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I220888 C

Project Report

Title Page

Project Title: Office Network Topology with Branch and HQ Networks
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Date: 4 Dec 2024

Objective

The primary goal of this project is to design, configure, and implement a secure, scalable, and functional network topology for an office environment. The topology connects a Headquarter (HQ) office and branch office using IPsec VPN for secure communication. VLAN segmentation, routing, and appropriate security measures are applied to ensure optimal network performance and data protection.

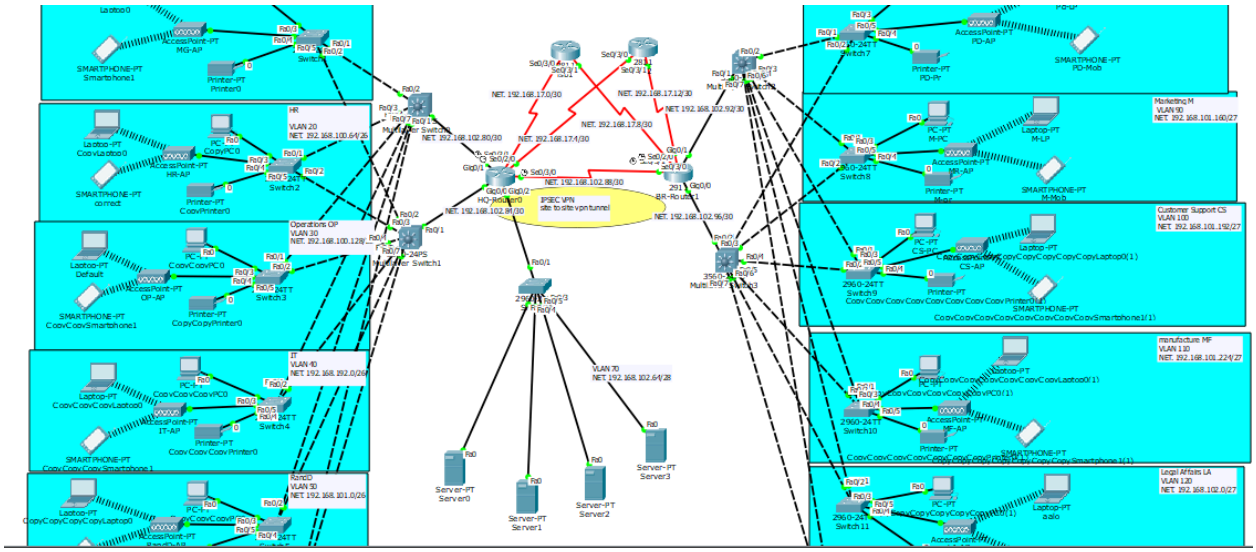
Technologies Used

1. **Hardware and Simulators**:
    - Cisco Packet Tracer
    - Routers and Layer 2/3 Switches
2. **Protocols**:
    - OSPF for dynamic routing
    - IPsec VPN for secure communication between HQ and Branch
    - VLANs for network segmentation
3. **Tools**:
    - SSH for secure remote access
    - Cisco IOS CLI for configuration
4. **Security Mechanisms**:
    - Service password encryption
    - SSH-based management
    - Crypto ISAKMP for VPN configuration

Implementation Details

Design and Approach

1. **Topology**: The network comprises a Headquarter (HQ) and Branch office connected via an IPsec VPN tunnel. Both locations use VLANs to segment the network logically into departments like HR, Marketing, IT, etc.



2. **Key Features**:
    - VLANs are implemented for network segmentation to reduce broadcast domains.
    - OSPF is configured to enable efficient dynamic routing.
    - Eigrp
    - Static IP routes are added for backup connectivity.
    - IPsec VPN is configured to establish secure communication between the HQ and branch offices.
    - ACLs are applied to control and restrict network traffic.
    - Natting

Configuration Steps

1. Basic Setup:

- Hostnames, banner messages, and encrypted passwords are configured on all routers and switches.

2. VLAN Configuration:

- VLANs are created for departments at both HQ and branch offices. Trunk and access ports are configured on switches.

3. Layer 3 VLANs and Routing:

- Layer 3 switches at both locations perform inter-VLAN routing.

4. OSPF Routing:

- Dynamic routing using OSPF is set up on routers and switches.

5. Eigrp Routing:

- Dynamic routing using OSPF is set up on routers and switches.

5. IPsec VPN:

- Configured on HQ and branch routers for secure communication.

Results and Testing

Testing Methodology:

- **Connectivity**: Ping tests between HQ and branch networks ensure proper routing.
- **VLAN Segmentation**: Each VLAN is tested to ensure isolation and proper inter-VLAN routing.
- **VPN Tunnel**: The IPsec VPN is tested using ping and traceroute commands.

Challenges and Learnings

1. **Challenges**:
    - Initial misconfiguration of OSPF networks caused route advertisement issues.
    - Troubleshooting IPsec VPN tunnels took additional time due to NAT traversal.
2. **Learnings**:
    - Gained proficiency in configuring advanced routing and VPN features.
    - Improved troubleshooting skills using Cisco debugging commands.

