NATIONAL UNIVERSITY OF COMPUTER & EMERGING SCIENCE
Computer Network Lab (CL3001)
Lab Session 09

Objective:

- Introduction to Subnets & Subnetting
- Purpose of Subnetting
- Subnet tables of different IPv4 classes.
- Introduction of CIDR
- Implementation of Subnetting

SUBNETTING

1. What is Subnet:

A subnet, or subnetwork, is a network inside a network. Subnets make networks more efficient. Through subnetting, network traffic can travel a shorter distance without passing through unnecessary routers to reach its destination.

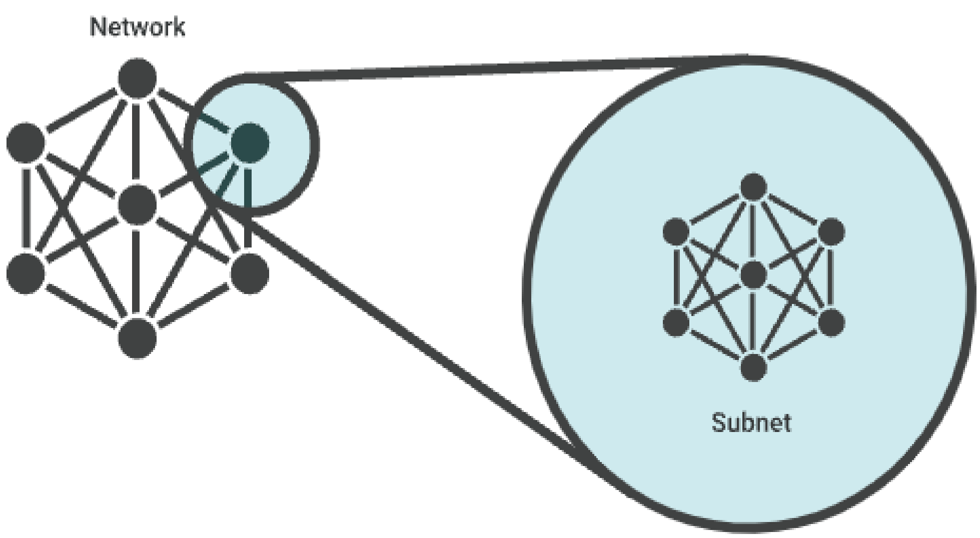

Fig-1: Subnet in network

Imagine Alice puts a letter in the mail that is addressed to Bob, who lives in the town right next to hers. For the letter to reach Bob as quickly as possible, it should be delivered right from Alice's post office to the post office in Bob's town, and then to Bob. If the letter is first sent to a post office hundreds of miles away, Alice's letter could take a lot longer to reach Bob.

Like the postal service, networks are more efficient when messages travel as directly as possible. When a network receives data packets from another network, it will sort and route those packets by subnet so that the packets do not take an inefficient route to their destination.

2. What is Subnetting:

A subnet is just a range of IP addresses. All the devices in the same subnet can communicate directly with one another without going through any routers. In IPv4, a network interface is connected to only one subnet and has only one IP address. In IPv6 things are slightly more complicated, so we'll save IPv6 subnetting for another article. But it's useful to understand IPv4 first because the basic concepts are the same.

My laptop is on a subnet that also includes a server, a printer, a couple of other workstations, and a router. If I want to communicate with another device in my subnet, I can send packets to it directly. If it's not on my subnet, I need to forward the packet to a router first. That router also needs to be on my subnet. My computer knows that another device is in my subnet by looking at my own IP address and my subnet mask.

Suppose my IP address is 192.168.101.15 and my subnet mask is 255.255.255.0. There are 32 bits in the IP address and the same number in the mask. We always write those 32 bits as four 8-bit numbers, often called octets. The thing that can make it confusing is that we use decimal notation for each of those 8-bit numbers, but the mechanics of subnetting are really going on in binary.

3. Purpose of Subnetting:

To subnet a network means to create logical divisions of the network. Subnetting, therefore, involves dividing the network into smaller portions called subnets. Subnetting applies to IP addresses because this is done by borrowing bits from the host portion of the IP address. In a sense, the IP address then has three components - the network part, the subnet part and, finally, the host part.

We create a subnet by logically grabbing the last bit from the network component of the address and using it to determine the number of subnets required. In the following example, a Class C address normally has 24 bits for the network address and eight for the host, but we are going to borrow the left- most bit of the host address and declare it as identifying the subnet

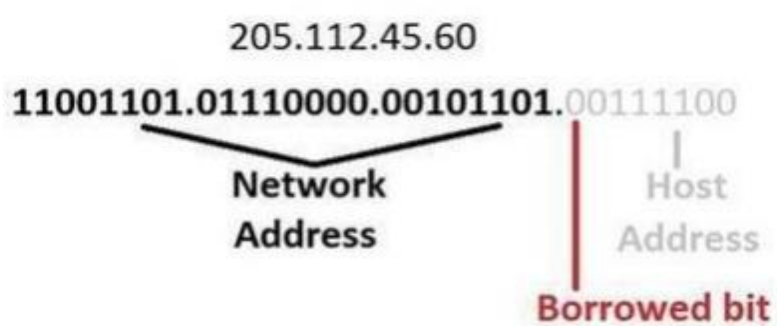

Fig-2: Bits concept of IP

If the bit is a 0, then that will be one subnet; if the bit is a 1 that would be the second subnet. Of course, with only one borrowed bit we can only have two possible subnets. By the same token, that also reduces the number of hosts we can have on the network to 127 (but actually 125 useable addresses given all zeros and all ones are not recommended addresses), down from 255.

