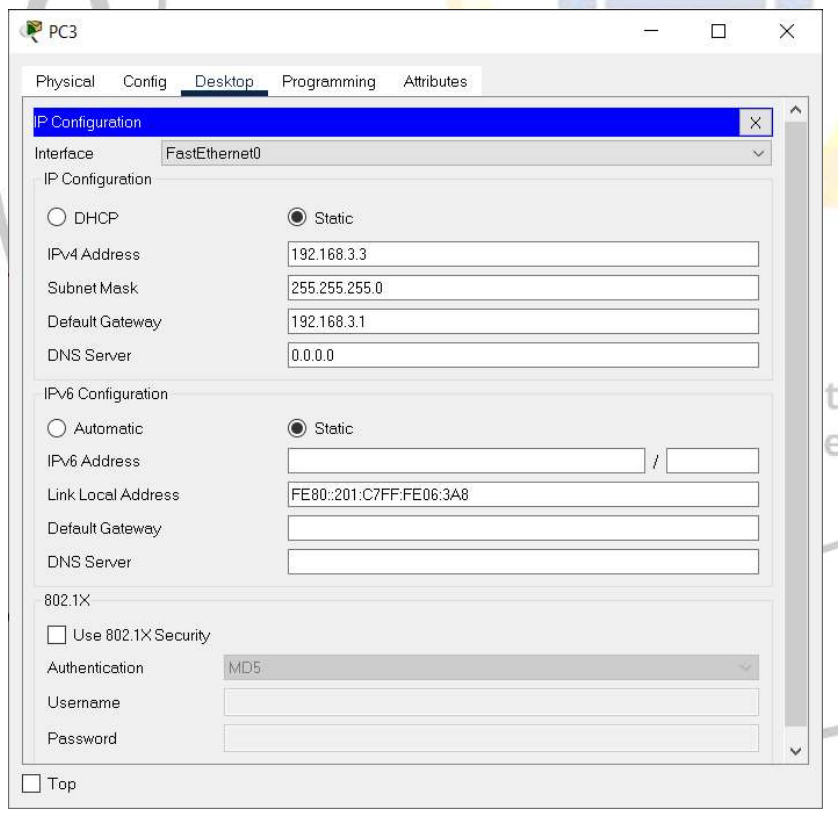




Design and Discussion:




PC2
Physical
Config
Desktop
Programming
Attributes
IP Configuration
Interface
FastEthernet0
IP Configuration
DHCP
Static
IPv4 Address
192.168.3.2
Subnet Mask
255.255.255.0
Default Gateway
192.168.3.1
DNS Server
0.0.0.0
IPv6 Configuration
Automatic
Static
IPv6 Address
Link Local Address
FE80::202:16FF:FEB2:9E54
Default Gateway
DNS Server
802.1X
Use 802.1X Security
Authentication
MD5
Username
Password
Top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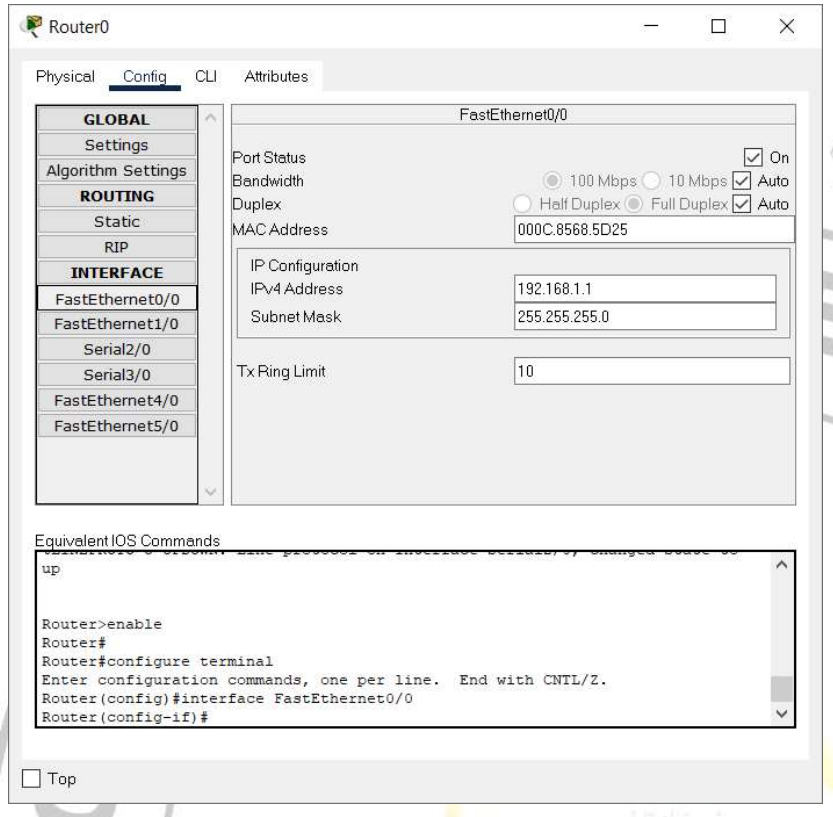
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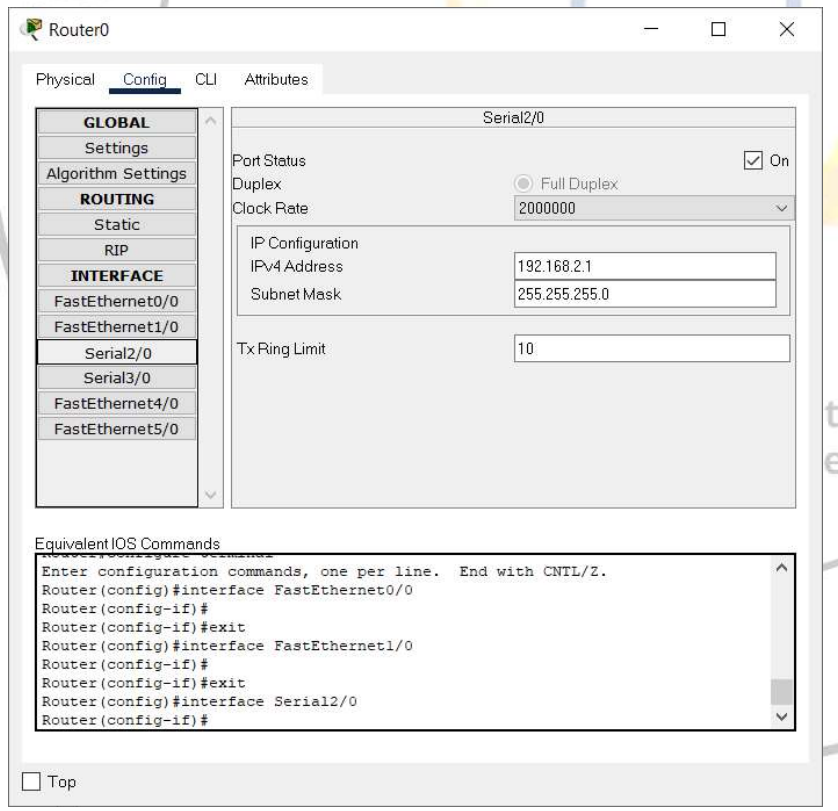
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
INTERFACE
FastEthernet0/0
FastEthernet1/0
Serial2/0
Serial3/0
FastEthernet4/0
FastEthernet5/0
FastEthernet0/0
Port Status
On
Bandwidth
100 Mbps
10 Mbps
Auto
Duplex
Half Duplex
Full Duplex
Auto
MAC Address
000C.8568.5D25
IP Configuration
IPv4 Address
192.168.1.1
Subnet Mask
255.255.255.0
Tx Ring Limit
10
Equivalent IOS Commands
up
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#
Top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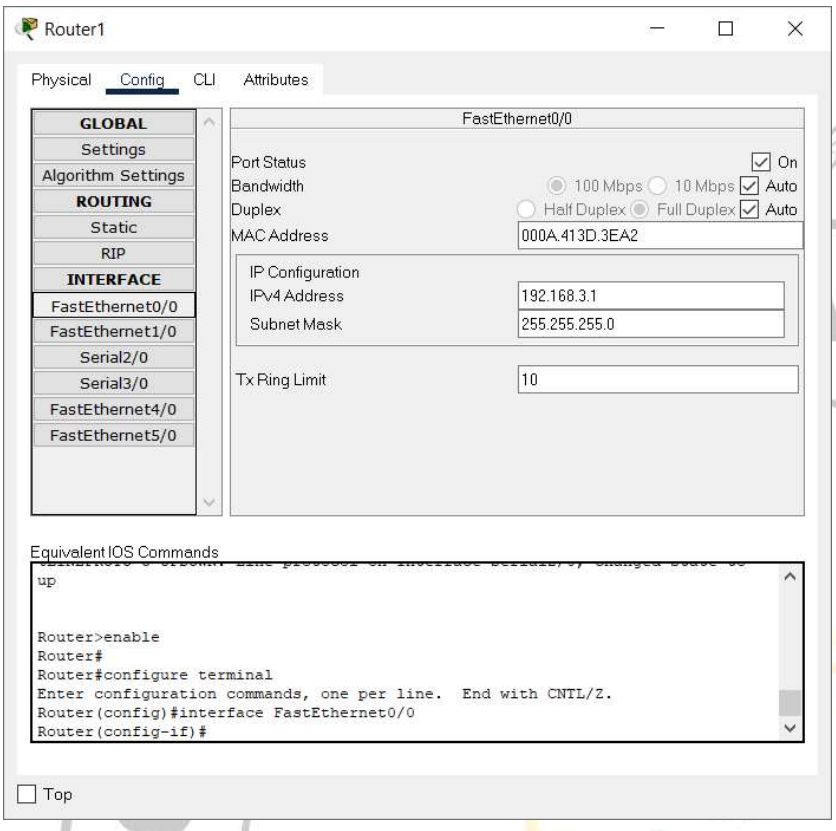
FastEthernet1/0
Serial2/0
Serial3/0
FastEthernet4/0
FastEthernet5/0
Serial2/0
Port Status
On
Duplex
Full Duplex
Clock Rate
2000000
IP Configuration