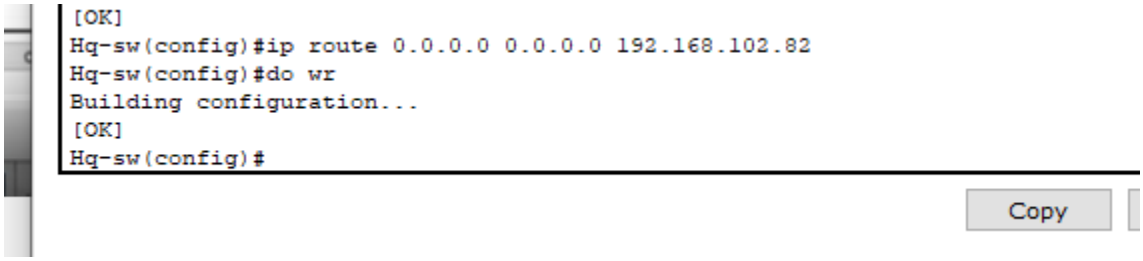
Conclusion

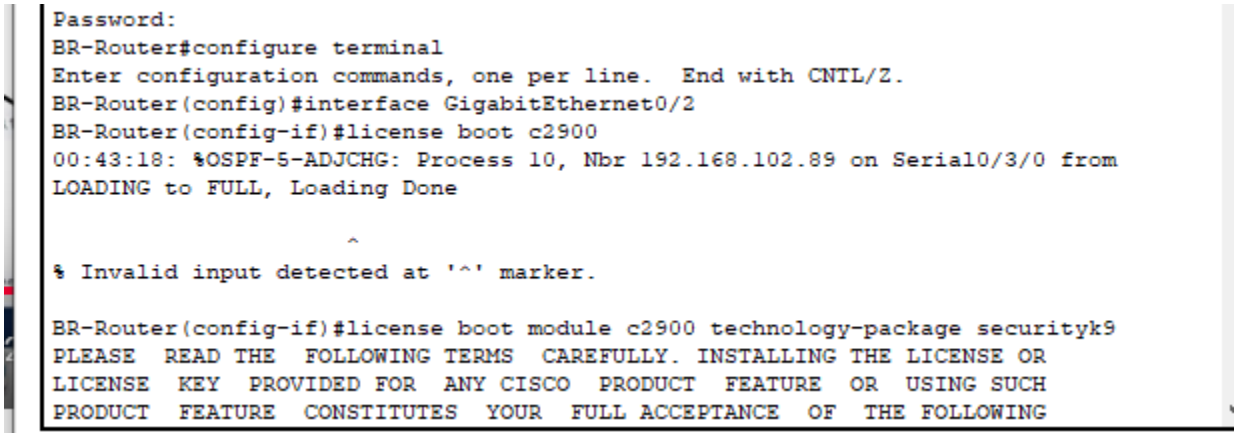
The project successfully achieved its objective of implementing a functional and secure office network topology. The HQ and branch networks communicate securely over an IPsec VPN, with robust VLAN segmentation and dynamic routing ensuring performance and scalability.

Future Recommendations:

- Implement advanced security mechanisms such as IDS/IPS.
- Use redundant links and high-availability protocols like HSRP for improved reliability.

Configuration Images





HQ-Router0

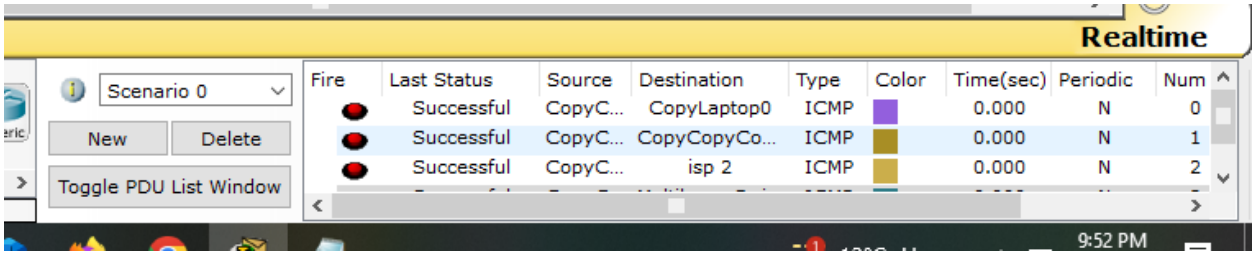
Physical | Config | CLI

IOS Command Line Interface

```
  1  Diffie-Hellman group 1
  2  Diffie-Hellman group 2
  5  Diffie-Hellman group 5
Hq-Router(config-isakmp)#group 5
Hq-Router(config-isakmp)#ex
Hq-Router(config)#crypto isakmp key ?
  WORD  The UNENCRYPTED (cleartext) user password
Hq-Router(config)#crypto isakmp key 123 address 192.168.102.90
Hq-Router(config)#do wr
Building configuration...
[OK]
Hq-Router(config)#crypto ipsec transform-set vpn-set esp-aes esp-share
                                                                    ^
% Invalid input detected at '^' marker.

Hq-Router(config)#crypto ipsec transform-set vpn-set esp-aes esp-sha-hmac
Hq-Router(config)#
Hq-Router(config)#
Hq-Router(config)#crypto map vpn-map 10 ipsec-isakmp
% NOTE: This new crypto map will remain disabled until a peer
        and a valid access list have been configured.
Hq-Router(config-crypto-map)#description this vpn connects to branch-network
Hq-Router(config-crypto-map)#set peer 192.168.102.90
Hq-Router(config-crypto-map)#set transform-set vpn-set
Hq-Router(config-crypto-map)#match address 110
Hq-Router(config-crypto-map)#ex
Hq-Router(config)#
Hq-Router(config)#interface Serial0/3/0
Hq-Router(config-if)#crypto map vpn-map
```

Copy | Paste



```
Hq-Router>enable
Password:
Hq-Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Hq-Router(config)#interface GigabitEthernet0/2
Hq-Router(config-if)#no ip address
Hq-Router(config-if)#
Hq-Router(config-if)#exit
Hq-Router(config)#interface GigabitEthernet0/2
Hq-Router(config-if)#interface GigabitEthernet0/2.70
Hq-Router(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/2.70, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2.70, changed
state to up

Hq-Router(config-subif)#encapsulation dot1Q 70
Hq-Router(config-subif)#ip address 192.168.102.65 255.255.255.240
Hq-Router(config-subif)#exit
Hq-Router(config)#do wr
Building configuration...
[OK]
Hq-Router(config)#
```

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```
[OK]
BR-Router(config)#ip nat inside source list 1 int se0/2/0 overload
BR-Router(config)#ip nat inside source list 1 int se0/3/1 overload
BR-Router(config)#do wr
Building configuration...
[OK]
BR-Router(config)#
BR-Router(config)#
BR-Router(config)#access-list 1 permit 192.168.101.128 0.0.0.31
BR-Router(config)#access-list 1 permit 192.168.101.160 0.0.0.31
BR-Router(config)#access-list 1 permit 192.168.101.192 0.0.0.31
BR-Router(config)#access-list 1 permit 192.168.101.224 0.0.0.31
BR-Router(config)#access-list 1 permit 192.168.102.0 0.0.0.31
BR-Router(config)#access-list 1 permit 192.168.102.32 0.0.0.31
BR-Router(config)#do wr
Building configuration...
[OK]
```