So how can you tell how many bits should be borrowed, or, in other words, how many subnets we want to have on our network? The answer is with a subnet mask.

Subnet masks sound a lot scarier than they really are. All that a subnet mask does is indicate how many bits are being "borrowed" from the host component of an IP address.

If you can't remember anything about subnetting, remember this concept. It is the foundation of all subnetting. The reason a subnet mask has this name is that it literally masks out the host bits being borrowed from the host address portion of the IP address. In the following diagram, there is a subnet mask for a Class C address. The subnet mask is 255.255.255.128 which, when translated into bits, indicates which bits of the host part of the address will be used to determine the subnet number.

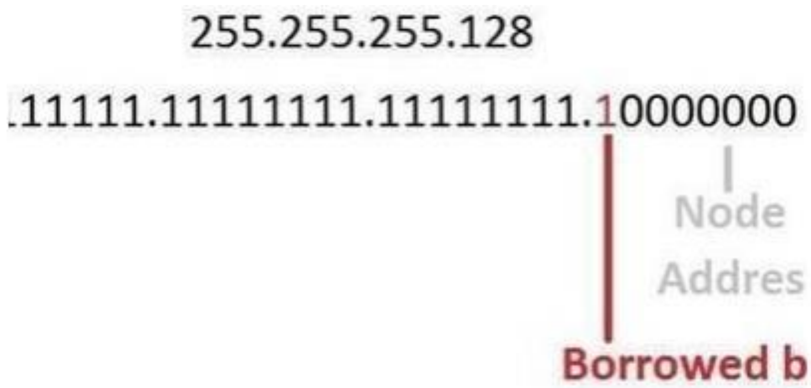

Fig-3: Borrowed bit from host section to network section

More bits borrowed means fewer individually addressable hosts that can be on the network. Sometimes, all the combinations and permutations can be confusing, so here are some tables of subnet possibilities.

4. Subnet Tables of IPv4:

In pervious lab we study the default subnet mask for each class IPv4. In this section we provided the subnet tables of class A, B & C when we create subnet from these IP address.

Address Class	Value in First Octet	Classful Mask (Dotted Decimal)	Classful Mask (Prefix Notation)
Class A	1–126	255.0.0.0	/8
Class B	128–191	255.255.0.0	/16
Class C	192–223	255.255.255.0	/24
Class D	224–239	—	—
Class E	240–255	—	—

Fig-4: Default Subnet mask of each IPv4 class

CLASS A HOST/Subnet Table

ass A Host/Subnet Table

lass A bits	Subnet Mask	Effective Subnets	Effective Hosts	Number of Subnet Mask bits
1	255.128.0.0	2	8388606	/9
2	255.192.0.0	4	4194302	/10
3	255.224.0.0	8	2097150	/11
4	255.240.0.0	16	1048574	/12
5	255.248.0.0	32	524286	/13
6	255.252.0.0	64	262142	/14
7	255.254.0.0	128	131070	/15
8	255.255.0.0	256	65534	/16
9	255.255.128.0	512	32766	/17
10	255.255.192.0	1024	16382	/18
11	255.255.224.0	2048	8190	/19
12	255.255.240.0	4096	4094	/20
13	255.255.248.0	8192	2046	/21
14	255.255.252.0	16384	1022	/22
15	255.255.254.0	32768	510	/23
16	255.255.255.0	65536	254	/24
17	255.255.255.128	131072	126	/25
18	255.255.255.192	262144	62	/26
19	255.255.255.224	524288	30	/27
20	255.255.255.240	1048576	14	/28
21	255.255.255.248	2097152	6	/29
22	255.255.255.252	4194304	2	/30
23	255.255.255.254	8388608	2	/31

Fig-5: Class A subnet table

CLASS B HOST/Subnet Table

ass B Host/Subnet Table

lass B bits	Subnet Mask	Effective Subnets	Effective Hosts	Number of Subnet Mask bits
1	255.255.128.0	2	32766	/17
2	255.255.192.0	4	16382	/18
3	255.255.224.0	8	8190	/19
4	255.255.240.0	16	4094	/20
5	255.255.248.0	32	2046	/21
6	255.255.252.0	64	1022	/22
7	255.255.254.0	128	510	/23
8	255.255.255.0	256	254	/24
9	255.255.255.128	512	126	/25
10	255.255.255.192	1024	62	/26
11	255.255.255.224	2048	30	/27
12	255.255.255.240	4096	14	/28
13	255.255.255.248	8192	6	/29
14	255.255.255.252	16384	2	/30
15	255.255.255.254	32768	2	/31

Fig-6: Class B subnet table

CLASS C HOST/Subnet Table

ass C Host/Subnet Table

lass C bits	Subnet Mask	Effective Subnets	Effective Hosts	Number of Subnet Mask bits
1	255.255.255.128	2	126	/25
2	255.255.255.192	4	62	/26
3	255.255.255.224	8	30	/27
4	255.255.255.240	16	14	/28
5	255.255.255.248	32	6	/29
6	255.255.255.252	64	2	/30
7	255.255.255.254	128	2	/31

Fig-7: Class C subnet table

5. CIDR:

Having spent a whole bunch of time learning about IP addresses and classes, you might be surprised that in reality they are not used anymore other than to understand the basic concepts of IP addressing.
Instead, network administrators use Classless Internet Domain Routing (CIDR), pronounced "cider", to represent IP addresses. The idea behind CIDR is to adapt the concept of subnetting to the entire Internet. In short, classless addressing means that instead of breaking a particular network into subnets, we can aggregate networks into larger supernets.

