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Internetworking

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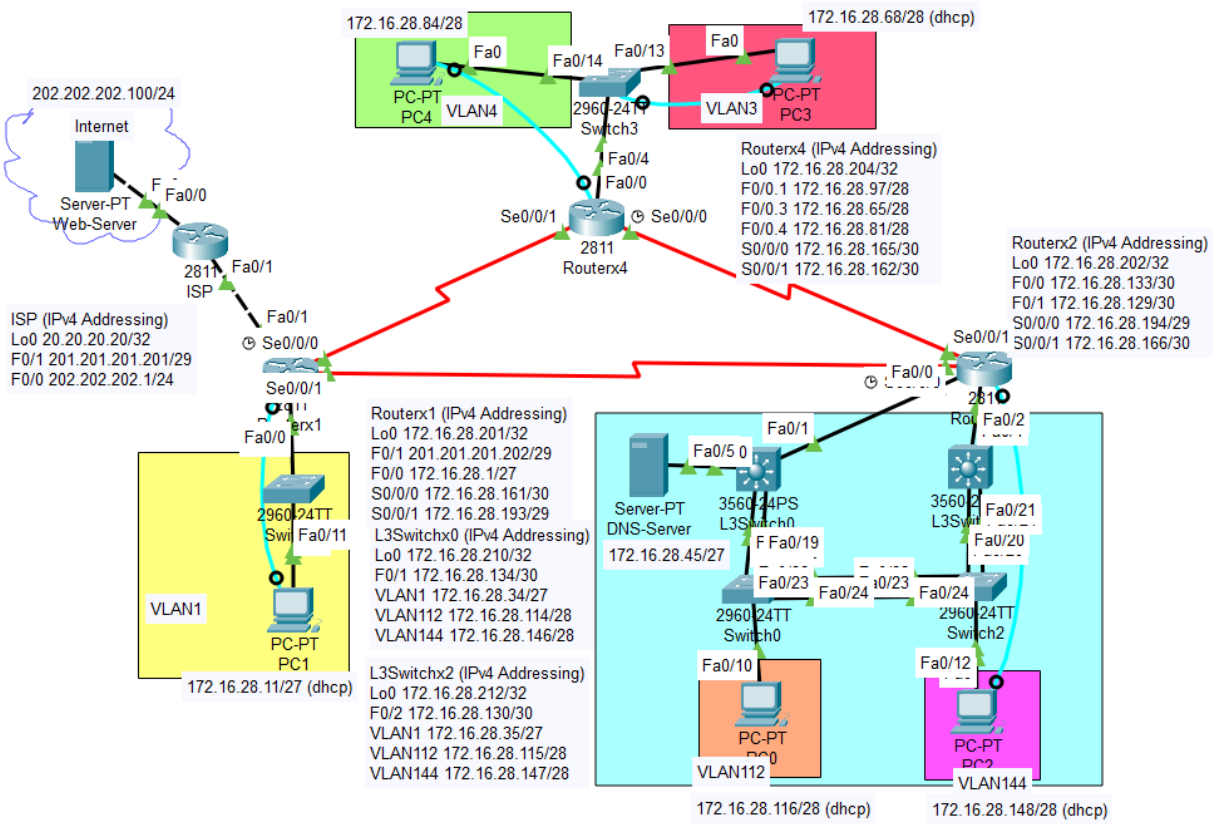
Final Challenge Lab

Description: In this lab, I utilized all of my networking skills to create a complex network.

Topology/Diagram:



Verifications (One Per Page) to follow.

VLANs:

Make sure all VLANs are created and named according to the network topology.
Configure each interface to belong to the appropriate VLAN.
Ensure that the appropriate mode of operation is set for each switch interface.

For the router-on-a-stick topology, we can see appropriate VLANs exist and interfaces are set:

```
Switchx3>sh vlan

VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
1    default                           active    Fa0/1, Fa0/2, Fa0/3, Fa0/5
                                                 Fa0/6, Fa0/7, Fa0/8, Fa0/9
                                                 Fa0/10, Fa0/11, Fa0/12, Fa0/15
                                                 Fa0/16, Fa0/17, Fa0/18, Fa0/19
                                                 Fa0/20, Fa0/21, Fa0/22, Fa0/23
                                                 Fa0/24, Gig0/1, Gig0/2
3    RED                               active    Fa0/13
4    GREEN                             active    Fa0/14
```

For the multilayer switched network:
The VLANs are created and set to interfaces as well as learned using VTP

```
112  ORANGE                              active    Fa0/10

144  PURPLE                               active    Fa0/12
------- --------- ----------------- ----------------------------------------
L3Switch0>sh vtp status
VTP Version capable             : 1 to 2
VTP version running             : 1
VTP Domain Name                 : CHALLENGE
VTP Pruning Mode                : Disabled
VTP Traps Generation            : Disabled
Device ID                       : 0004.9A05.9290
Configuration last modified by 172.16.28.35 at 3-1-93 00:04:14
Local updater ID is 172.16.28.34 on interface Vl1 (lowest numbered VLAN interface

Feature VLAN :
--------------
VTP Operating Mode                : Server
Maximum VLANs supported locally   : 1005
Number of existing VLANs          : 7
Configuration Revision            : 24
MD5 digest                        : 0x01 0x4F 0x0A 0x7A 0x52 0xC4 0x82 0xD8
                                    0xD6 0xF5 0x6F 0x75 0xA0 0x35 0xA8 0xDA
```

.