```
%SYS-5-CONFIG_I: Configured from console by console

Hq-sw#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Hq-sw(config)#int fa0/1
Hq-sw(config-if)#no switchport
Hq-sw(config-if)#ip address 192.168.102.81 255.255.255.252
Hq-sw(config-if)#exit
Hq-sw(config)#do wr
Building configuration...
[OK]
Hq-sw(config)#
```

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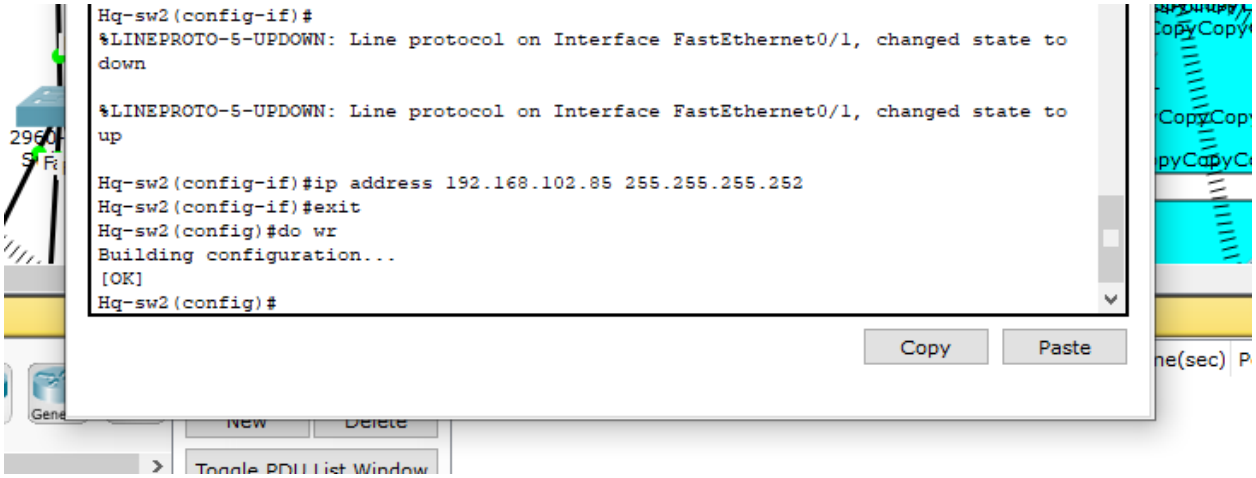
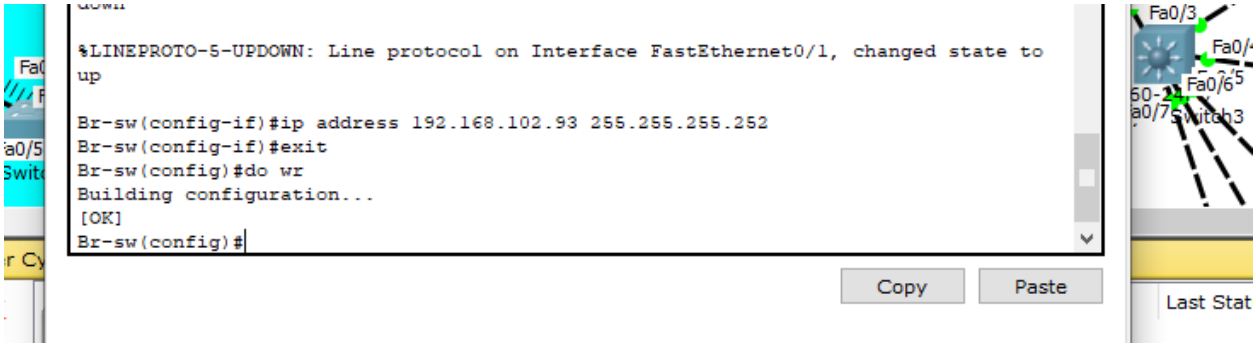
Toggle PDU List Window

Type Color


Hq-sw2(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
Hq-sw2(config-if)#ip address 192.168.102.85 255.255.255.252
Hq-sw2(config-if)#exit
Hq-sw2(config)#do wr
Building configuration...
[OK]
Hq-sw2(config)#
Copy
Paste


%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
Br-sw(config-if)#ip address 192.168.102.93 255.255.255.252
Br-sw(config-if)#exit
Br-sw(config)#do wr
Building configuration...
[OK]
Br-sw(config)#
Copy
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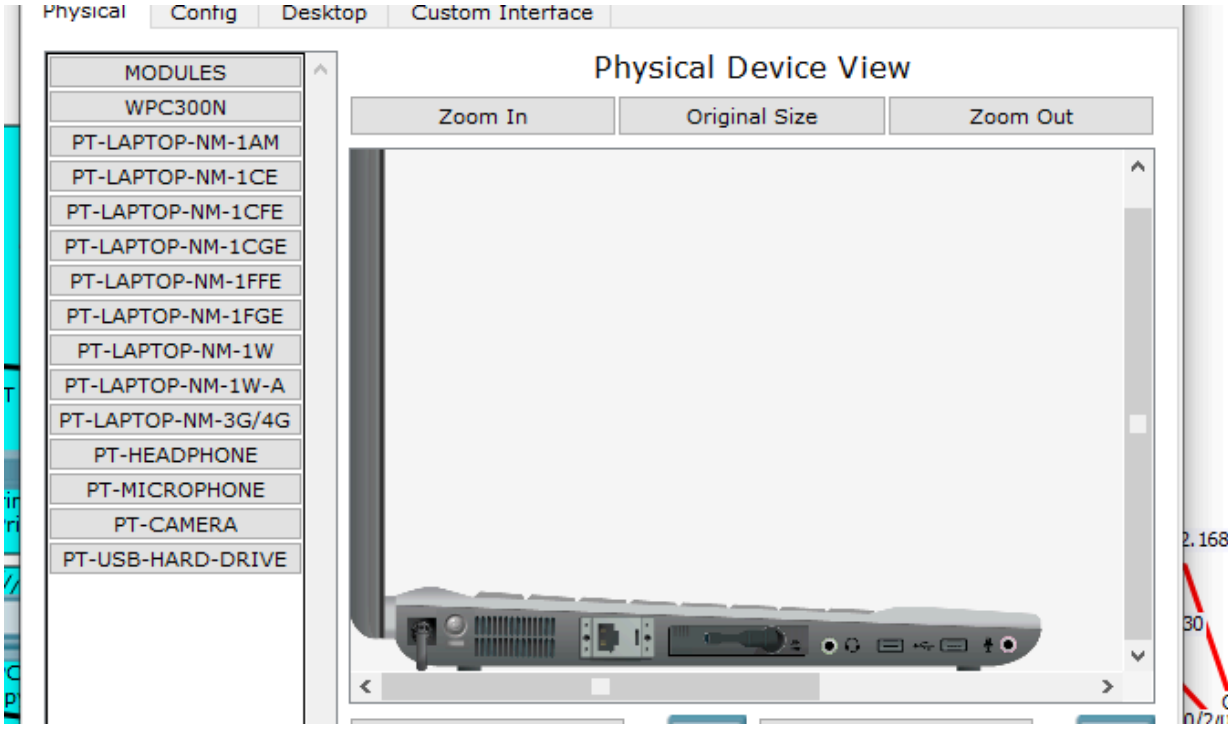
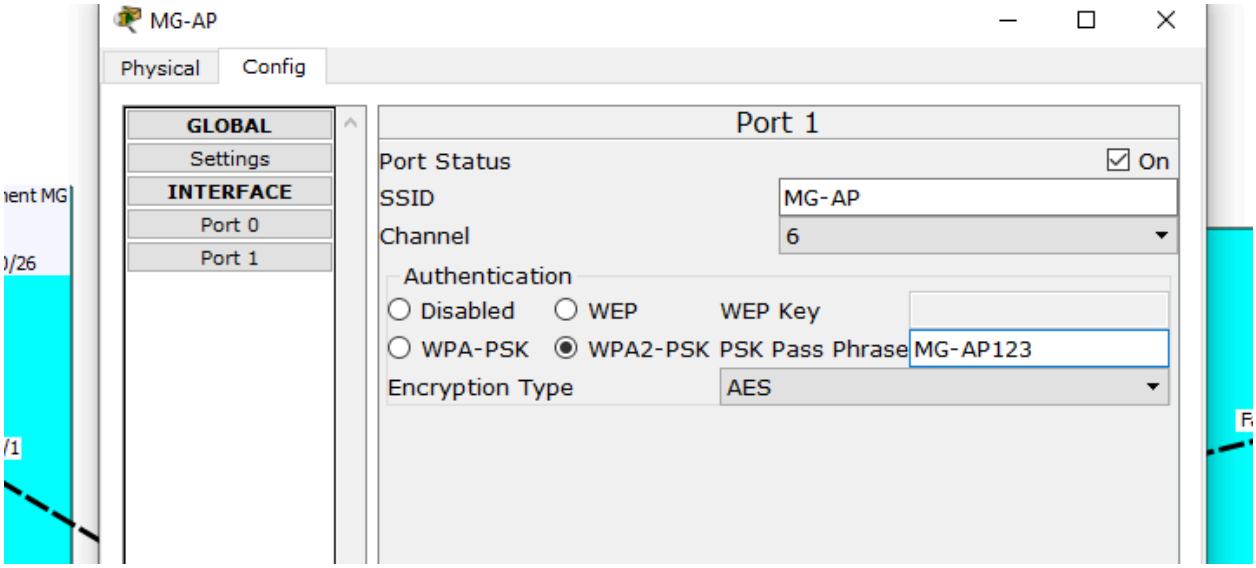

Physical
Config
Desktop
Custom Interface
MODULES
WPC300N
PT-LAPTOP-NM-1AM
PT-LAPTOP-NM-1CE
PT-LAPTOP-NM-1CFE
PT-LAPTOP-NM-1CGE
PT-LAPTOP-NM-1FFE
PT-LAPTOP-NM-1FGE
PT-LAPTOP-NM-1W
PT-LAPTOP-NM-1W-A
PT-LAPTOP-NM-3G/4G
PT-HEADPHONE
PT-MICROPHONE
PT-CAMERA
PT-USB-HARD-DRIVE
Physical Device View
Zoom In
Original Size
Zoom Out