CIDR is therefore often referred to as supernetting, where the principles of subnetting are applied to larger networks. CIDR is written out in a network/mask format, where the mask is tacked onto the network address in the form of the number of bits used in the mask. An example would be 205.112.45.60/25. What is most important to understand about the CIDR method of subnetting is the use the network prefix (the /25 of 205.112.45.60/25), rather than the classful way of using the first three bits of the IP address to determine the dividing point between the network number and the host number.

The process for understanding what this mean is

1. The “205” in the first octet means this IP address would normally contain 24 bits to represent the network portion of the address. With eight bits to an octet, the arithmetic is 3 x 8 = 24, or looking at it the other way around, “/24” means no bits are being borrowed from the last octet.
2. But this is “/25,” which indicates it is “borrowing” one bit from the host portion of the address.
3. With only one bit, there can only be two unique subnets.
4. So, this is the equivalent of a net mask of 255.255.255.128, where there is a maximum of 126 host addresses addressable on each of the two subnets.

So why did CIDR become so popular? Because it’s a much more efficient allocator of the IP address space. Using CIDR, a network admin can carve out a number of host addresses that’s closer to what is required than with the class approach.

For example, say a network admin has an IP address of 207.0.64.0/18 to work with. This block consists of 16,384 IP addresses. But if only 900 host addresses are required, this wastes scarce resources, leaving 15,484 (16,384 – 900) addresses unused. By using a subnet CIDR of 207.0.68.0/22 though, the network would address 1,024 nodes, which is much closer to the 900 host addresses required.

CIDR Address Blocks

CIDR Prefix	Dotted Decimal Notation	# Node Addresses	# of Traditional Class Networks
/13	255.248.0.0	512K	8 B or 2048 C class
/14	255.252.0.0	256K	4 B or 1024 C class
/15	255.254.0.0	128K	2 B or 512 C class
/16	255.255.0.0	64K	1 B or 256 C class
/17	255.255.128.0	32K	128 C class
/18	255.255.192.0	16K	64 C class
/19	255.255.224.0	8K	32 C class
/20	255.255.240.0	4K	16 C class
/21	255.255.248.0	2K	8 C class
/22	255.255.252.0	1K	4 C class
/23	255.255.254.0	512	2 C class
/24	255.255.255.0	256	1 C class
/25	255.255.255.128	128	1/2 C class
/26	255.255.255.192	64	1/4 C class
/27	255.255.255.224	32	1/8 C class

Fig-8: CIDR Address table

6. Implementation of Subnetting on Packet Tracer:

Consider an IP of Class C 192.168.1.0/27, using above IP calculate the subnets and implement the scenario in Cisco Packet Tracer.

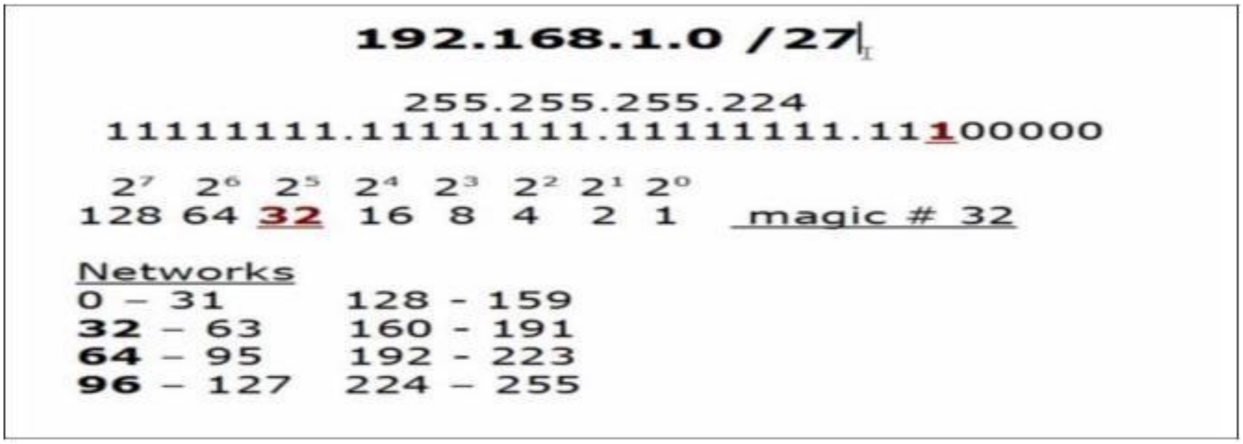

Fig-9: Logical Subnets

Calculation:

From above figure 3, we have:
Possible Subnets:2n = 23 =8 Possible Hosts = 32
Usable Hosts in each Subnet = 32 - 2 = 30

Note: 1st address of every subnet shows network address and last address shows Broadcast address. e.g., 0,32,64 & 96 represent Network address where 31,63,95 &127 represent Broadcast address.
Custom Subnet Mask = 255.255.255.224

Now implementing below figure 10 scenario on Cisco packet Tracer.

