HACETTEPE UNIVERSITY

DEPARTMENT OF
COMPUTER ENGINEERING

BBM453: Computer Networks Laboratory
Lab 11-12: Dynamic Routing-NAT

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Group 14
Source IP : 192.168.0.27

Dec 22,2021

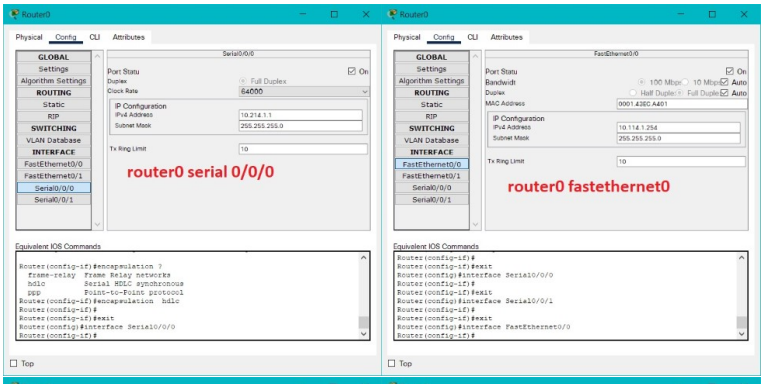
SOLUTIONS

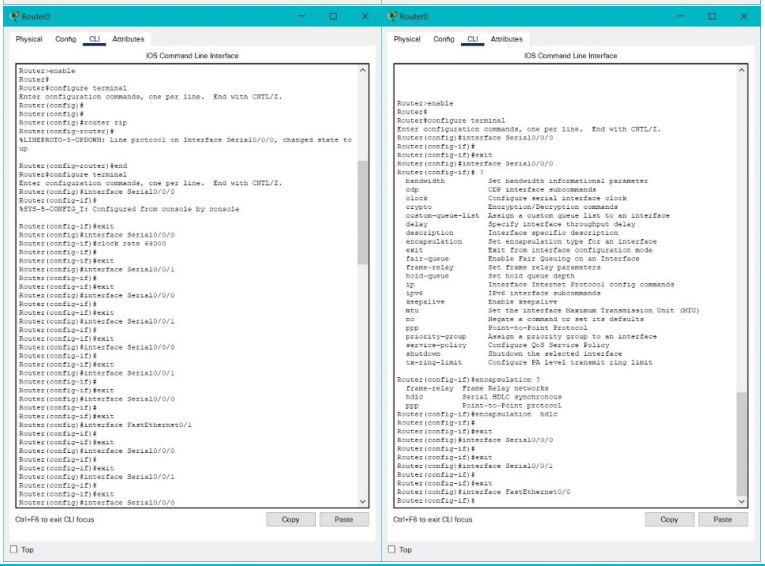
LAB 11

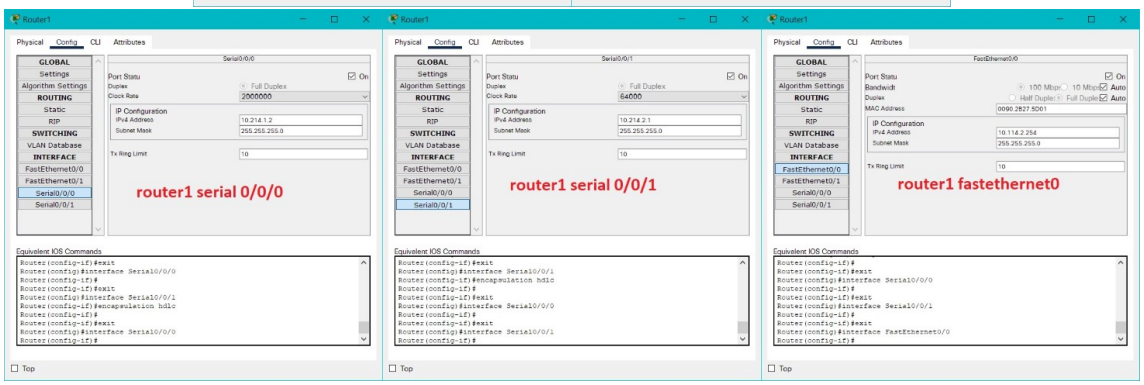
EXPERIMENT STEPS

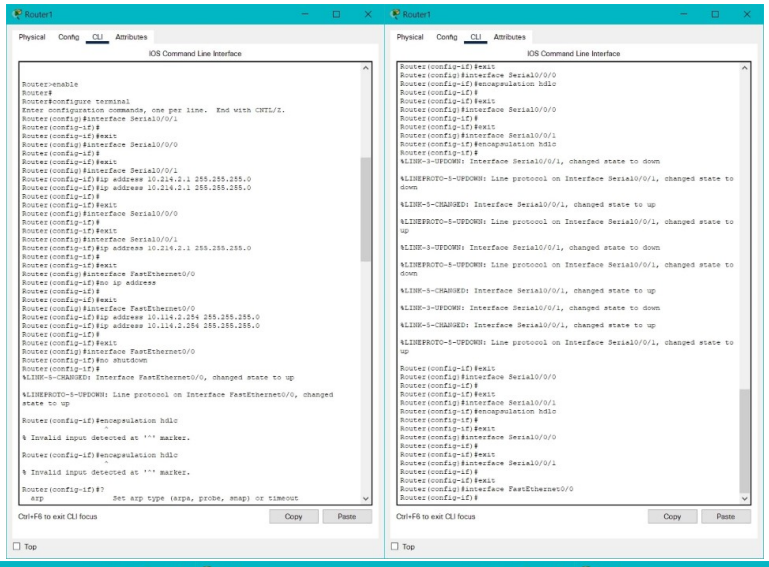
1. First, you should create lab topology described in the Lab09-Routing Experiment Figure2.

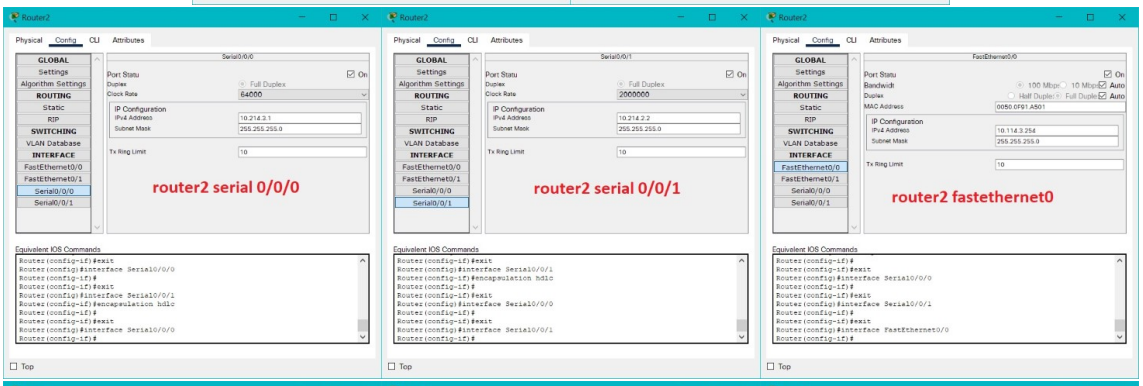
We already created the topology in mentioned lab. So we just copied the according file which also had no unnecessary configurations. Everything is set and ready to move to next step.