```
Hq-Router(config-if)#
Hq-Router(config-if)#exit
Hq-Router(config)#interface Serial0/3/0
Hq-Router(config-if)#ex
Hq-Router(config)#int se0/2/0
Hq-Router(config-if)#ip nat outside
Hq-Router(config-if)#int se0/3/1
Hq-Router(config-if)#ip nat outside
Hq-Router(config-if)#ex
Hq-Router(config)#int range gig0/0-2
Hq-Router(config-if-range)#ip nat inside
Hq-Router(config-if-range)#ex
Hq-Router(config)#do wr
Building configuration...
[OK]
```

```
Hq-sw#cont t
Enter configuration commands, one per line.  End with CNTL/Z.
Hq-sw(config)#ip routing
Hq-sw(config)#router ospf 10
Hq-sw(config-router)#network 192.168.100.0 0.0.0.63 area
% Incomplete command.
Hq-sw(config-router)#network 192.168.100.0 0.0.0.63 area 0
Hq-sw(config-router)#network 192.168.100.64 0.0.0.63 area 0
Hq-sw(config-router)#network 192.168.100. 0.0.0.63 area 0
Hq-sw(config-router)#network 192.168.100.128 0.0.0.63 area 0
Hq-sw(config-router)#network 192.168.100.192 0.0.0.63 area 0
Hq-sw(config-router)#network 192.168.101.0 0.0.0.63 area 0
Hq-sw(config-router)#network 192.168.101.64 0.0.0.63 area 0
Hq-sw(config-router)#network 192.168.102.80 0.0.0.3 area 0
Hq-sw(config-router)#exit
Hq-sw(config)#do wr
Building configuration...
[OK]
Hq-sw(config)#
```

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```
Hq-sw2#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Hq-sw2(config)#interface FastEthernet0/3
Hq-sw2(config-if)#ex
Hq-sw2(config)#ip routing
Hq-sw2(config)#router ospf 10
Hq-sw2(config-router)#network 192.168.100.0 0.0.0.63 area 0
Hq-sw2(config-router)#network 192.168.100.64 0.0.0.63 area 0
Hq-sw2(config-router)#network 192.168.100.128 0.0.0.63 area 0
Hq-sw2(config-router)#network 192.168.100.192 0.0.0.63 area 0
Hq-sw2(config-router)#network 192.168.101.0 0.0.0.63 area 0
Hq-sw2(config-router)#network 192.168.101.64 0.0.0.63 area 0
Hq-sw2(config-router)#network 192.168.102.84 0.0.0.3 area 0
Hq-sw2(config-router)#
Hq-sw2(config-router)#exit
Hq-sw2(config)#
Hq-sw2(config)#ip route 0.0.0.0 0.0.0.0 192.168.102.86
Hq-sw2(config)#do wr
Building configuration...
[OK]
Hq-sw2(config)#
```