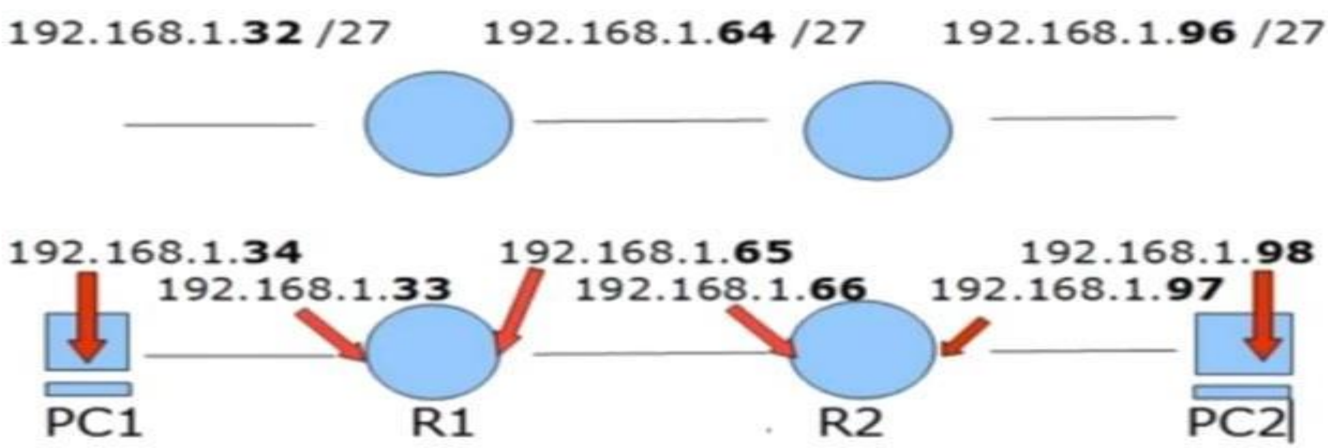

Fig-10: Scenario to implement

We have taken two routers R1 & R2 and connected their Fast Ethernet interface Fa 0/0 with the switch. While routers connected with their serial interface 2/0.

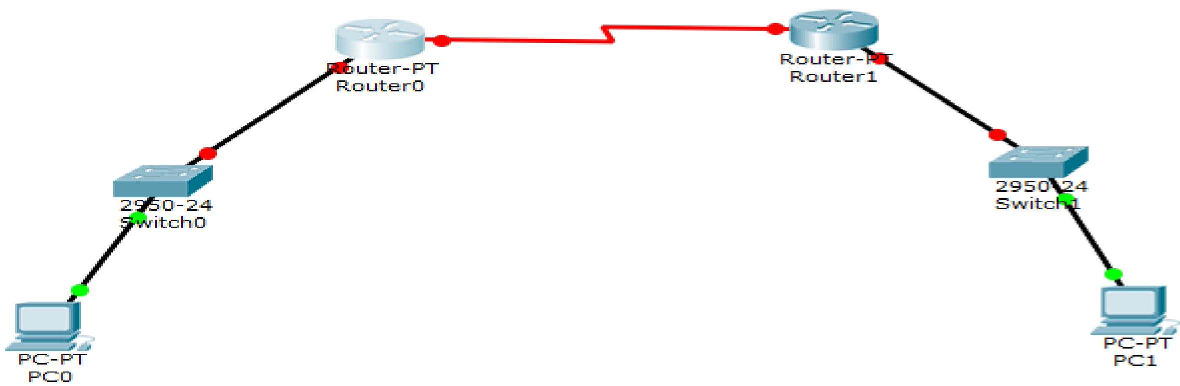

Fig-11: Network Topology

Now configuring PC0.