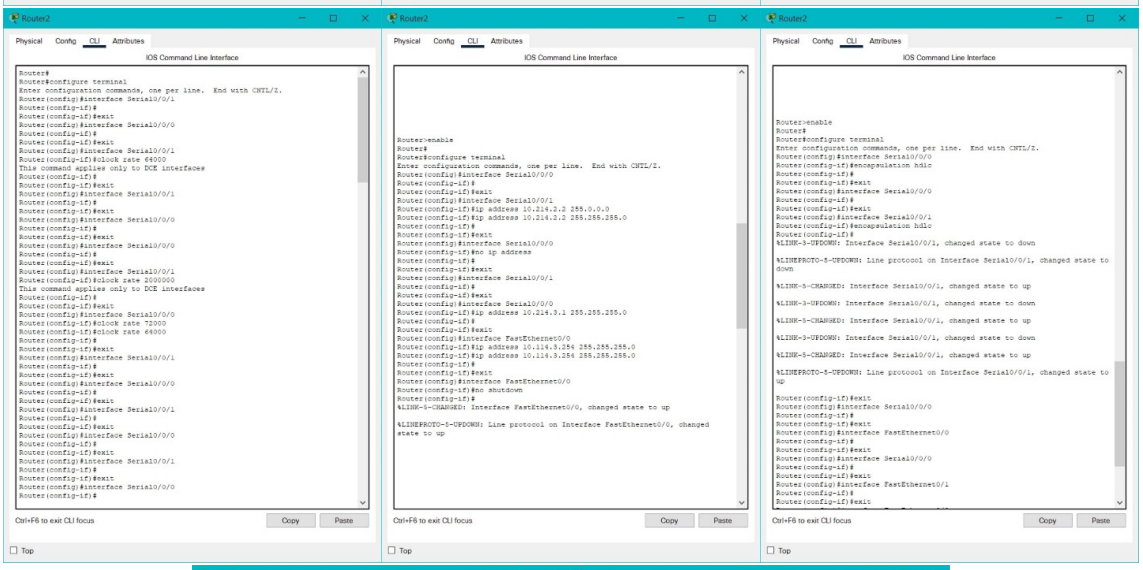


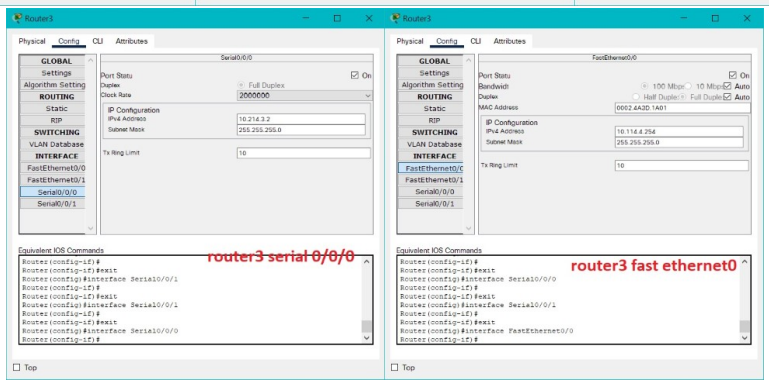


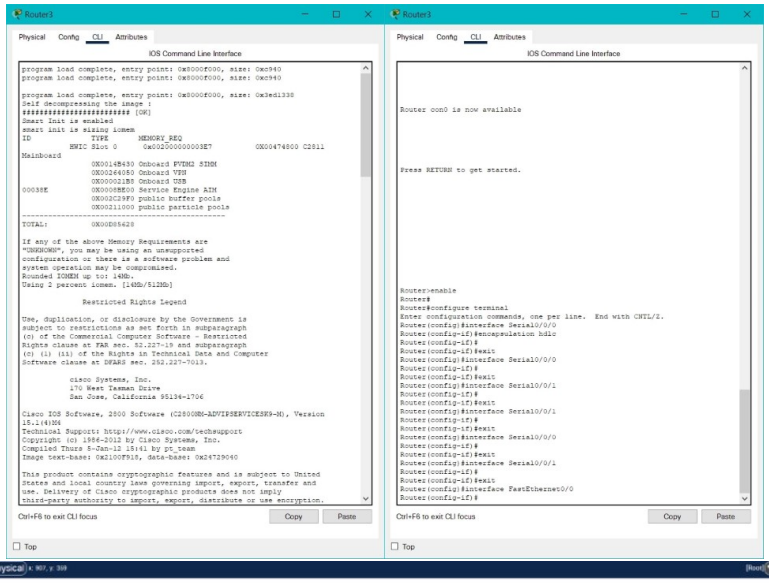


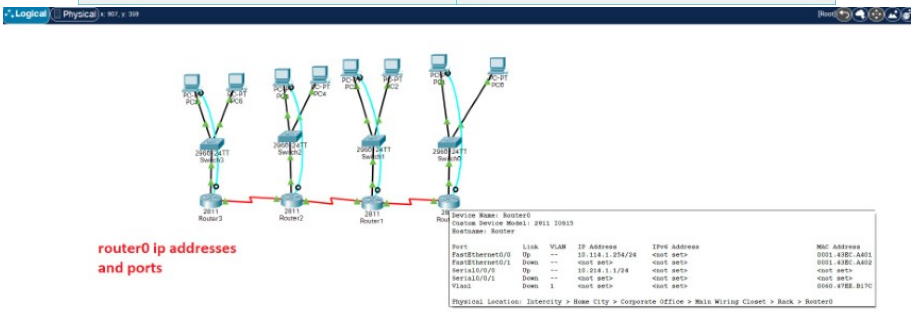



router2 serial 0/0/0
router2 serial 0/0/1
router2 fastethernet0

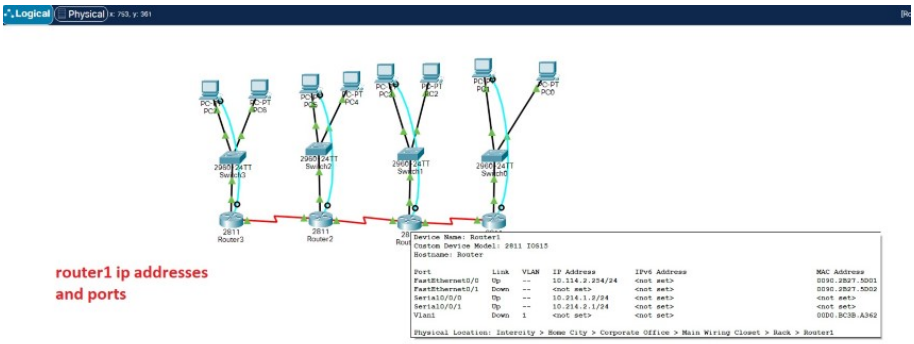



router3 serial 0/0/0
router3 fast ethernet0

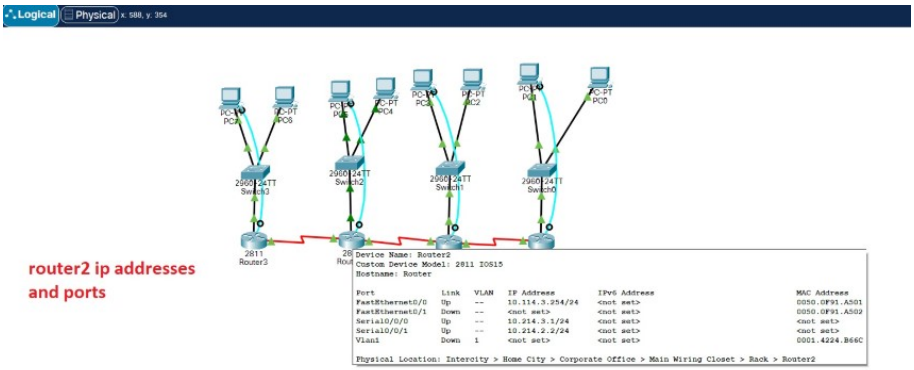




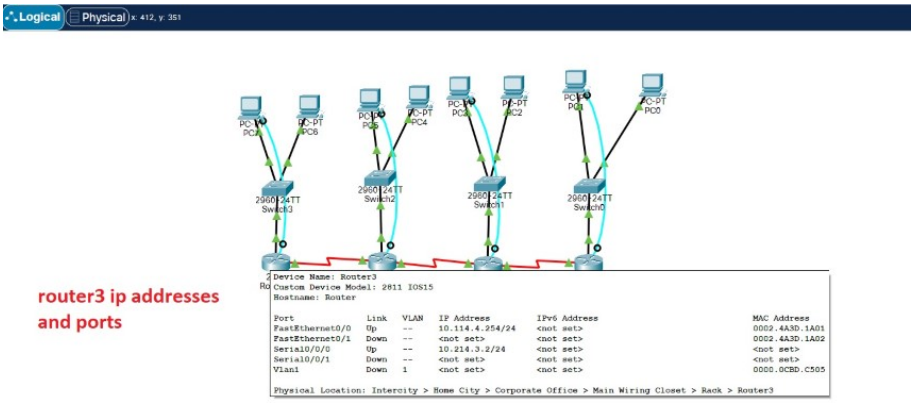
router0 ip addresses and ports



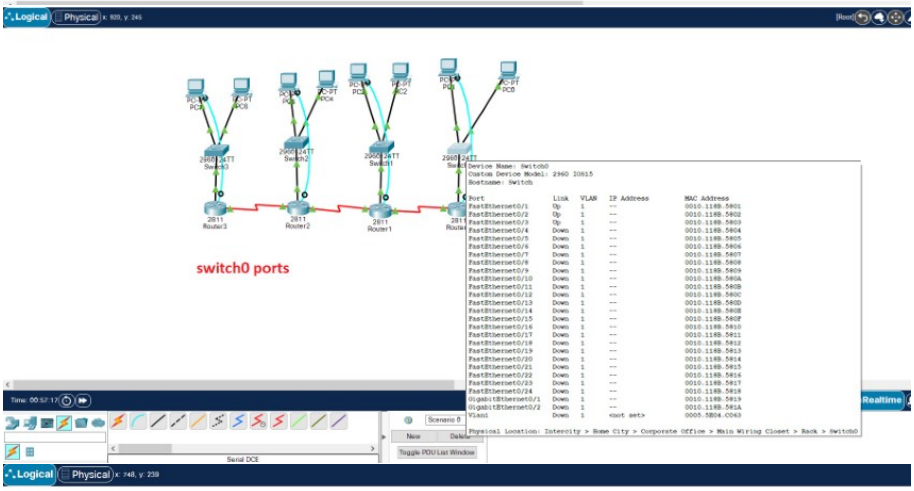
router1 ip addresses and ports



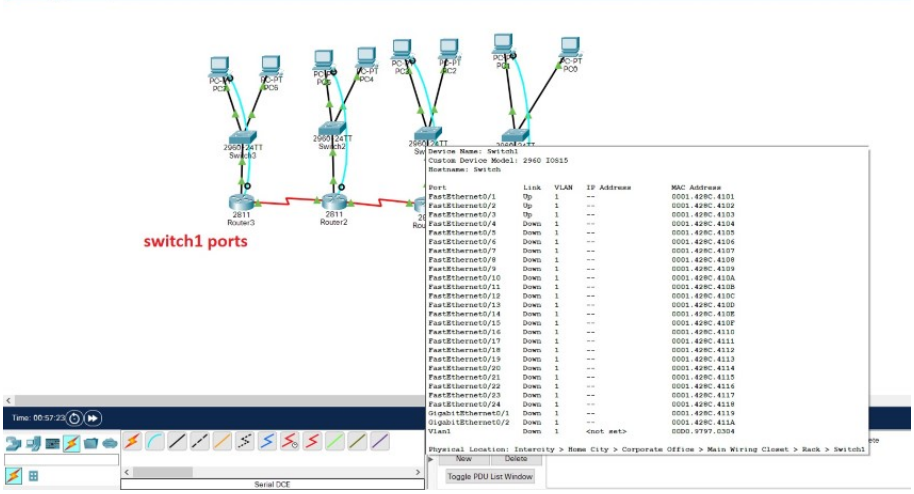
router2 ip addresses and ports



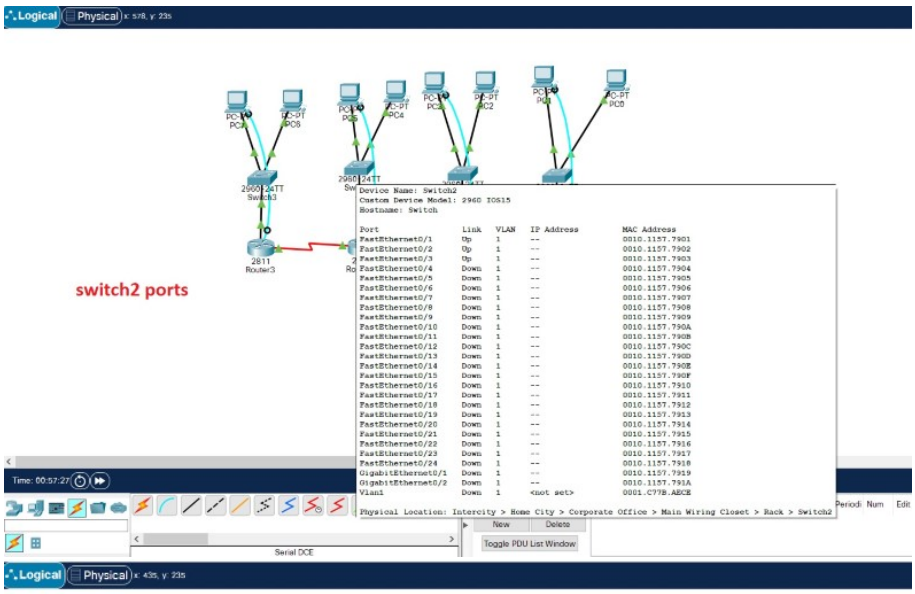
router3 ip addresses and ports

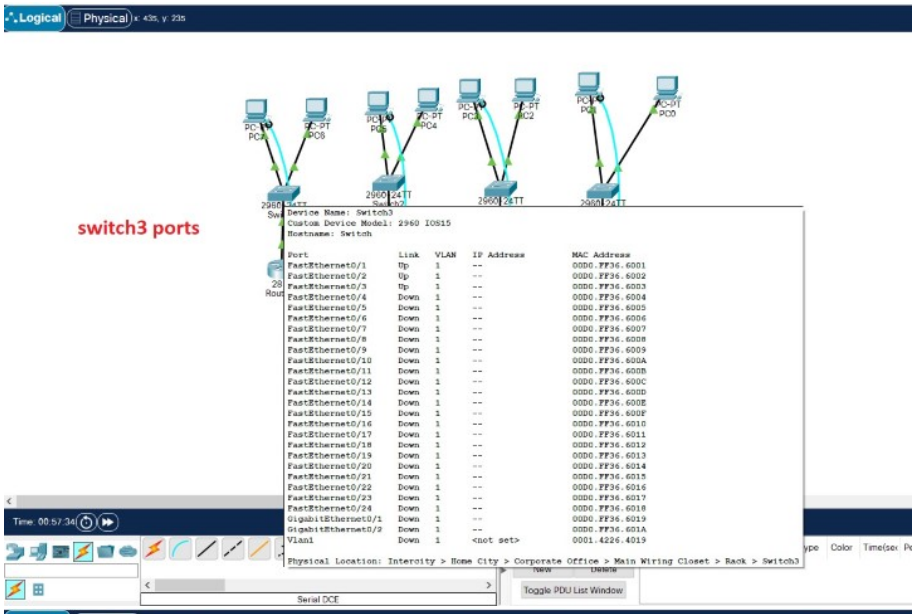


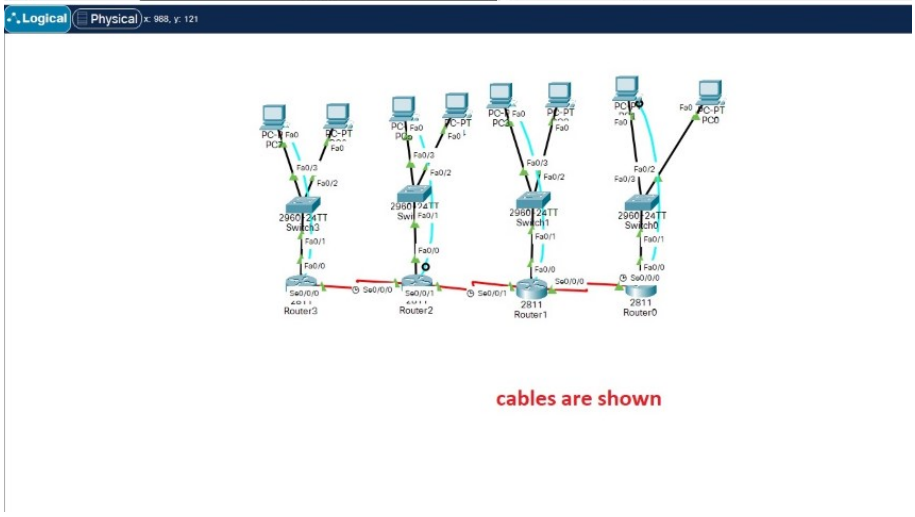
switch0 ports

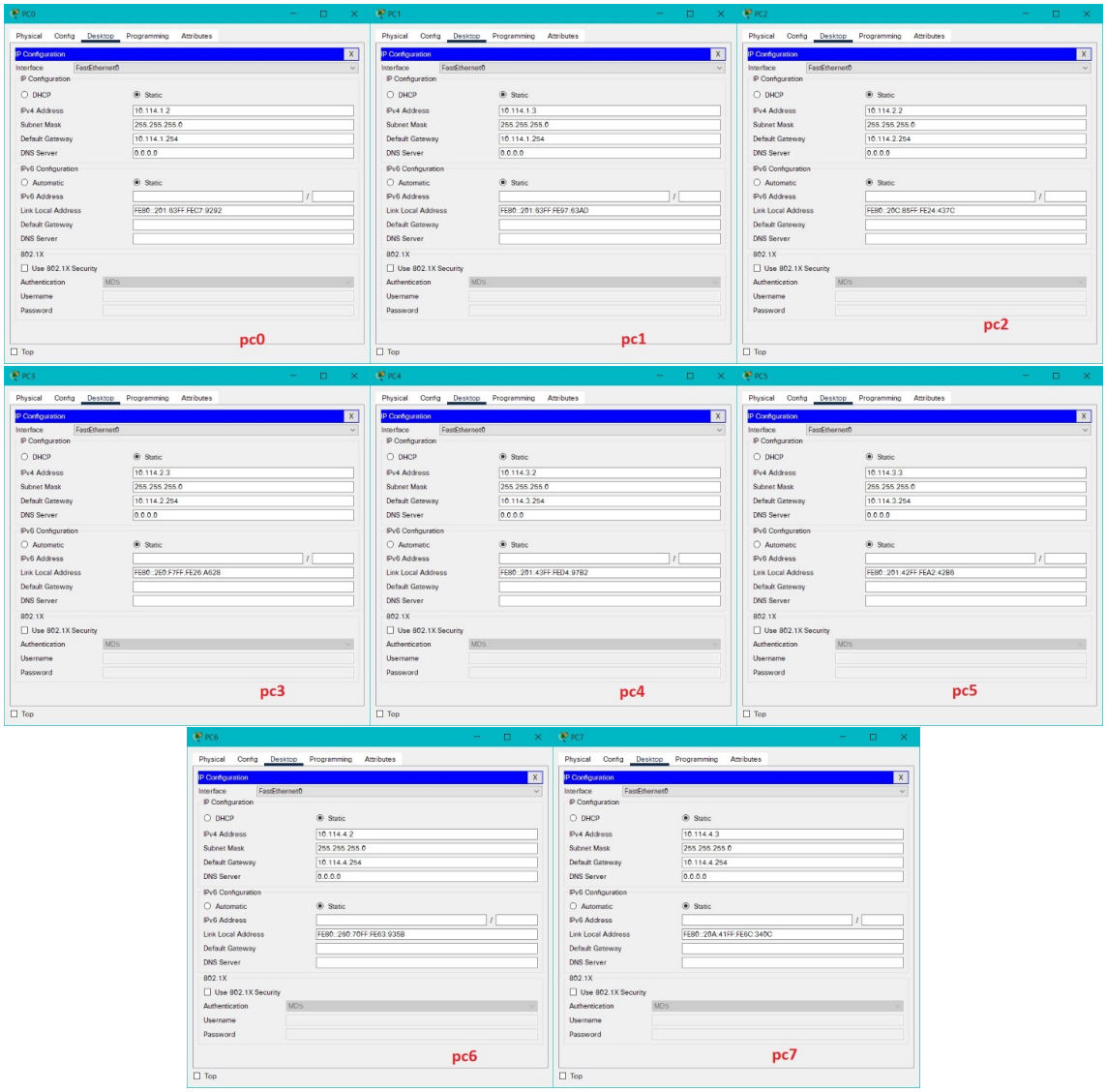


switch1 ports


Logical
Physical
switch2 ports
Device Name: Switch2