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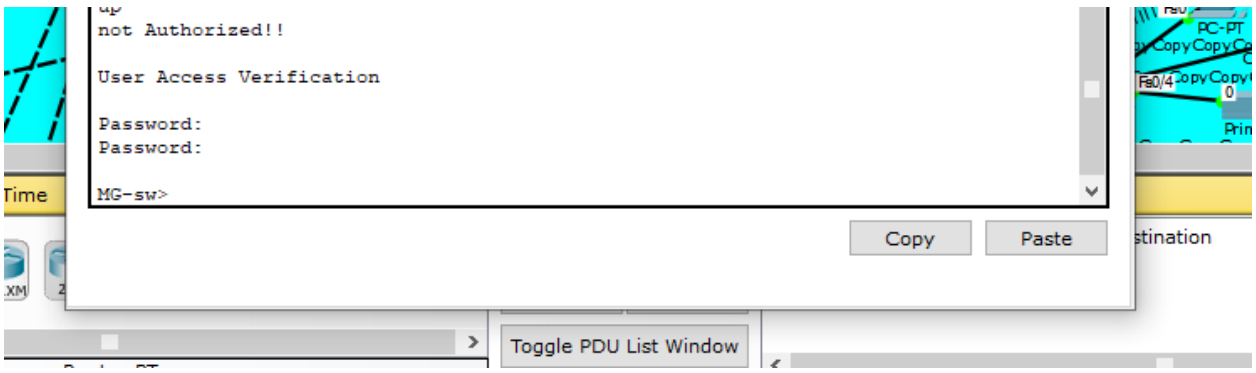
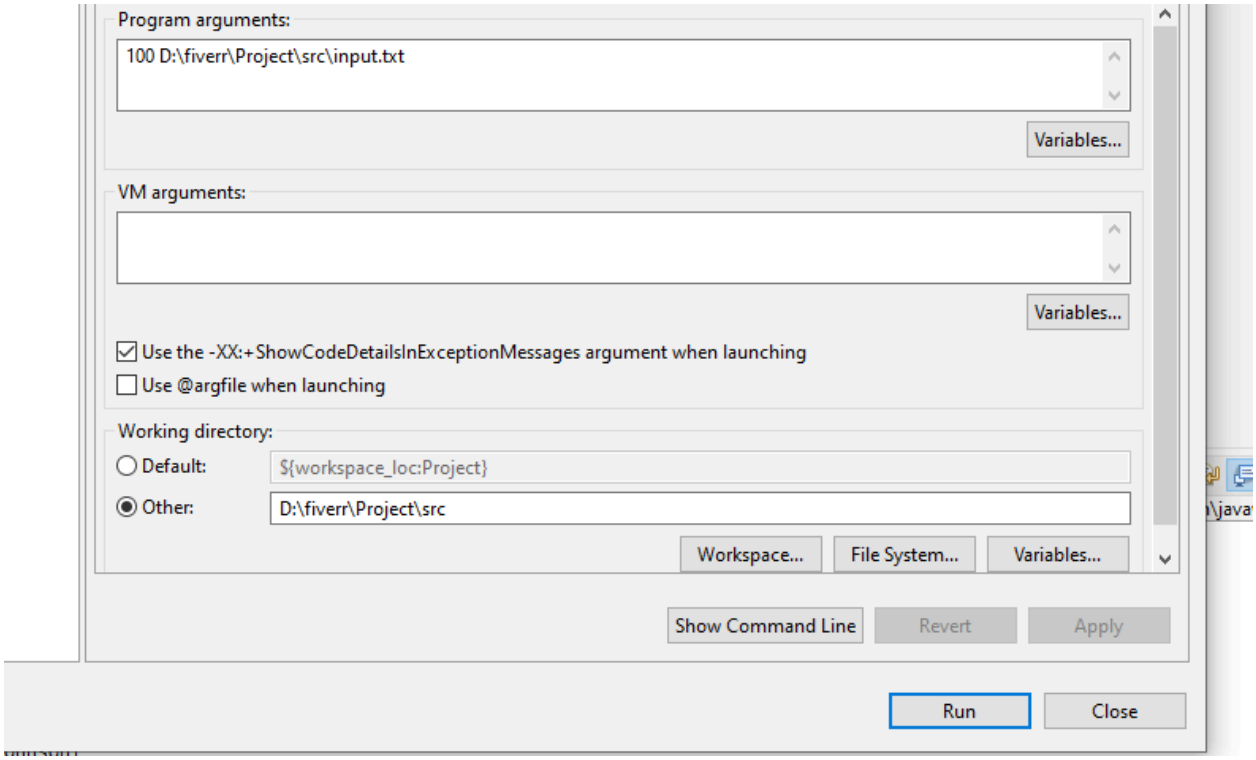
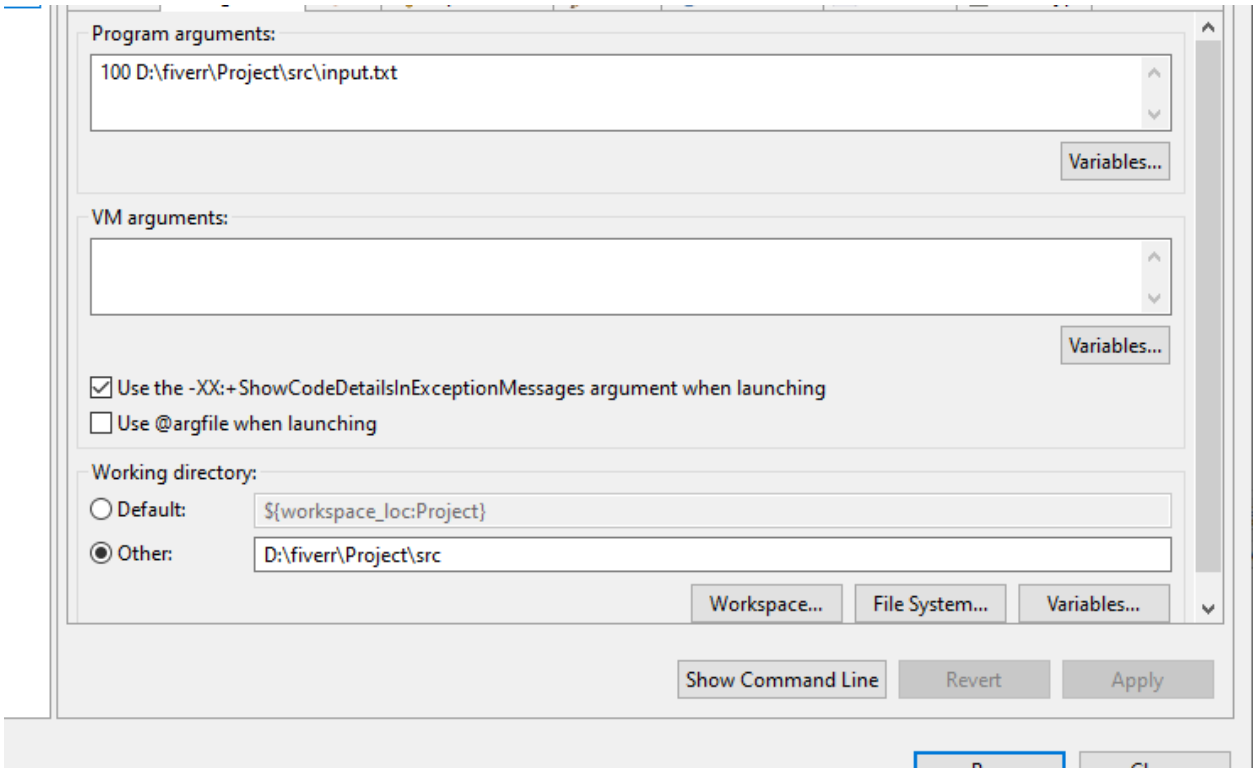
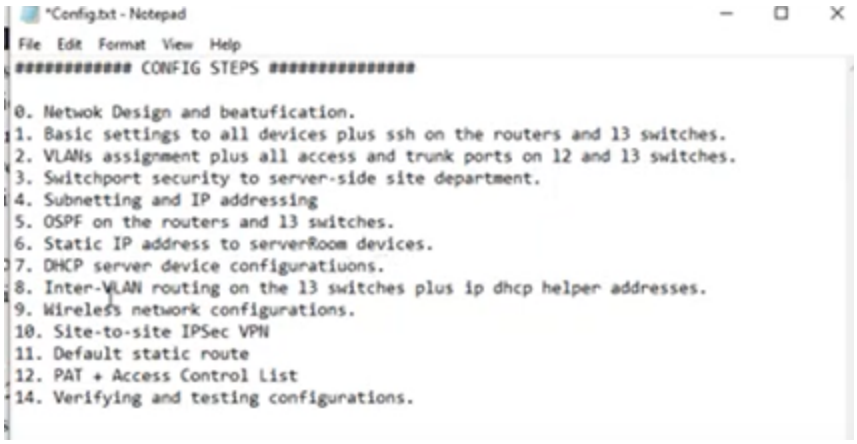