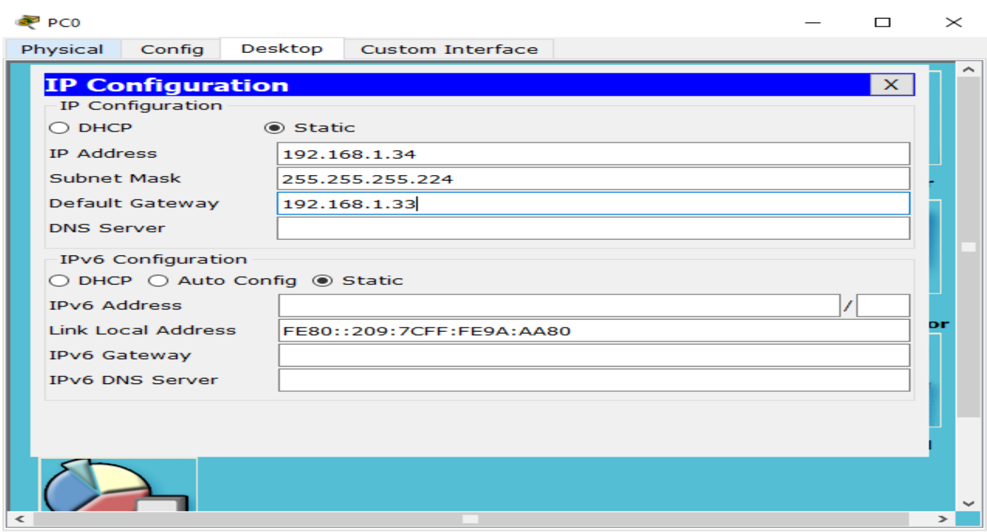

Fig-12: Assigning IP to PC0

Now configure the Interface FastEthernet0/0 of Router R0.

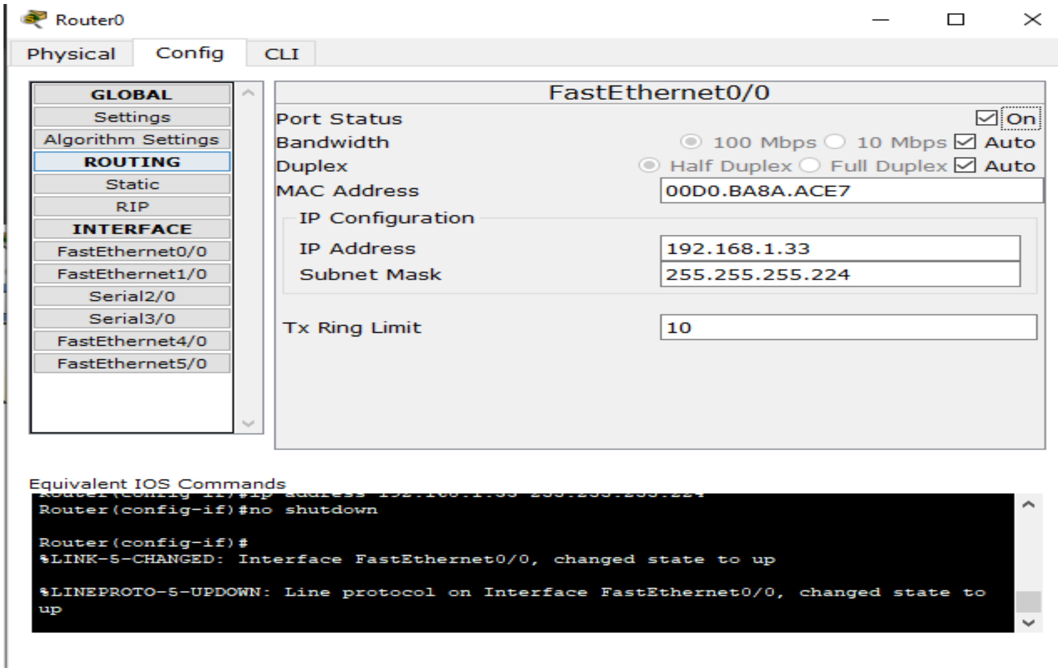

Fig-13: Interfacing Router 0 FastEthernet0/0

Configure the Interface Serial2/0 of Router R1

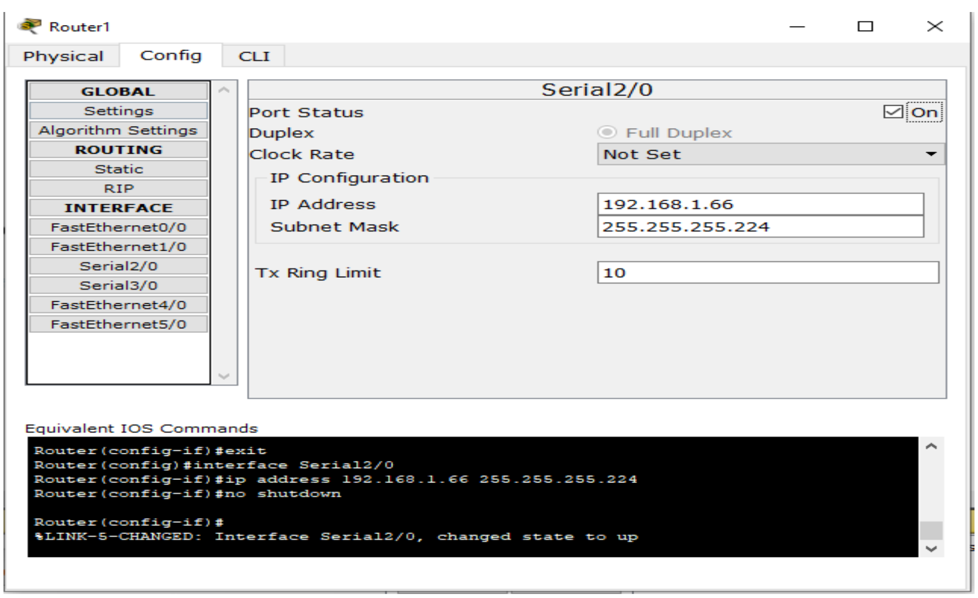

Fig-14: Interfacing Serial interface of Router 0

Now configuring PC1.