Custom Device Model: 2960 IOS15
Hostname: Switch
Physical Location: Intercity > Home City > Corporate Office > Main Wiring Closet > Rack > Switch2


Logical
Physical
switch3 ports
Device Name: Switch3
Custom Device Model: 2960 IOS15
Hostname: Switch
Physical Location: Intercity > Home City > Corporate Office > Main Wiring Closet > Rack > Switch3


Logical
Physical
Router3
Router2
Router1
Router0
cables are shown



2. Assign all interfaces (FastEthernet, Serial) described in the Lab Topology

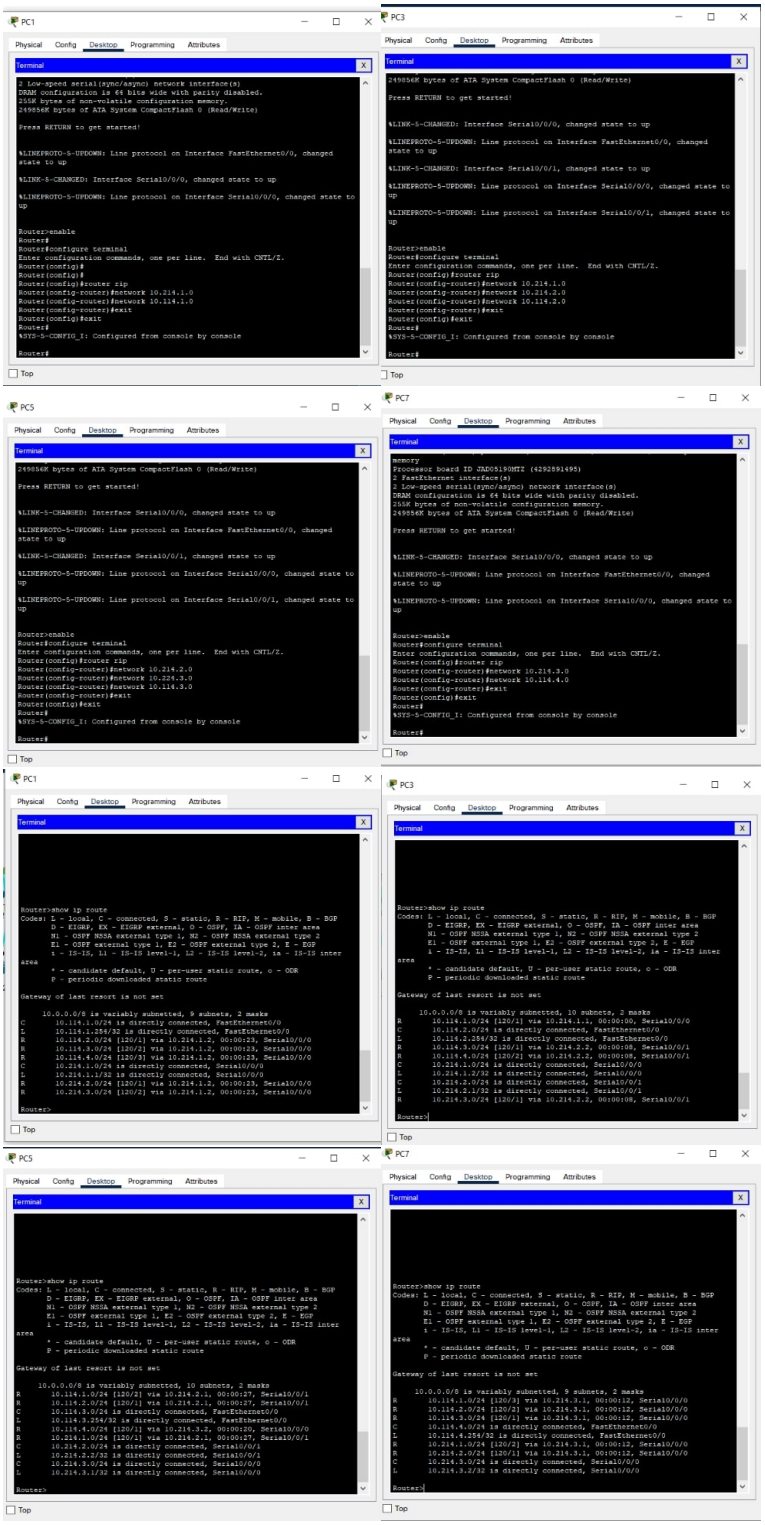
Interfaces are already assigned as shown in the screenshots in the previous question.

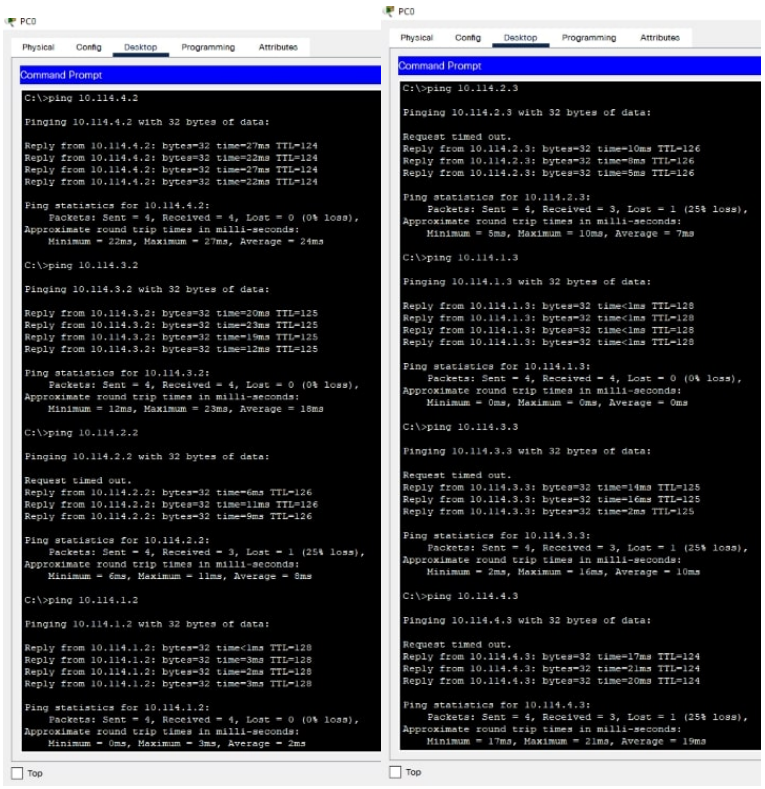
3. All groups should use the same dynamic routing protocols simultaneously. You have to research about routing protocol commands for Cisco Router.

We have done our research and added them to References.