Program arguments:
100 D:\fiverr\Project\src\input.txt
Variables...
VM arguments:
Variables...
Use the -XX:+ShowCodeDetailsInExceptionMessages argument when launching
Use @argfile when launching
Working directory:
Default:
${workspace_loc:Project}
Other:
D:\fiverr\Project\src
Workspace...
File System...
Variables...
Show Command Line
Revert
Apply
Run
Close


Program arguments:
100 D:\fiverr\Project\src\input.txt
Variables...
VM arguments:
Variables...
Use the -XX:+ShowCodeDetailsInExceptionMessages argument when launching
Use @argfile when launching
Working directory:
Default:
${workspace_loc:Project}
Other:
D:\fiverr\Project\src
Workspace...
File System...
Variables...
Show Command Line
Revert
Apply




```
Hq-Router(config)#interface Serial0/2/0
Hq-Router(config-if)#ex
Hq-Router(config)#router ospf 10
Hq-Router(config-router)#network 192.168.102.80 0.0.0.3 area 0
Hq-Router(config-router)#network 192.168.102.84 0.0.0.3 area 0
Hq-Router(config-router)#network 192.168.102.88 0.0.0.3 area 0
Hq-Router(config-router)#network 192.168.102.64 0.0.0.15 area 0
Hq-Router(config-router)#network 192.168.17.4 0.0.0.3 area 0
Hq-Router(config-router)#network 192.168.17.0 0.0.0.3 area 0
Hq-Router(config-router)#
Hq-Router(config-router)#exit
Hq-Router(config)#
Hq-Router(config)#ip route 0.0.0.0 0.0.0.0 192.168.17.2
Hq-Router(config)#ip route 0.0.0.0 0.0.0.0 192.168.17.6 70
Hq-Router(config)#do wr
Building configuration...
[OK]
Hq-Router(config)#
```