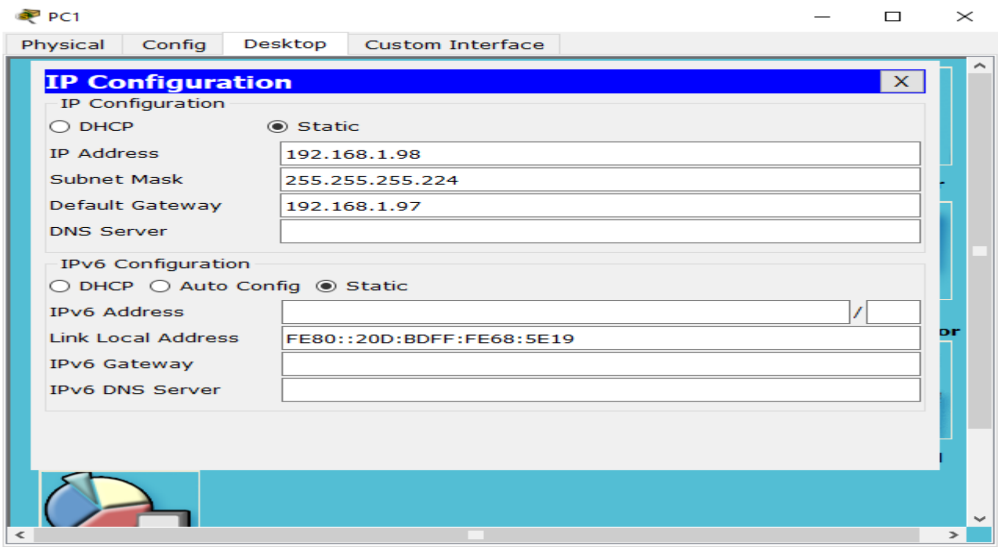

Fig-15: Assigning IP to PC1

Now we have gone through the entire configuration, all the interfaces are up as shown in figure 16.

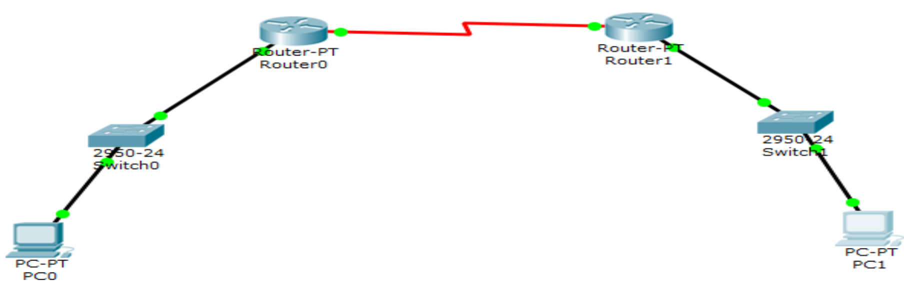

Fig-16: All links are up in network

Now let start the pinging the interfaces from PC0.As we ping 192.168.1.33 and 192.168.1.65, we got the reply because these interfaces are directly connected to Router R0.

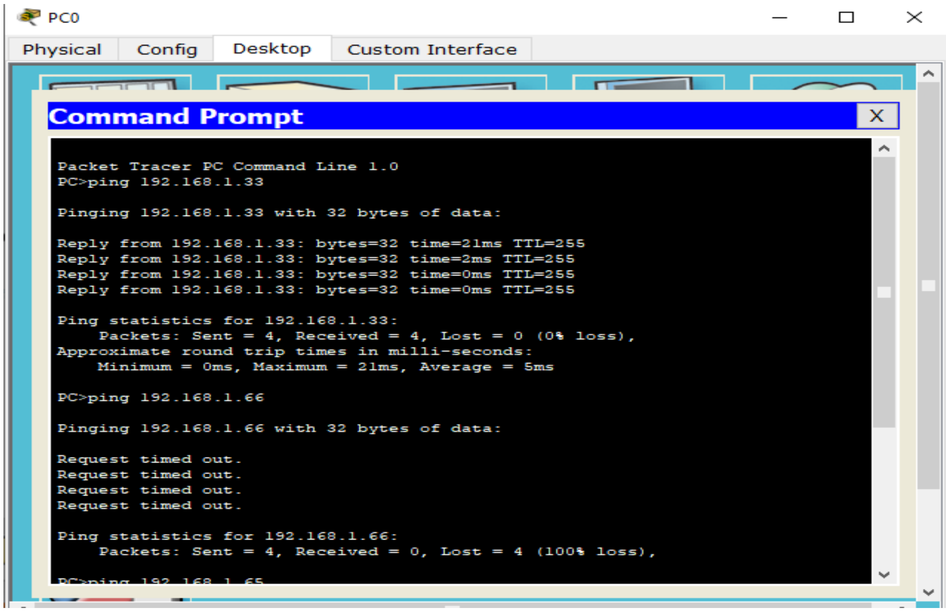

Fig-17: Ping result of before routing is applied

But when we ping 192.168.1.66, we got the Timed out because these interfaces are not directly connected to Router R1 as shown in figure 17.