4. Configure RIP protocol. Display routing tables and ping from your computer to all other remote computers.

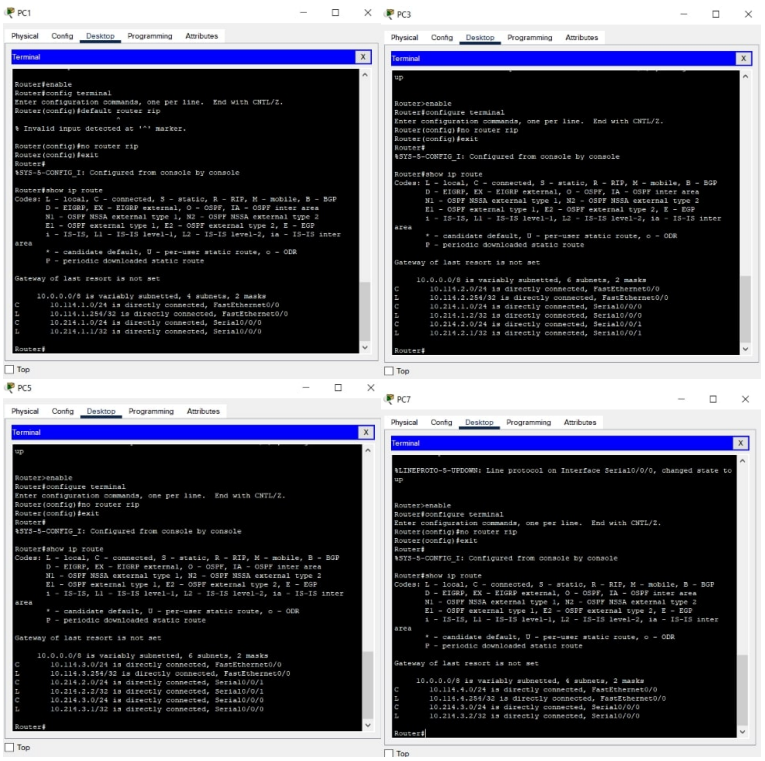
We configured and checked the tables. Then we tested pinging all computers from PC0.

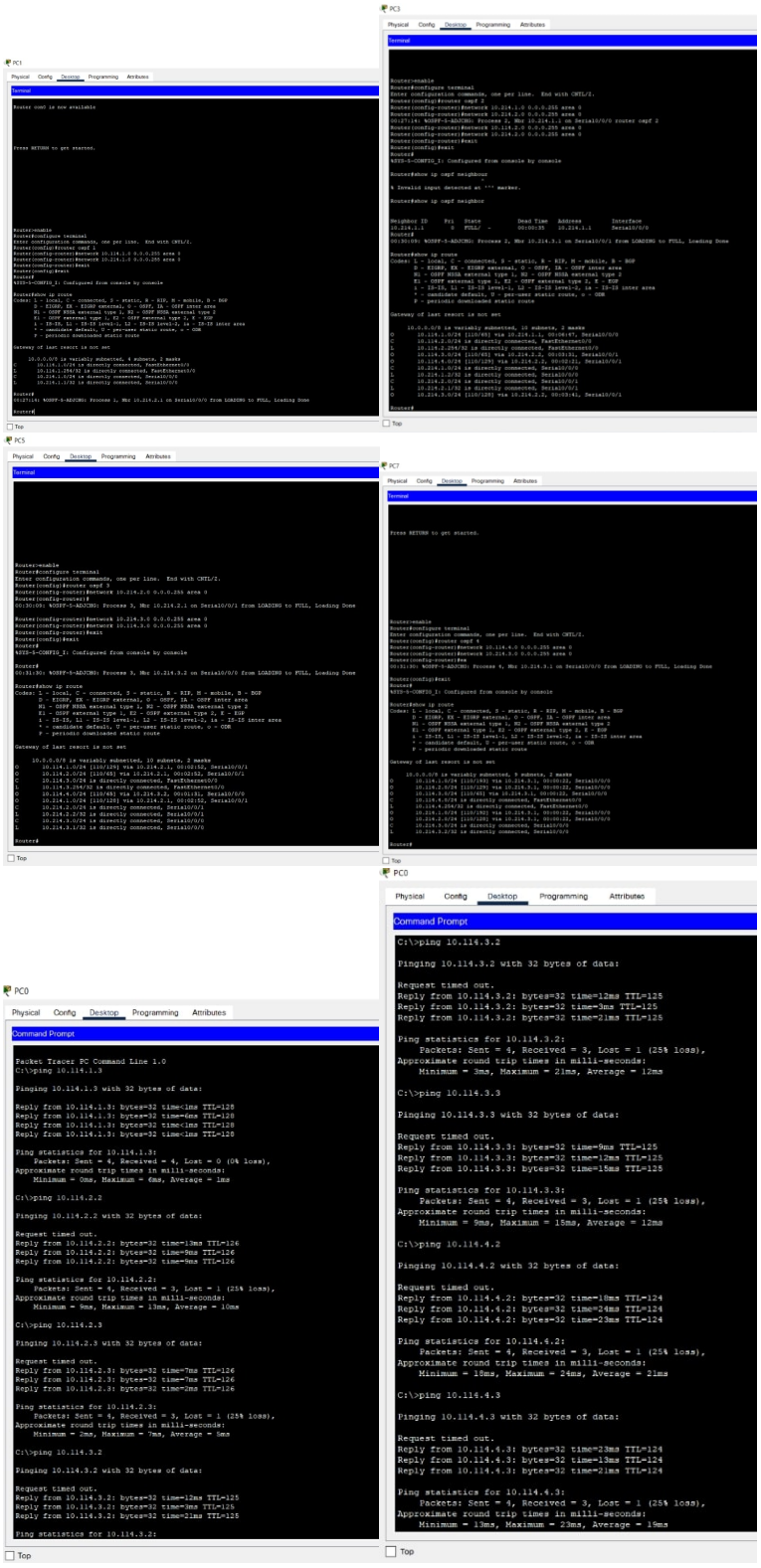




5. Remove RIP configuration and configure OSPF protocol. Display routing tables and ping from your computer to all other remote computers.

First we erased the RIP configurations and configured the OSPF and then checked the tables. Then we tested pinging all computers from PC0.

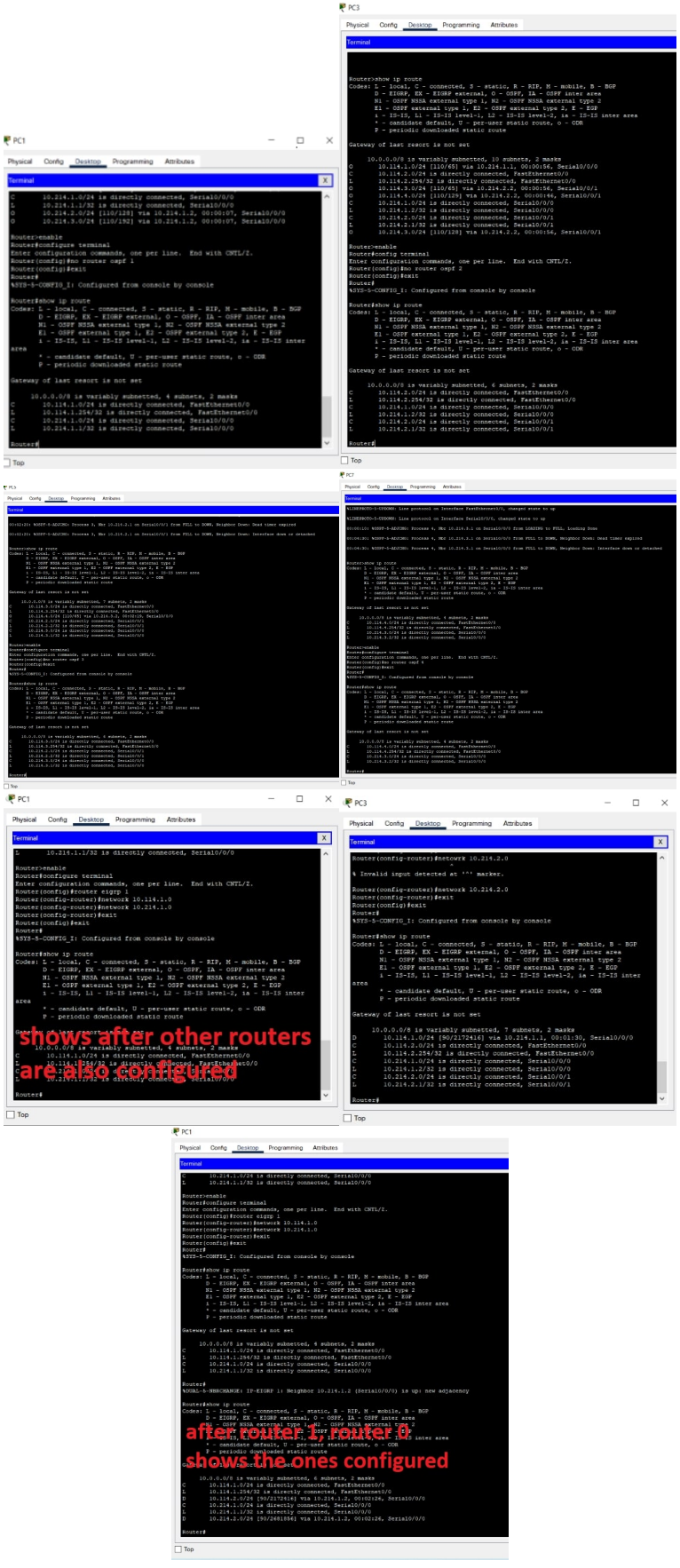




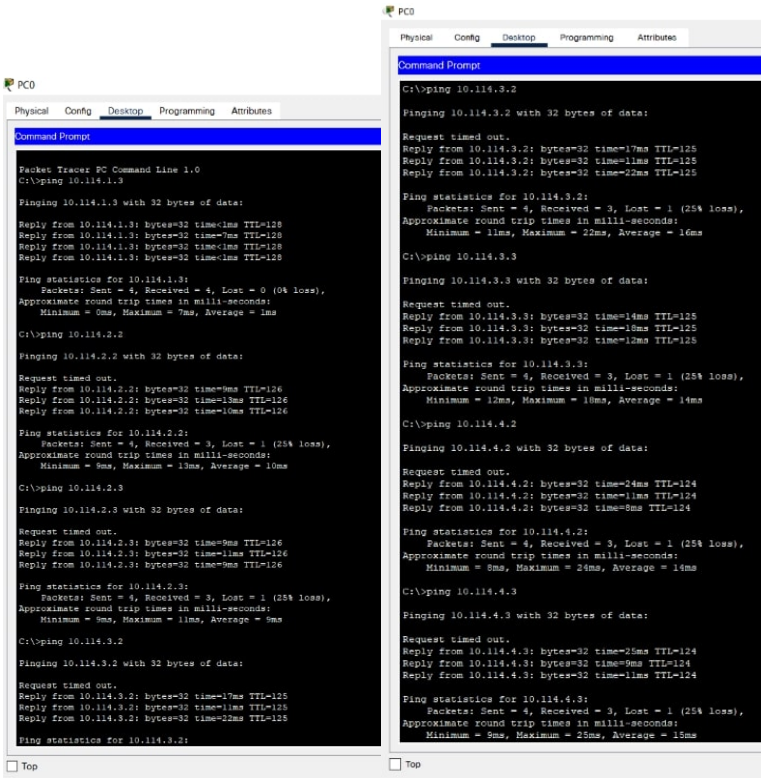
6.Remove OSPF configuration and configure EIGRP protocol. Display routing tables and ping from your computer to all other remote computers.

First we erased the OSPF configurations and configured the EIGRP. While we were configuring we realized it does not show at the first. Further research showed us this was normal because of EIGRP protocol. As we configured other routers the routings were also getting defined. Below are screenshots of the process. Then we tested pinging all

computers from PC0.