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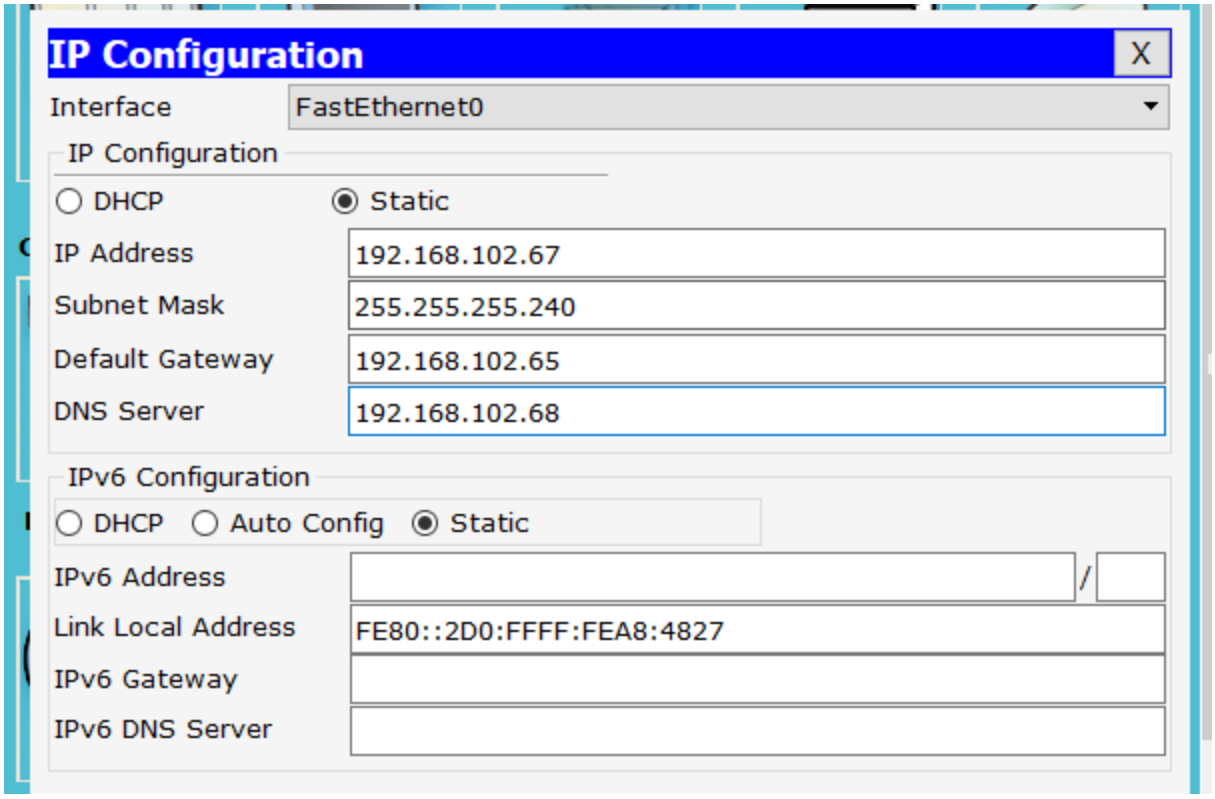
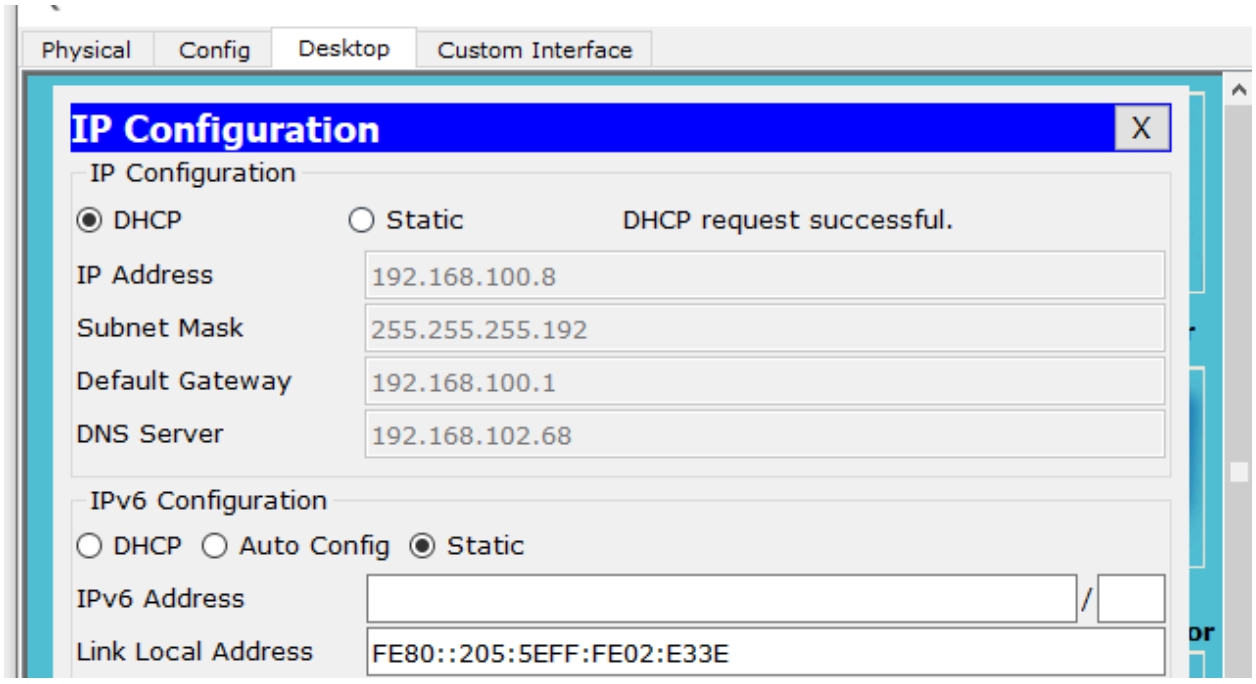
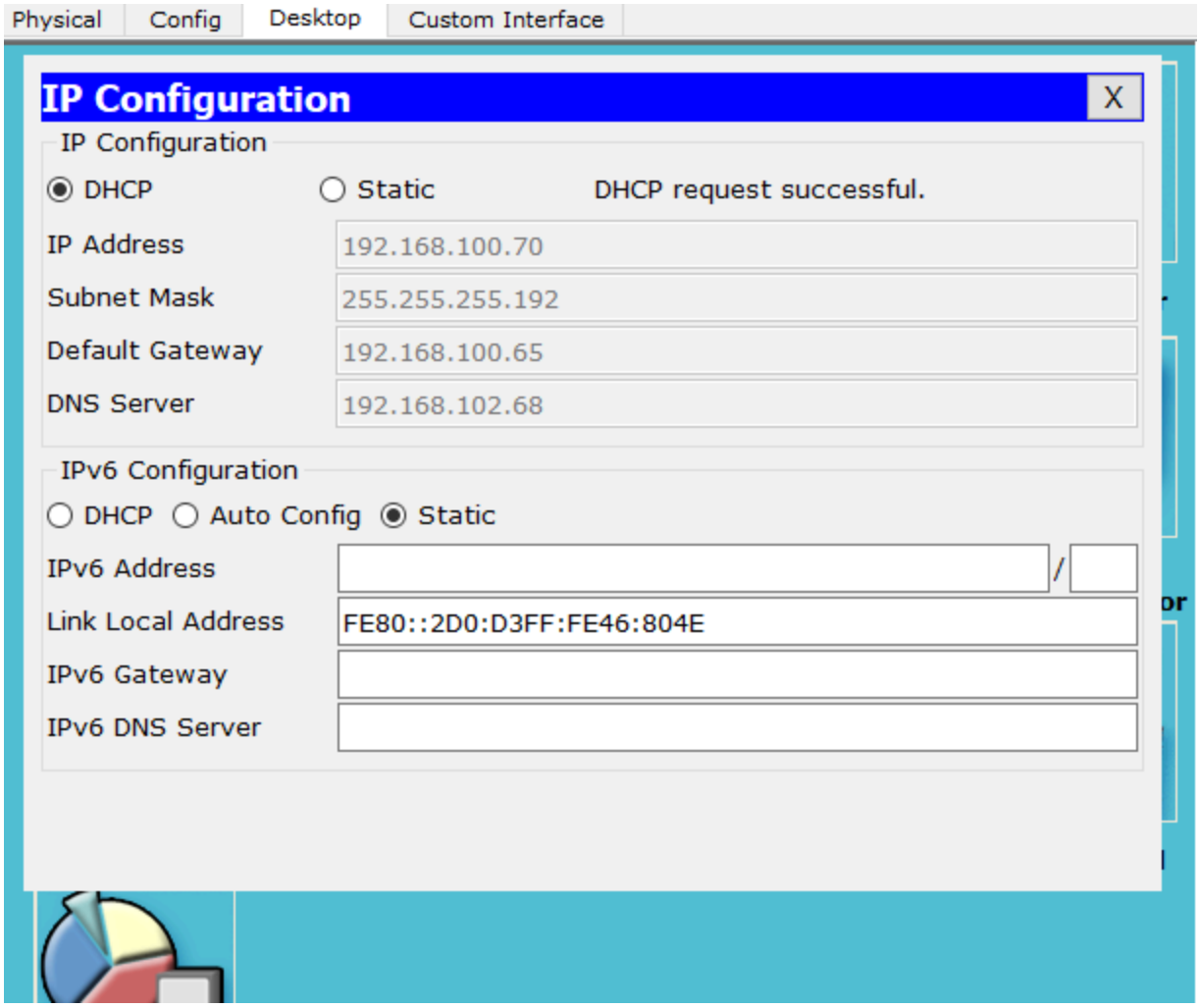
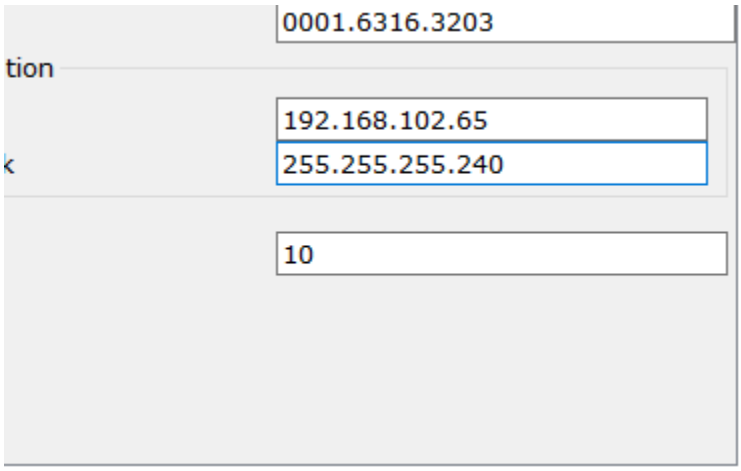
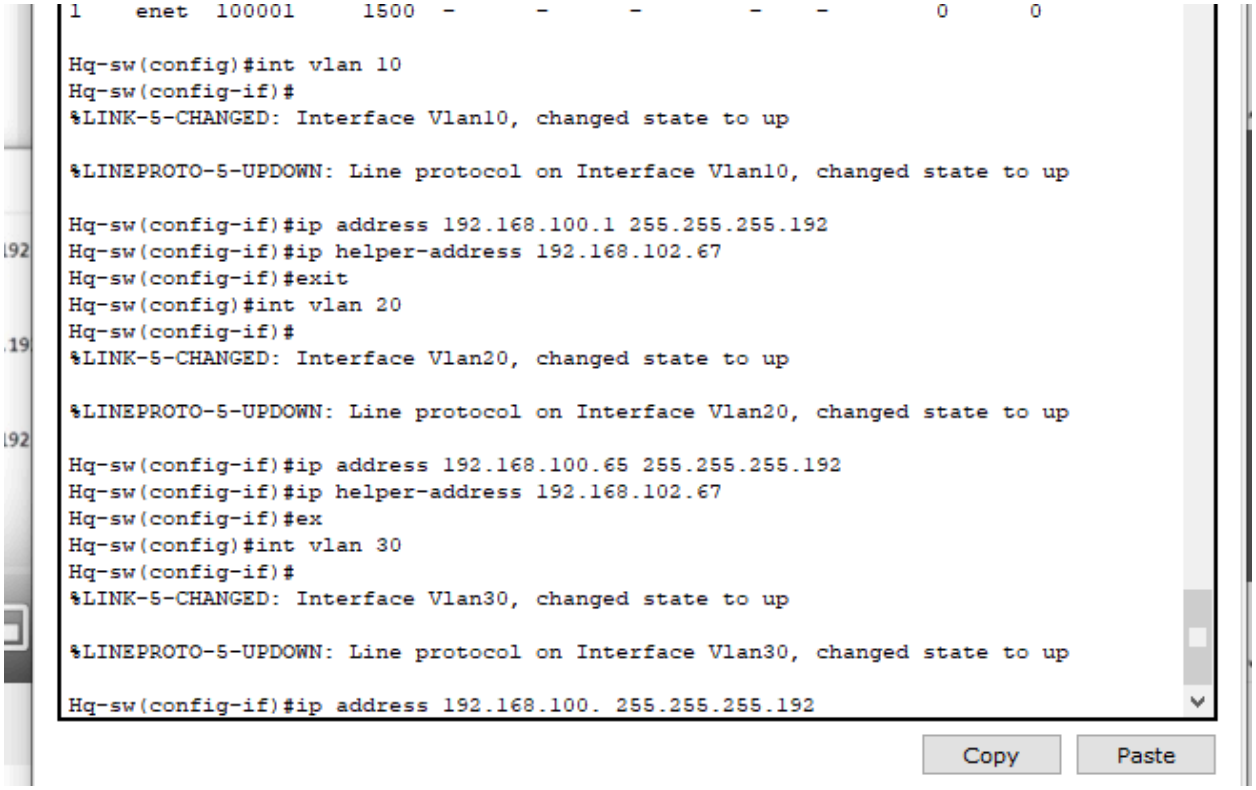