Therefore, we have to add static route in Router R0.

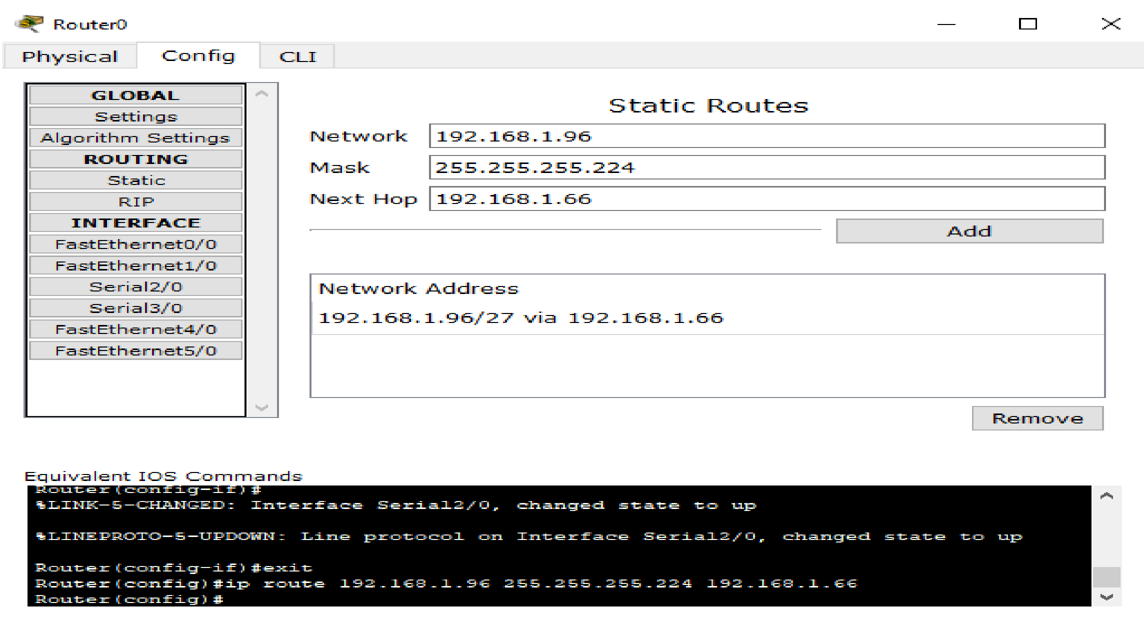

Fig-18: Applying Static Routing on Router 0

Therefore, we have to add static route in Router R1.

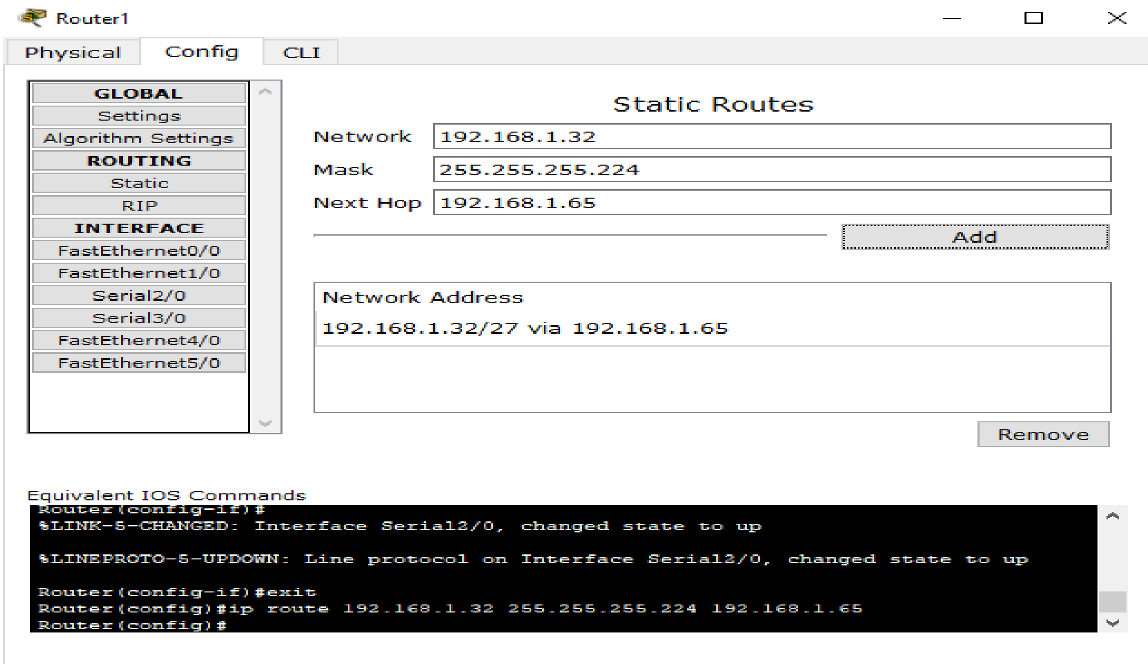

Fig-19: Applying Static Routing on Router 1

As you can see that we got the reply after adding the static route in Routers R0 & R1