PC5
Physical Config Desktop Programming Attributes
Terminal
Press RETURN to get started.
Router>enable
Router#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router eigrp 1
Router(config-router)#network 10.114.3.0
Router(config-router)#
%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 10.214.2.1 (Serial0/0/1) is up: new adjacency
Router(config-router)#network 10.214.2.0
Router(config-router)#network 10.214.3.0
Router(config-router)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
Router#
%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 10.214.3.2 (Serial0/0/0) is up: new adjacency
Router#exit
Router con0 is now available
Press RETURN to get started.
Top
PC7
Physical Config Desktop Programming Attributes
Terminal
Press RETURN to get started.
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router eigrp 1
Router(config-router)#network 10.114.4.0
Router(config-router)#
%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 10.214.3.1 (Serial0/0/0) is up: new adjacency
Router(config-router)#network 10.214.3.0
Router(config-router)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
Router#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route
Gateway of last resort is not set
10.0.0.0/8 is variably subnetted, 9 subnets, 2 masks
D 10.114.1.0/24 [90/3196416] via 10.214.3.1, 00:00:21, Serial0/0/0
D 10.114.2.0/24 [90/2684416] via 10.214.3.1, 00:00:21, Serial0/0/0
D 10.114.3.0/24 [90/21726] via 10.214.3.1, 00:00:21, Serial0/0/0
C 10.114.4.0/24 is directly connected, FastEthernet0/0
L 10.114.4.254/32 is directly connected, FastEthernet0/0
D 10.214.1.0/24 [90/3198976] via 10.214.3.1, 00:00:21, Serial0/0/0
D 10.214.2.0/24 [90/2681856] via 10.214.3.1, 00:00:21, Serial0/0/0
C 10.214.3.0/24 is directly connected, Serial0/0/0
L 10.214.3.2/32 is directly connected, Serial0/0/0
Router#
Top
PC1
Physical Config Desktop Programming Attributes
Terminal
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route
Gateway of last resort is not set
10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C 10.114.1.0/24 is directly connected, FastEthernet0/0
L 10.114.1.254/32 is directly connected, FastEthernet0/0
D 10.214.2.0/24 [90/21726416] via 10.214.1.2, 00:02:26, Serial0/0/0
C 10.214.1.0/24 is directly connected, Serial0/0/0
L 10.214.1.1/32 is directly connected, Serial0/0/0
D 10.214.2.0/24 [90/2681856] via 10.214.1.2, 00:02:26, Serial0/0/0
Router#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route
Gateway of last resort is not set
10.0.0.0/8 is variably subnetted, 9 subnets, 2 masks
C 10.114.1.0/24 is directly connected, FastEthernet0/0
L 10.114.1.254/32 is directly connected, FastEthernet0/0
D 10.114.2.0/24 [90/21726416] via 10.214.1.2, 00:08:49, Serial0/0/0
D 10.114.3.0/24 [90/2684416] via 10.214.1.2, 00:04:04, Serial0/0/0
D 10.114.4.0/24 [90/3196416] via 10.214.1.2, 00:03:15, Serial0/0/0
C 10.214.1.0/24 is directly connected, Serial0/0/0
L 10.214.1.1/32 is directly connected, Serial0/0/0
D 10.214.2.0/24 [90/2681856] via 10.214.1.2, 00:08:46, Serial0/0/0
D 10.214.3.0/24 [90/3198976] via 10.214.1.2, 00:04:04, Serial0/0/0
Router#
Top
PC3
Physical Config Desktop Programming Attributes
Terminal
10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
D 10.114.1.0/24 [90/21726416] via 10.214.1.1, 00:01:30, Serial0/0/0
C 10.114.2.0/24 is directly connected, FastEthernet0/0
L 10.114.2.254/32 is directly connected, FastEthernet0/0
C 10.214.1.0/24 is directly connected, Serial0/0/0
L 10.214.1.2/32 is directly connected, Serial0/0/0
C 10.214.2.0/24 is directly connected, Serial0/0/1
L 10.214.2.1/32 is directly connected, Serial0/0/1
Router#
%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 10.214.2.2 (Serial0/0/1) is up: new adjacency
Router#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route
Gateway of last resort is not set
10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
D 10.114.1.0/24 [90/21726416] via 10.214.1.1, 00:08:21, Serial0/0/0
C 10.114.2.0/24 is directly connected, FastEthernet0/0
L 10.114.2.254/32 is directly connected, FastEthernet0/0
D 10.114.3.0/24 [90/21726416] via 10.214.2.2, 00:05:40, Serial0/0/1
D 10.114.4.0/24 [90/2684416] via 10.214.2.2, 00:02:46, Serial0/0/1
C 10.214.1.0/24 is directly connected, Serial0/0/0
L 10.214.1.2/32 is directly connected, Serial0/0/0
C 10.214.2.0/24 is directly connected, Serial0/0/1
L 10.214.2.1/32 is directly connected, Serial0/0/1
D 10.214.3.0/24 [90/2681856] via 10.214.2.2, 00:05:40, Serial0/0/1
Router#
Top
PC5
Physical Config Desktop Programming Attributes
Terminal
Router#exit
Router con0 is now available
Press RETURN to get started.
Router>show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route
Gateway of last resort is not set
10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
D 10.114.1.0/24 [90/2684416] via 10.214.2.1, 00:02:08, Serial0/0/1
D 10.114.2.0/24 [90/21726416] via 10.214.2.1, 00:02:08, Serial0/0/1
C 10.114.3.0/24 is directly connected, FastEthernet0/0
L 10.114.3.254/32 is directly connected, FastEthernet0/0
D 10.114.4.0/24 [90/21726416] via 10.214.3.2, 00:01:14, Serial0/0/0
D 10.214.1.0/24 [90/2681856] via 10.214.2.1, 00:02:08, Serial0/0/1
C 10.214.2.0/24 is directly connected, Serial0/0/1
L 10.214.2.2/32 is directly connected, Serial0/0/1
C 10.214.3.0/24 is directly connected, Serial0/0/0
L 10.214.3.1/32 is directly connected, Serial0/0/0
Router#
Top


PC0
Physical
Config
Desktop
Programming
Attributes
Command Prompt
Packet Tracer PC Command Line 1.0
C:\>ping 10.114.1.3
Pinging 10.114.1.3 with 32 bytes of data:
Reply from 10.114.1.3: bytes=32 time<1ms TTL=128
Reply from 10.114.1.3: bytes=32 time=7ms TTL=128
Reply from 10.114.1.3: bytes=32 time<1ms TTL=128
Reply from 10.114.1.3: bytes=32 time<1ms TTL=128
Ping statistics for 10.114.1.3:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 7ms, Average = 1ms
C:\>ping 10.114.2.2
Pinging 10.114.2.2 with 32 bytes of data:
Request timed out.
Reply from 10.114.2.2: bytes=32 time=9ms TTL=126
Reply from 10.114.2.2: bytes=32 time=13ms TTL=126
Reply from 10.114.2.2: bytes=32 time=10ms TTL=126
Ping statistics for 10.114.2.2:
Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
Minimum = 9ms, Maximum = 13ms, Average = 10ms
C:\>ping 10.114.2.3
Pinging 10.114.2.3 with 32 bytes of data:
Request timed out.
Reply from 10.114.2.3: bytes=32 time=9ms TTL=126
Reply from 10.114.2.3: bytes=32 time=11ms TTL=126
Reply from 10.114.2.3: bytes=32 time=9ms TTL=126
Ping statistics for 10.114.2.3:
Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
Minimum = 9ms, Maximum = 11ms, Average = 9ms
C:\>ping 10.114.3.2
Pinging 10.114.3.2 with 32 bytes of data:
Request timed out.
Reply from 10.114.3.2: bytes=32 time=17ms TTL=125
Reply from 10.114.3.2: bytes=32 time=11ms TTL=125
Reply from 10.114.3.2: bytes=32 time=22ms TTL=125
Ping statistics for 10.114.3.2:
Top
PC0
Physical
Config
Desktop
Programming
Attributes
Command Prompt
C:\>ping 10.114.3.2
Pinging 10.114.3.2 with 32 bytes of data:
Request timed out.
Reply from 10.114.3.2: bytes=32 time=17ms TTL=125
Reply from 10.114.3.2: bytes=32 time=11ms TTL=125
Reply from 10.114.3.2: bytes=32 time=22ms TTL=125
Ping statistics for 10.114.3.2:
Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
Minimum = 11ms, Maximum = 22ms, Average = 16ms
C:\>ping 10.114.3.3
Pinging 10.114.3.3 with 32 bytes of data:
Request timed out.
Reply from 10.114.3.3: bytes=32 time=14ms TTL=125
Reply from 10.114.3.3: bytes=32 time=18ms TTL=125
Reply from 10.114.3.3: bytes=32 time=12ms TTL=125
Ping statistics for 10.114.3.3:
Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
Minimum = 12ms, Maximum = 18ms, Average = 14ms
C:\>ping 10.114.4.2
Pinging 10.114.4.2 with 32 bytes of data:
Request timed out.
Reply from 10.114.4.2: bytes=32 time=24ms TTL=124
Reply from 10.114.4.2: bytes=32 time=11ms TTL=124
Reply from 10.114.4.2: bytes=32 time=8ms TTL=124
Ping statistics for 10.114.4.2:
Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
Minimum = 8ms, Maximum = 24ms, Average = 14ms
C:\>ping 10.114.4.3
Pinging 10.114.4.3 with 32 bytes of data:
Request timed out.
Reply from 10.114.4.3: bytes=32 time=25ms TTL=124
Reply from 10.114.4.3: bytes=32 time=9ms TTL=124
Reply from 10.114.4.3: bytes=32 time=11ms TTL=124
Ping statistics for 10.114.4.3:
Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
Minimum = 9ms, Maximum = 25ms, Average = 15ms
Top

LAB 12

EXPERIMENT STEPS

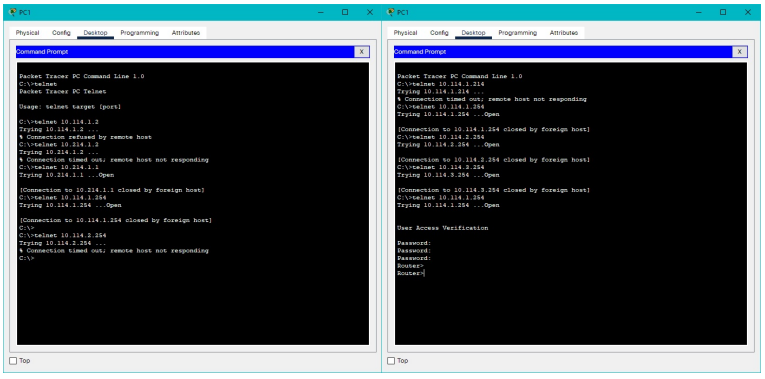
1. Your aim is to configure NAT on your router and translate your PC's IP address in your group to a single IP from your subnet. After translation process, you will be able to test your address translation with pinging to new IP addresses and using show commands. Another way to test your configuration is to connect remotely to another group's router and running show user command to see logged in users on that router.

Yes we are going to configure them down below.