IP Configuration
X
Interface
FastEthernet0
IP Configuration
DHCP
Static
IP Address
192.168.102.67
Subnet Mask
255.255.255.240
Default Gateway
192.168.102.65
DNS Server
192.168.102.68
IPv6 Configuration
DHCP
Auto Config
Static
IPv6 Address
Link Local Address
FE80::2D0:FFFF:FEA8:4827
IPv6 Gateway
IPv6 DNS Server


Physical
Config
Desktop
Custom Interface
IP Configuration
X
IP Configuration
DHCP
Static
DHCP request successful.
IP Address
192.168.100.8
Subnet Mask
255.255.255.192
Default Gateway
192.168.100.1
DNS Server
192.168.102.68
IPv6 Configuration
DHCP
Auto Config
Static
IPv6 Address
Link Local Address
FE80::205:5EFF:FE02:E33E


Physical
Config
Desktop
Custom Interface
IP Configuration
X
IP Configuration
DHCP
Static
DHCP request successful.
IP Address
192.168.100.70
Subnet Mask
255.255.255.192
Default Gateway
192.168.100.65
DNS Server
192.168.102.68
IPv6 Configuration
DHCP
Auto Config
Static
IPv6 Address
Link Local Address
FE80::2D0:D3FF:FE46:804E
IPv6 Gateway
IPv6 DNS Server


0001.6316.3203
tion
192.168.102.65
255.255.255.240
10


Printer-PT
PC-PT
Printer-PT


1 enet 100001 1500 - - - - - 0 0
Hq-sw(config)#int vlan 10
Hq-sw(config-if)#
%LINK-5-CHANGED: Interface Vlan10, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan10, changed state to up
Hq-sw(config-if)#ip address 192.168.100.1 255.255.255.192
Hq-sw(config-if)#ip helper-address 192.168.102.67
Hq-sw(config-if)#exit
Hq-sw(config)#int vlan 20
Hq-sw(config-if)#
%LINK-5-CHANGED: Interface Vlan20, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan20, changed state to up
Hq-sw(config-if)#ip address 192.168.100.65 255.255.255.192
Hq-sw(config-if)#ip helper-address 192.168.102.67
Hq-sw(config-if)#ex
Hq-sw(config)#int vlan 30
Hq-sw(config-if)#
%LINK-5-CHANGED: Interface Vlan30, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan30, changed state to up
Hq-sw(config-if)#ip address 192.168.100. 255.255.255.192
Copy
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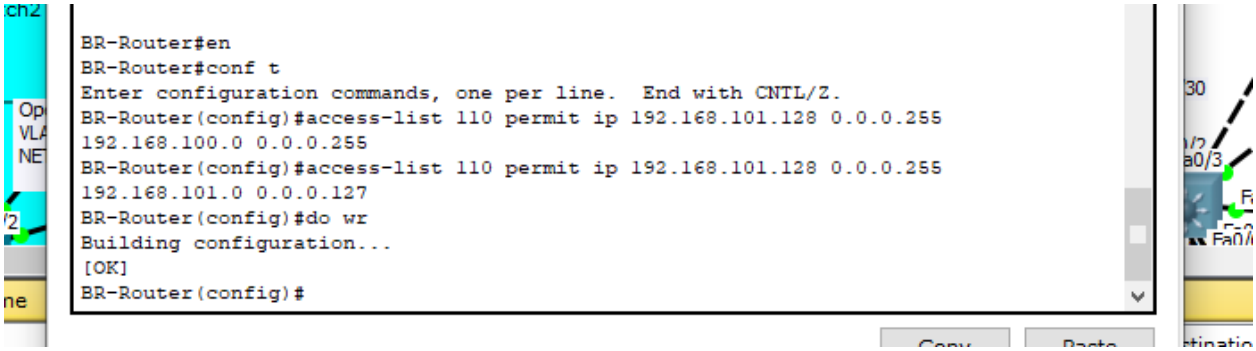
BR-Router#en
BR-Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
BR-Router(config)#access-list 110 permit ip 192.168.101.128 0.0.0.255
192.168.100.0 0.0.0.255
BR-Router(config)#access-list 110 permit ip 192.168.101.128 0.0.0.255
192.168.101.0 0.0.0.127
BR-Router(config)#do wr
Building configuration...
[OK]
BR-Router(config)#