IPv4 Address
192.168.2.1
Subnet Mask
255.255.255.0
Tx Ring Limit
10
Equivalent IOS Commands
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet1/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface Serial2/0
Router(config-if)#
Top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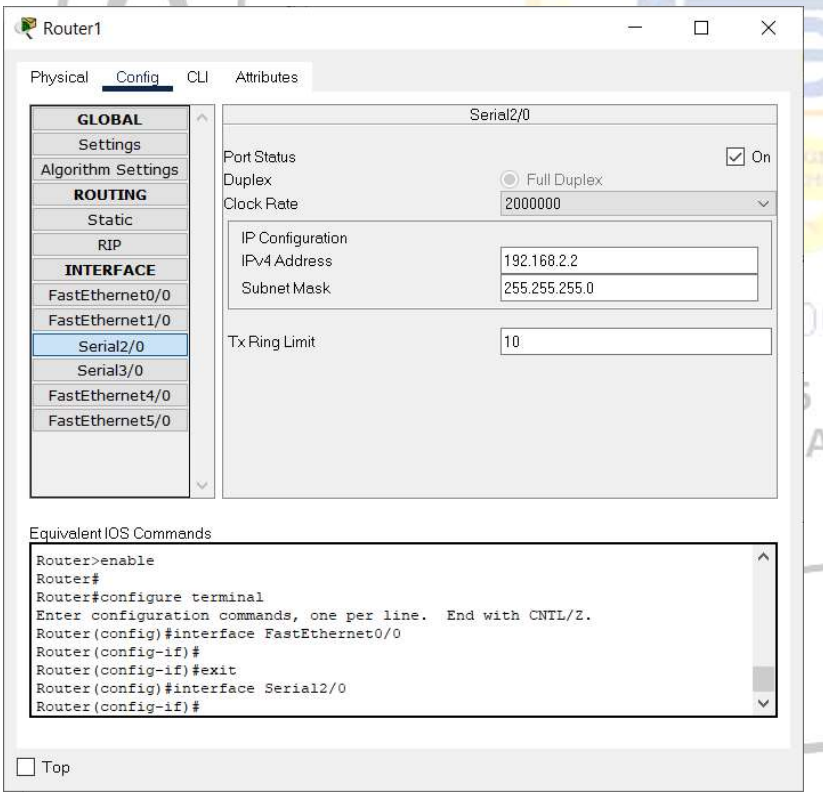
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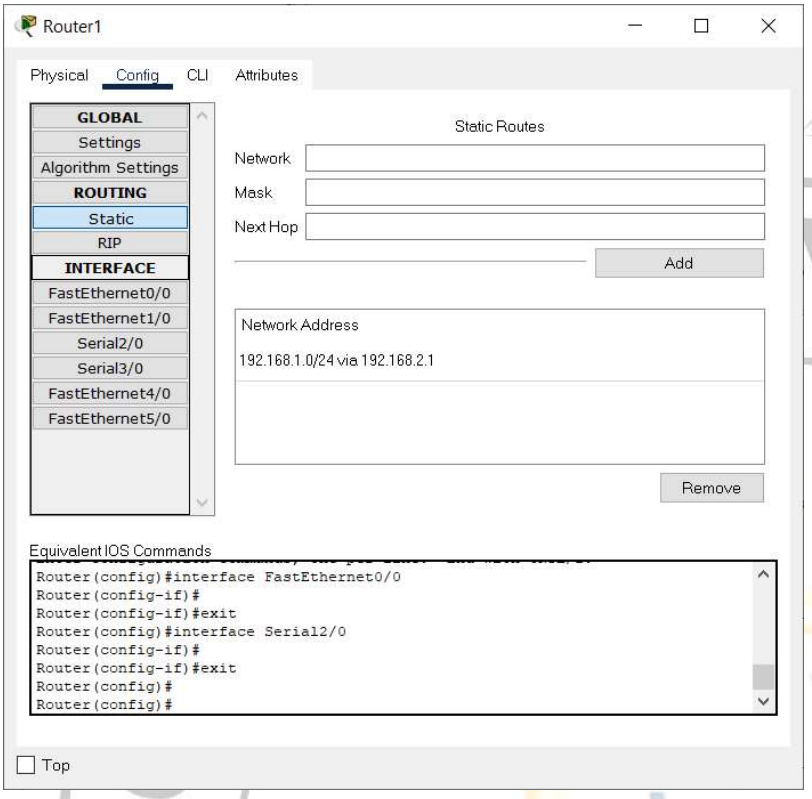
Router(config-if)#exit
Router(config)#interface Serial2/0
Router(config-if)#
Top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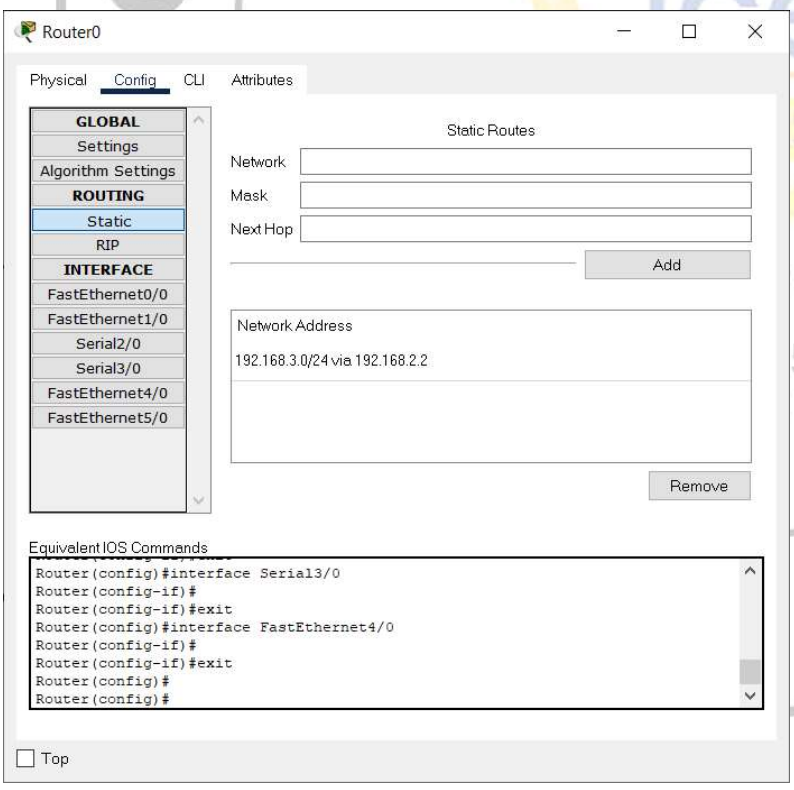
FastEthernet0/0
FastEthernet1/0
Serial2/0
Serial3/0
FastEthernet4/0
FastEthernet5/0
Static Routes
Network
Mask
Next Hop
Add
Network Address
192.168.1.0/24 via 192.168.2.1
Remove
Equivalent IOS Commands
Router(config)#interface FastEthernet0/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface Serial2/0
Router(config-if)#
Router(config-if)#exit
Router(config)#
Router(config)#
Top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FastEthernet5/0
Static Routes
Network
Mask
Next Hop
Add
Network Address
192.168.3.0/24 via 192.168.2.2
Remove
Equivalent IOS Commands
Router(config)#interface Serial3/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet4/0
Router(config-if)#
Router(config-if)#exit
Router(config)#
Router(config)#
Top

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC1	PC3	ICMP		0.000	N	10	(edit)	(delete)
	Successful	PC0	PC2	ICMP		0.000	N	11	(edit)	(delete)
	Successful	PC0	PC3	ICMP		0.000	N	12	(edit)	(delete)

Learning Outcomes: The student should have the ability to:

LO5.1 Outline a network using CISCO packet tracer.

LO5.2 Explain the configuration of IP addressing, subnetting and masking.

LO5.3 Illustrate the configuration of IP addressing, subnetting, masking in CISCO packet tracer.

Course Outcomes: Upon completion of the course students will be able todevelop the network using IP addressing and subnetting / supernetting schemes.

Conclusion: Thus students have understood and successfully implemented IP address, subnet, subnet mask for a network.

Viva Questions:

1. What is subnet and subnet mask?
2. What is the difference between physical and logical address?
3. Suppose 4 subnets are to be created how many host bits needs to be included as a part of network bits?
4. Can we send packets from one subnet to another with a switch?

For Faculty Use:

Correction Parameters	**Formative Assessment [40%]**	**Timely completion of Practical [40%]**	**Attendance / Learning Attitude [20%]**	
Marks Obtained				