Basic Router Configurations

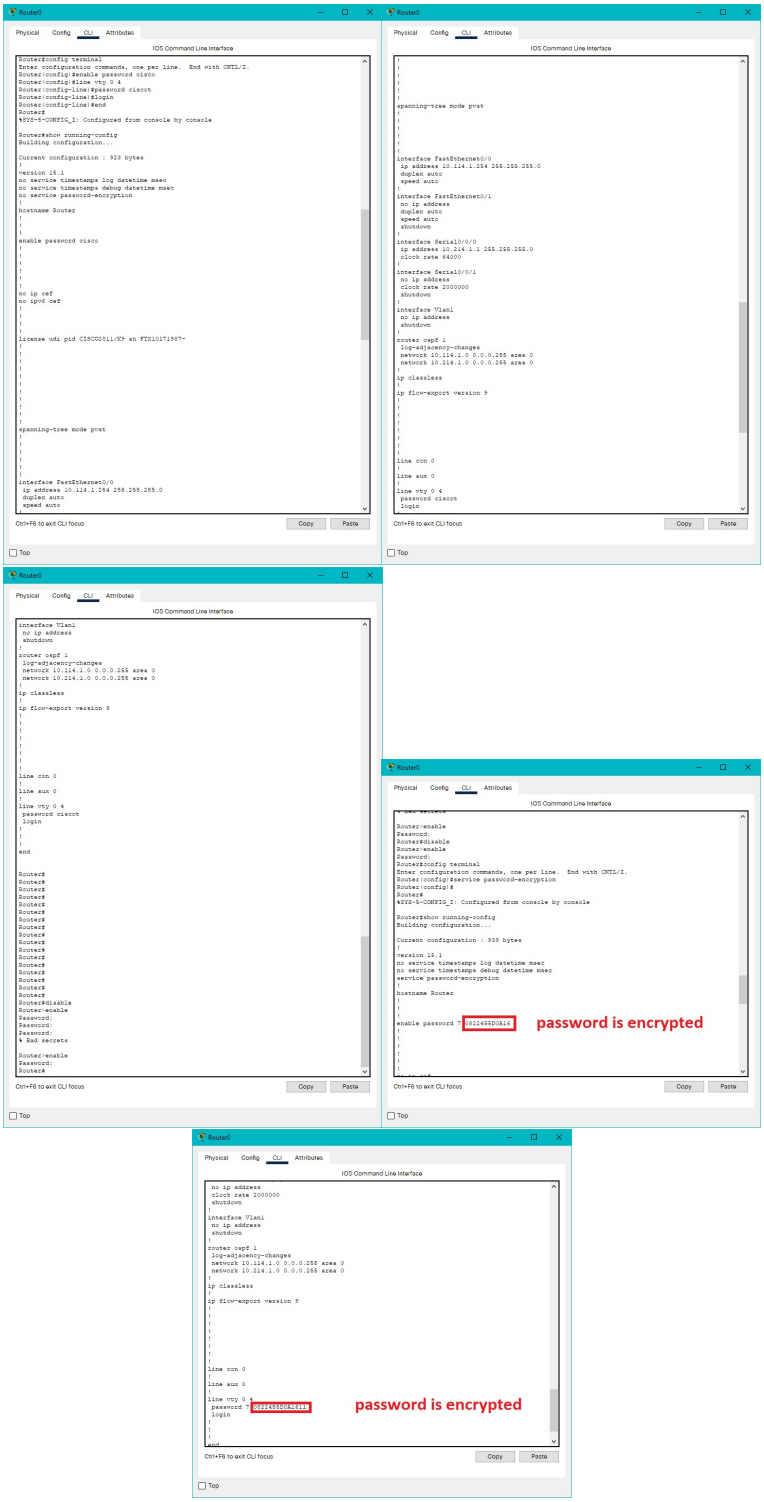
2. You are going to use telnet for remote connection. To be able to use telnet, you have to configure necessary password steps for security restrictions. For example try to telnet (from your PC) to another group's Router (IP address of Serial interface), and understand why you are not able connect to the Router.

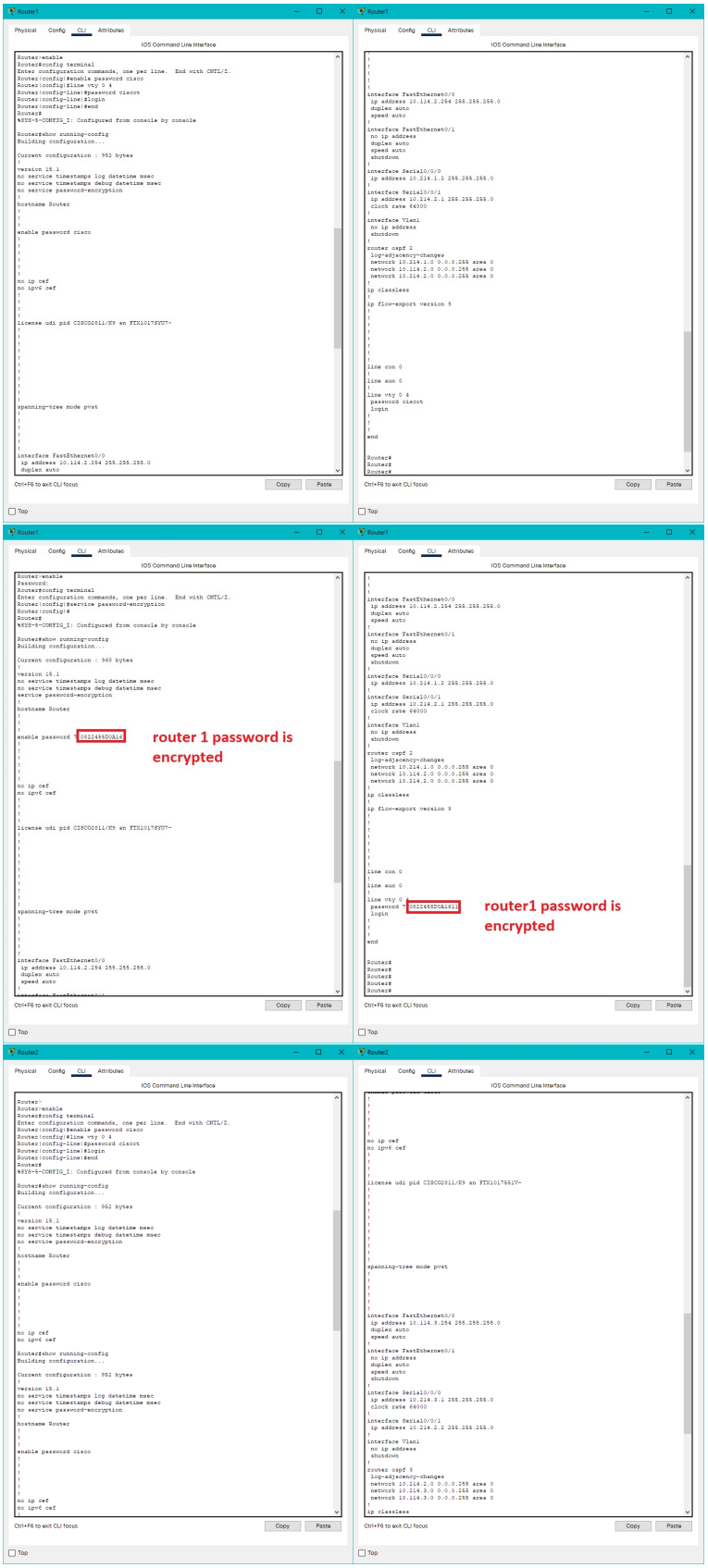
We tried first and it was not able connect because there was no routing. We set basic ospf routing and it was able to connect but needed to configure the password. When we configure password in the next steps, it was able to connect.

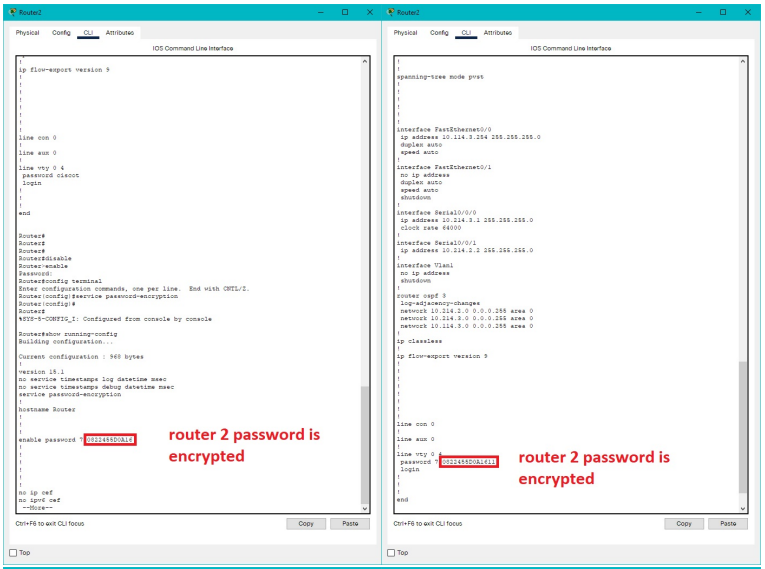


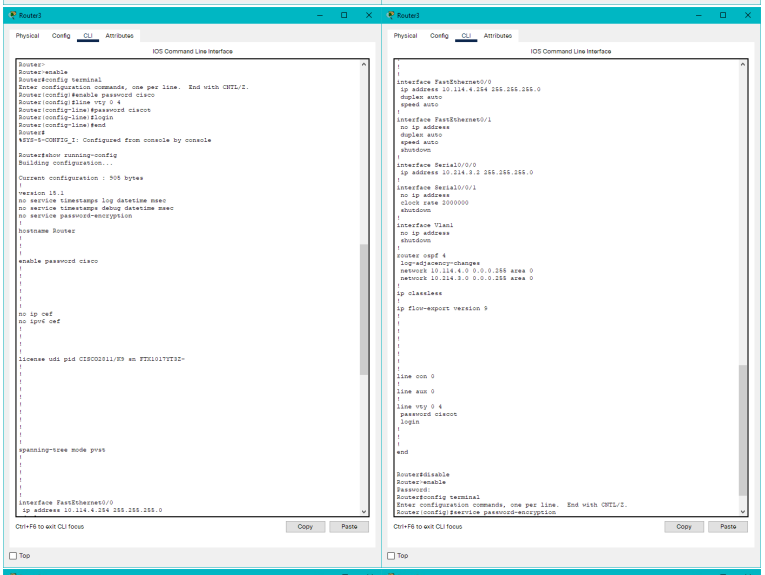
3-4-5. You have to set enable password and telnet password for remote connection. Display your configuration changes on running-config and try logout from Router using disable command and then enable again. You should observe that all text passwords can be easily seen in config file. That is also a security bug. You should use encryption service for encrypting password texts.

We added specified passwords to all routers and configured the encrypting texts.