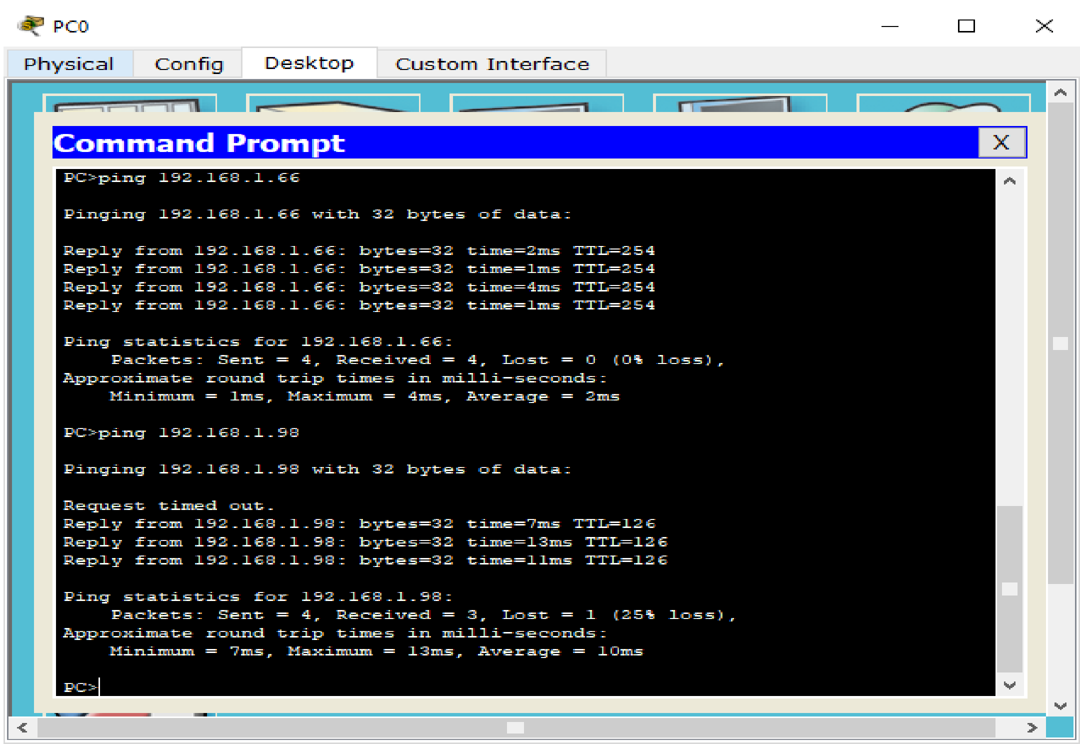

Fig-20: Ping is successful after static routing is applied

Now using show ip route command we can see all the details of routing table saved in R0.

Fig-21: IP routes detail of router R0

7. Lab Exercise:

Q1: Implement the above given example on cisco packet tracer but use network address as10.20.0.0/24. Use Fig 11.

Q2: Let consider an example of subnetting for ABC Company. There are 3 departments i.e. Finance, HRand Development. You have to perform subnetting for the allocation of the given requirement

120 PCs for Development
35 PCs for Finance
10 PCs for HR

The network address for the given scenario is 200.16.100.0/24. Only show calculation.

Q3: Let consider an example of subnetting for FAST NUCES. There are 3 department i.e. CS, EE andBBA. You have to perform subnetting for the allocation of the given requirement

90 PCs for CS
50 PCs for EE
20 PCs for BBA

The network address for the given scenario is 195.168.10.0/24. Implement it on Cisco Packet Tracer

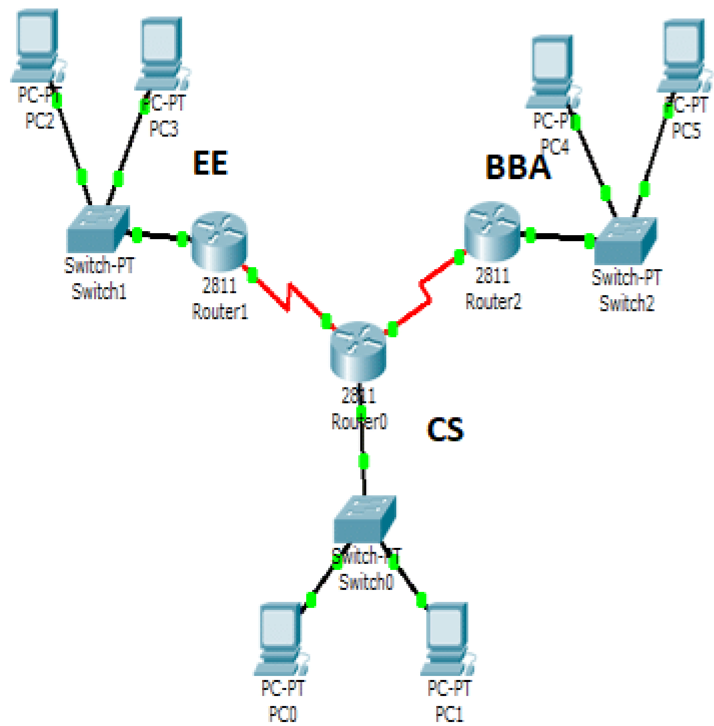

Fig-22: Network Topology for Question 3