password is encrypted
password is encrypted

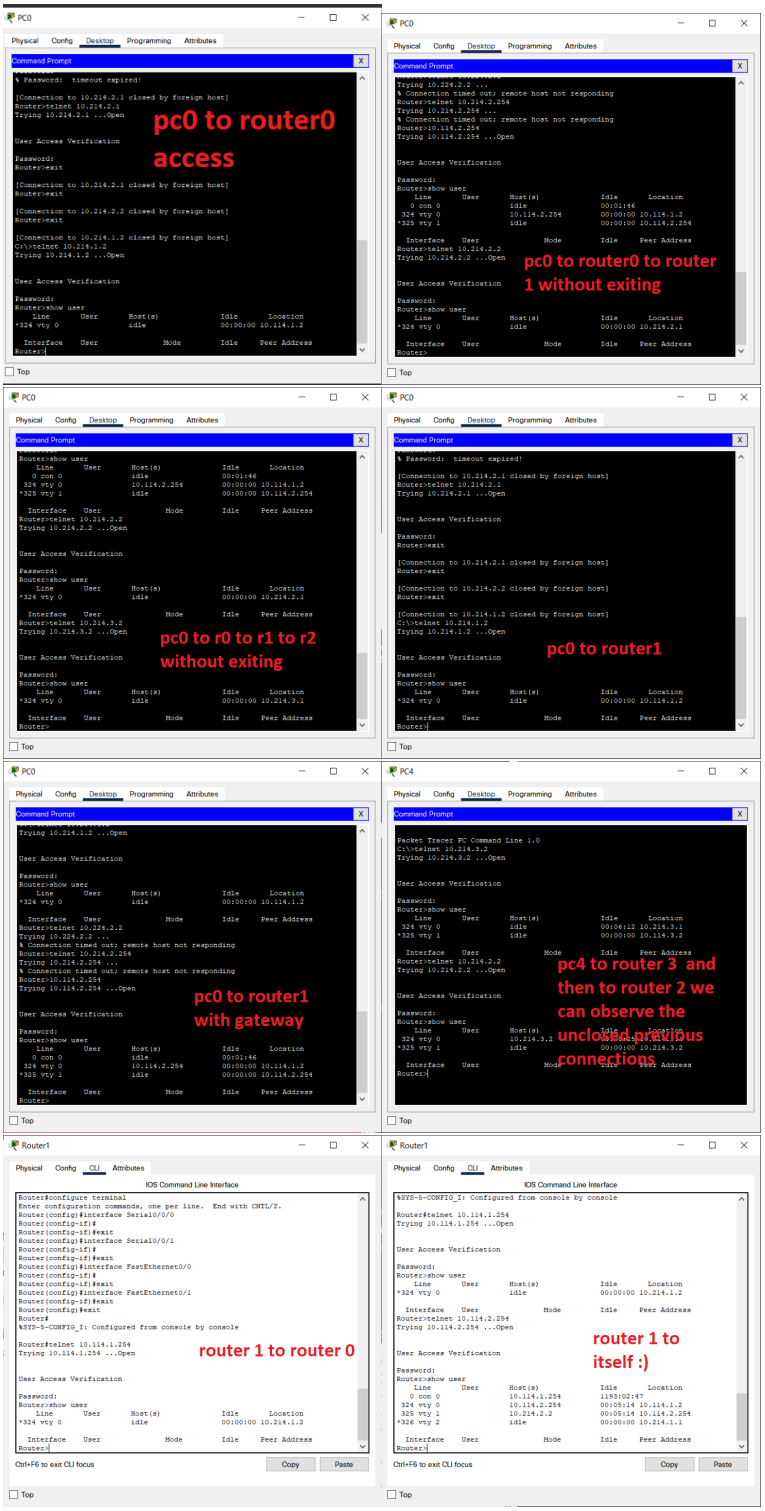

router 1 password is encrypted
router1 password is encrypted


router 2 password is encrypted
router 2 password is encrypted


router 3 password is encrypted
router 3 password is encrypted

6. Now you are ready to telnet (from your PC) to another remote Routers. Enter their telnet and enable passwords and login to their router. Use show user command to display logged-in connections on the router in this session. Observe your IP address of your client. The * shows your connection.

We have tested all possible scenarios. Accessed all routers with different methods. Accessed from routers, accessed within routers, left connection open and accessed from another PC etc. Check down below for screenshots of some test covering cases:



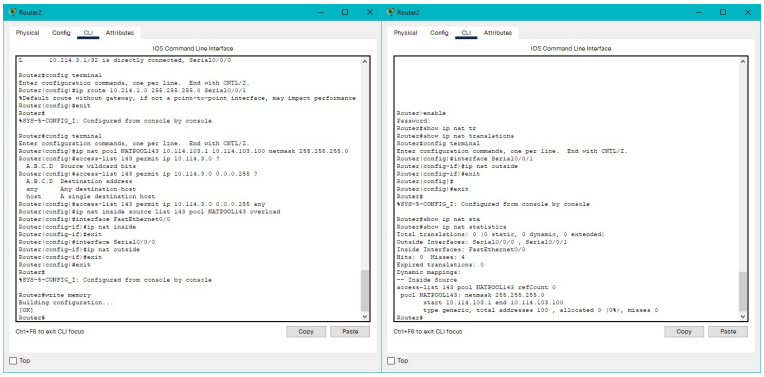
7. If a router supports address translation, then the connection interfaces to which the address translation is to be applied, must be specified and defined as inside or outside. This is done using the ip nat [inside | outside] command while in the sub-configuration mode.

This part was really hard and took us lots of trying. So the screenshots of exact configuration moments might be lacking but we will add complete logs and describe which commands we entered to achieve the results. First of all we must clear this out: It is a known and real issue that two computers behind NAT networks are unable to reach other. For this there are various methods to punch a hole, but for any of them to work there must be a static NAT translation. Our current choice of NAT translation which is overload uses 1 IP for outer world and uses ports for inner world. The game breaking thing is the translation is cleared out when it is unused. So when a PC from outer world wants to reach a PC from inside with a NAT attained IP it is really hard because at a given moment that PC might not even be on the NAT list or who know which port is assigned to it. This is a real issue in p2p networks etc.

Another thing to mention is routing. With NAT routing is simple as inside world => whole internet. However by enforcing this topology we need to ensure all routing are done and encapsulated with static routing.

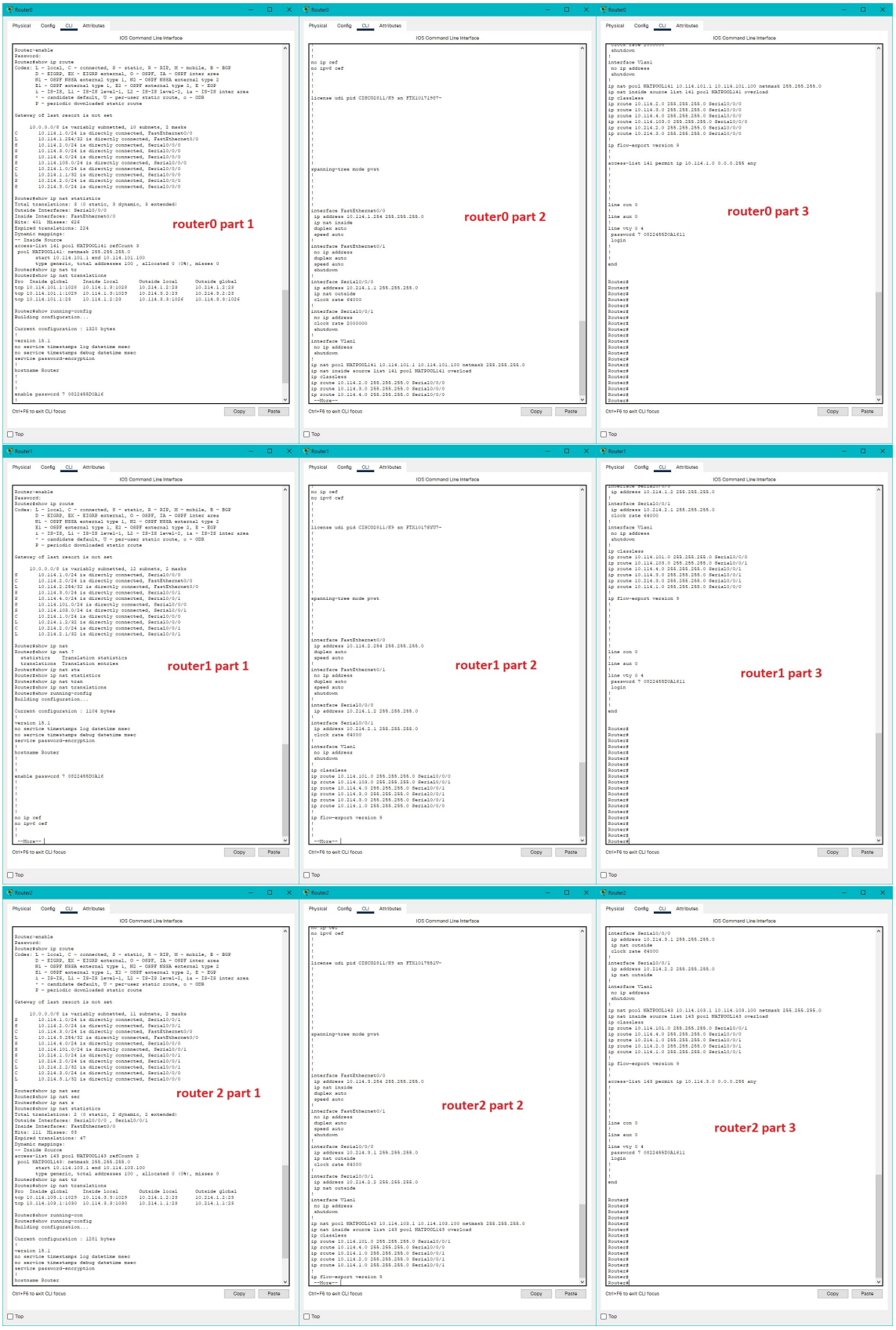
In our experiment for realistic test and ensuring results we chose this method. Router 0 and router 3 are NAT routers. Their NAT IP is 10.114.101.1 for router 0, 10.114.103.1 for router 3. All routers route this IP addresses accordingly and all PC networks and router networks.

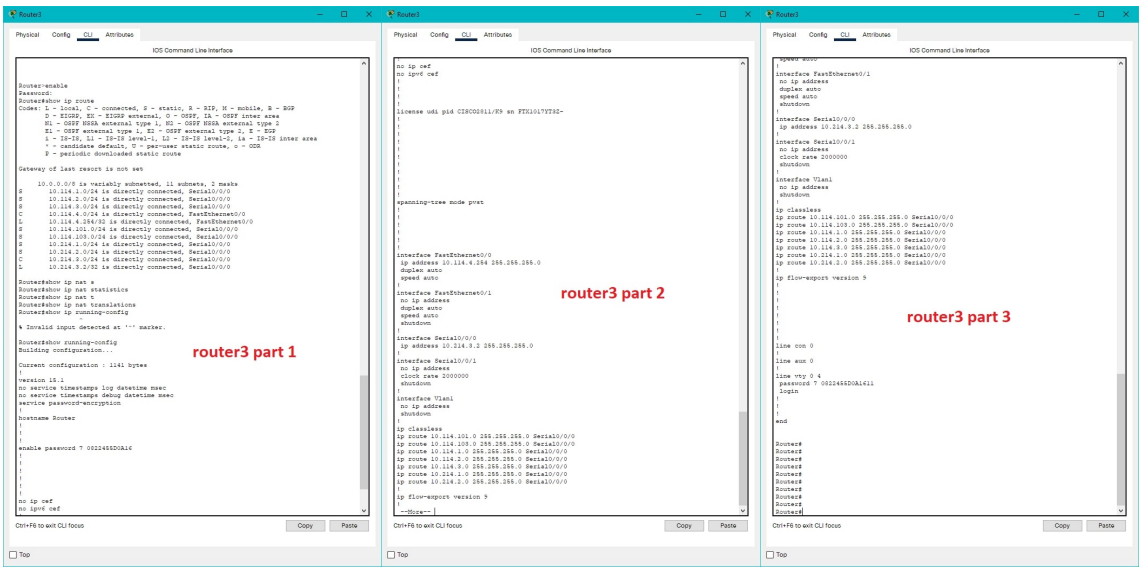
Expected result, which is confirmed by screenshots below, is this: PC4 and PC5 can access outer world and their IP will NAT ed to 10.114.103.1. PC0 and PC1 will be NAT ed to 10.114.101.1. Other PCs are not behind a NAT network. NAT ed PCs can not be accessed from other NAT ed PCs. From outside world NAT ed PCs can be accessed by their inner IPs however returned message will be NAT ed. From NAT ed pcs they can access routers and PCs with their NAT ed IPs (Not the NAT ed PCs).



Commands we entered for router 2 are shown above. Similar commands are entered for router 0 but with NATPOOL141, access-list 141 and ip 10.114.101.1 and of course according interfaces and permitted IPs. We are aware of one thing we might not have done here which is defining a range like 10.114.103.1 10.114.103.100. This is unnecessary considering overloaded NATs will always have 1 IP address. However changing or redoing this was also unnecessary. Other thing to mention is after configuring NAT we used write memory because it wouldn't register sometimes.

Now below are log results for current routers using show ip route, show ip nat *, show running-config. Notice router 1 and 3 does not have NAT:



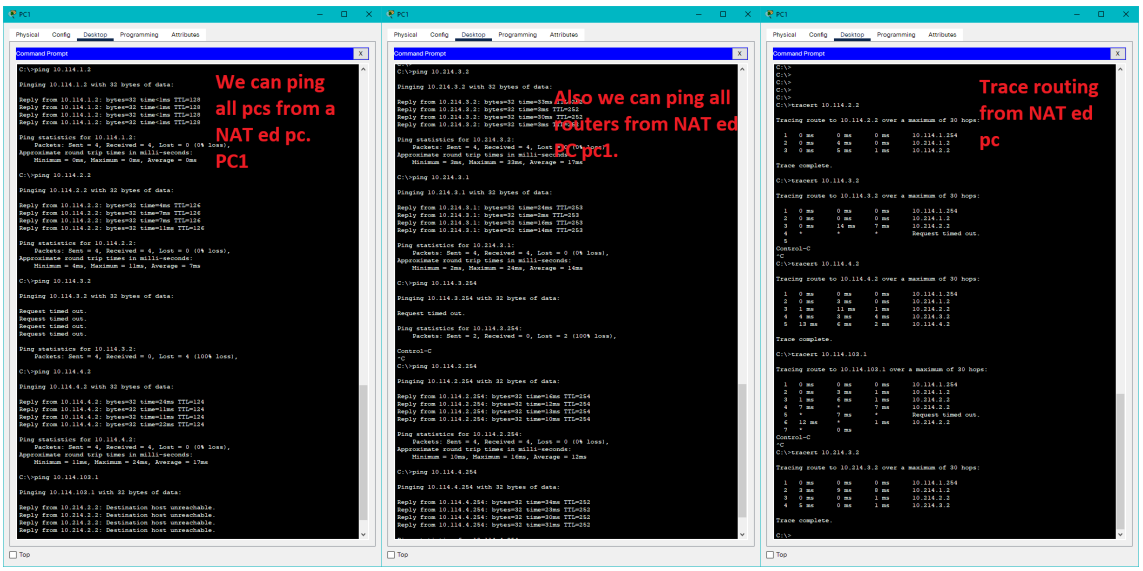


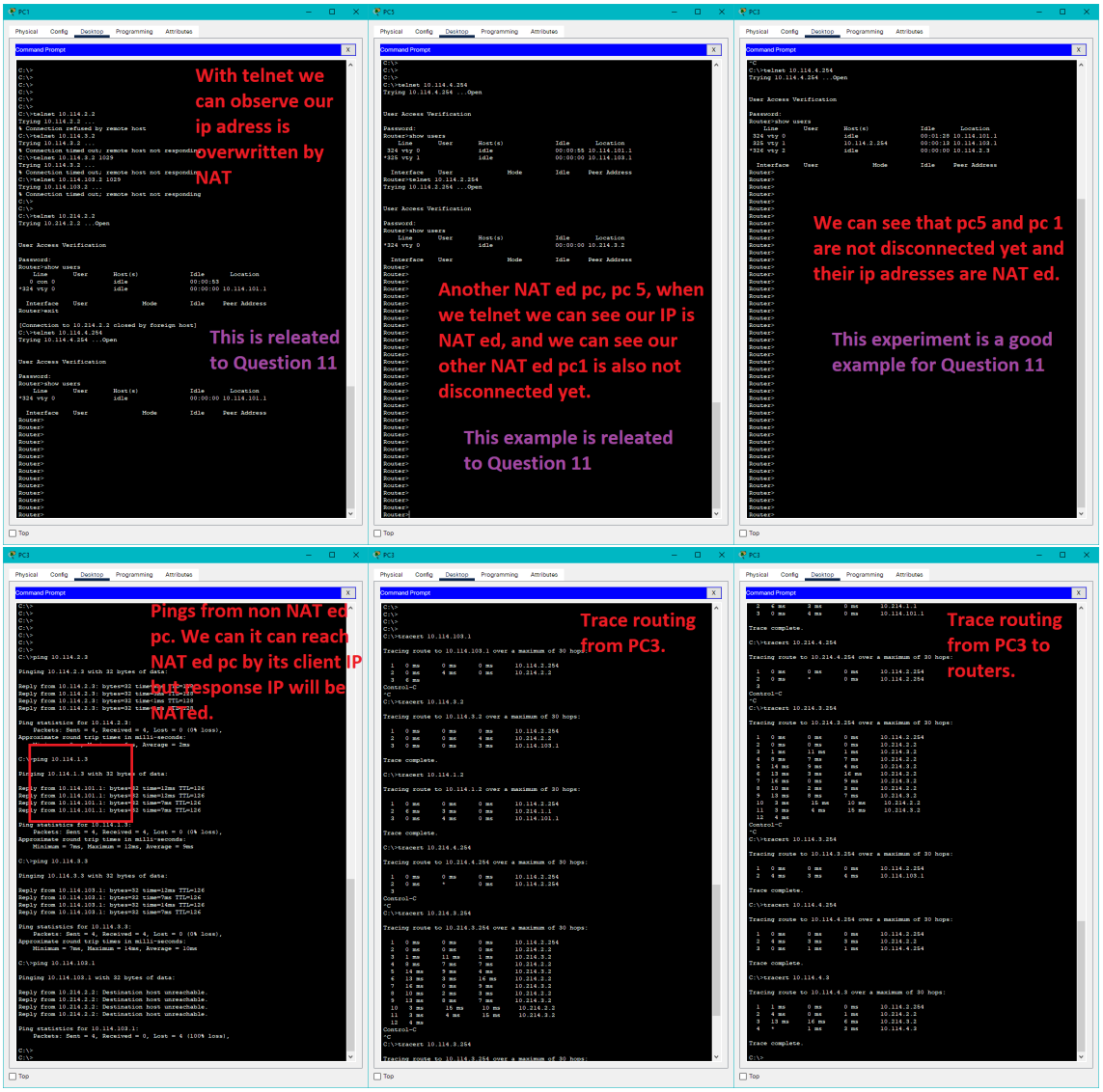
8. You are going to configure dynamic overloading NAT. Commands are same as dynamic NAT configuration with overload command at the end. You should translate your client IP to another IP from your subnet (for example: 10.100.X.99) using dynamic overloading NAT commands:

We have bundled this part with previous because of tons of testing etc. Check previous screen shots.

9. After NAT configuration, try to ping other groups client IP addresses and translated IP addresses. Discuss the results.

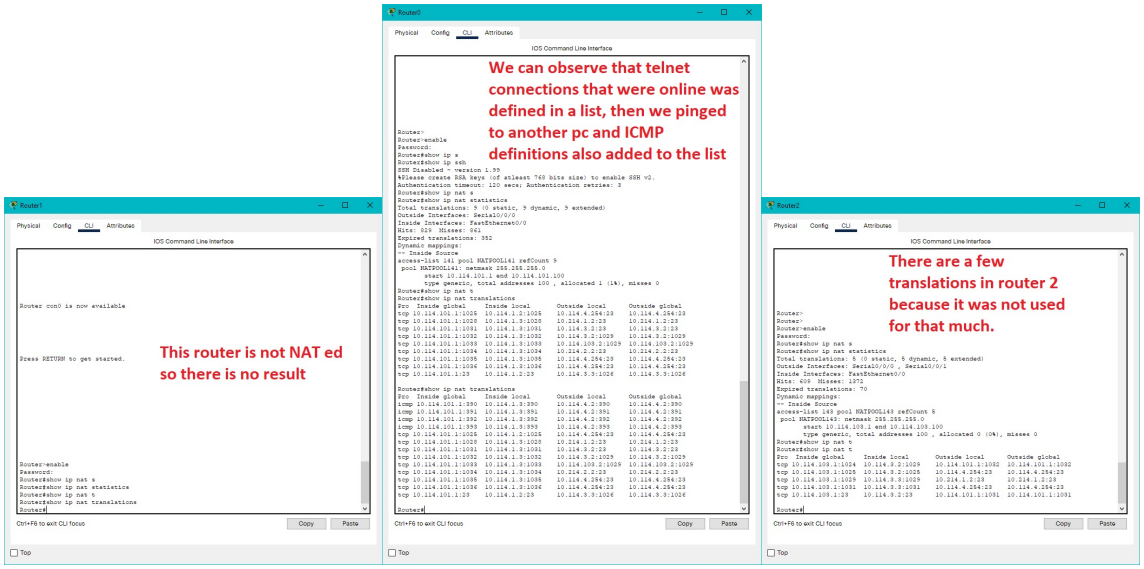
As expected when we pinged, trace routed, telnet accessed from a PC behind NAT their IP got overwritten. When we pinged a NAT ed client IP from non NAT ed PC the returned result had NAT ed IP. Reaching a NAT ed PC from another NAT ed PC was unable, as it should be. Reaching a NAT ed PC with their translated IP address worked only if that PC recently used network meaning they were in translate list. Otherwise it was also not possible.





10. Use show ip nat translation command to show translated IP addresses and port numbers. Discuss each column on the table (inside/outside, local/global). If you didn't see any output, you should successfully ping remote clients and also your PC should be pinged form outside.

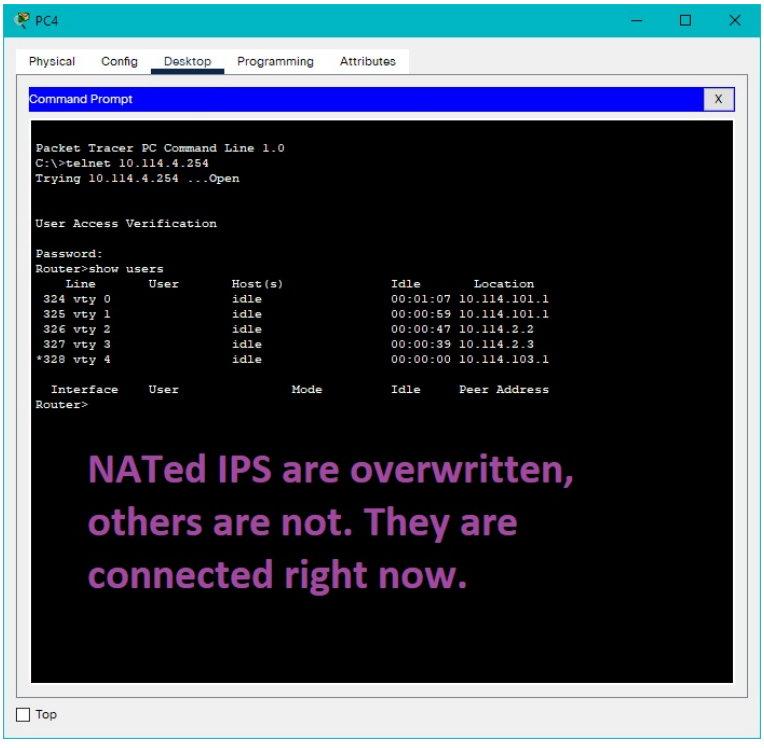
When we use ip nat translation on non NAT ed routers obviously we get nothing. We are also observing ip nat statistics. When we use this commands on NATed ip, still there is a chance translation list might be empty if router was idle. When we ping or telnet or traceroute it becomes active.



In the above screenshots we see that PRO column which is short for Protocol. This defines that translation protocol which is allowed for that translation. We also see Inside global, Inside local IP addresses. These are for our translated PC's IP addresses. Global one is the overwritten one and local is the insider one. We can see that port numbers are used to forward the IP. Outside global and Outside Local IP's seem to be the reached IP. Since we did not have a rule for that they are not changed.

11. Finally, connect to other remote Routers using telnet, and display connected users and observe your IP address.

We have observed telnets in question 9. Check the purple written experiments. Also down below is one extra experiment with a full user list. The observation results are expected. The NATed IPs overwritten. Down below we see pc0 and pc1 have same IP adress. Because they are behind same NAT.



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RIP Configuration
OSPF Configuration
EIGRP Configuration
Cisco NAT
NAT Overload
Access-list Bug