Etherchannel:

Configure link aggregation between the appropriate switches using the interfaces shown in the topology diagram.
Both sides should be unconditionally set using a standardized, non-proprietary protocol.
When this is correctly configured, all VLANs should be able to traverse this EtherChannel.

We can see the etherchannels are set up and consist of the right interfaces as well as use LACP: (Switch 2 as an example)

```
Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------

3      Po3(SU)            LACP    Fa0/20(P)  Fa0/21(P)
4      Po4(SU)            LACP    Fa0/23(P)  Fa0/24(P)
```

PC0 can ping the DNS server (this means the information passed safely through an etherchannel)

```
C:\>ping 172.16.28.45

Pinging 172.16.28.45 with 32 bytes of data:

Reply from 172.16.28.45: bytes=32 time<1ms TTL=127
Reply from 172.16.28.45: bytes=32 time=1ms TTL=127
Reply from 172.16.28.45: bytes=32 time<1ms TTL=127
Reply from 172.16.28.45: bytes=32 time<1ms TTL=127

Ping statistics for 172.16.28.45:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

If we shut down one of the interfaces that exists within the EtherChannel, the ping still functions, thus the other interfaces load balance:

```
C:\>ping 172.16.28.45

Pinging 172.16.28.45 with 32 bytes of data:

Reply from 172.16.28.45: bytes=32 time<1ms TTL=127
Reply from 172.16.28.45: bytes=32 time=1ms TTL=127
Reply from 172.16.28.45: bytes=32 time<1ms TTL=127
Reply from 172.16.28.45: bytes=32 time<1ms TTL=127

Ping statistics for 172.16.28.45:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

InterVLAN Routing with a Router-on-a-Stick:

We can see our “Router-on-a-Stick” has the right subinterfaces for our VLANs (1,3,4).

```
Routerx4#sh ip int bri
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/0        unassigned      YES unset  up                    up
FastEthernet0/0.1      172.16.28.97    YES manual up                    up
FastEthernet0/0.3      172.16.28.65    YES manual up                    up
FastEthernet0/0.4      172.16.28.81    YES manual up                    up
```

These subinterfaces are functional, and PC4 (VLAN4) can ping to PC3 (VLAN3)

```
C:\>ping 172.16.28.68

Pinging 172.16.28.68 with 32 bytes of data:

Reply from 172.16.28.68: bytes=32 time<1ms TTL=127
Reply from 172.16.28.68: bytes=32 time=17ms TTL=127
Reply from 172.16.28.68: bytes=32 time<1ms TTL=127
Reply from 172.16.28.68: bytes=32 time<1ms TTL=127

Ping statistics for 172.16.28.68:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 17ms, Average = 4ms
```

InterVLAN traffic is allowed to pass to and from the router via a trunking interface.

```
Switchx3>sh int trunk
Port        Mode         Encapsulation  Status        Native vlan
Fa0/4       on           802.1q         trunking      1

Port        Vlans allowed on trunk
Fa0/4       1,3-4
```

InterVLAN Routing with SVIs:

The VLANs are configured (From a sh ip int bri command):

```
Vlan1                  172.16.28.34    YES manual up                    up
Vlan112                172.16.28.114   YES manual up                    up
Vlan144                172.16.28.146   YES manual up                    up
```

We can see the VLANs in the layer 3 switch's routing table:

```
     172.16.0.0/16 is variably subnetted, 12 subnets, 5 masks
O       172.16.28.0/27 [110/130] via 172.16.28.133, 00:21:45, FastEthernet0/1
C       172.16.28.32/27 is directly connected, Vlan1
O       172.16.28.64/28 [110/66] via 172.16.28.133, 00:21:45, FastEthernet0/1
O       172.16.28.80/28 [110/66] via 172.16.28.133, 00:21:45, FastEthernet0/1
C       172.16.28.112/28 is directly connected, Vlan112
O       172.16.28.128/30 [110/2] via 172.16.28.115, 00:21:45, Vlan112
                         [110/2] via 172.16.28.147, 00:21:45, Vlan144
                         [110/2] via 172.16.28.133, 00:21:45, FastEthernet0/1
C       172.16.28.132/30 is directly connected, FastEthernet0/1
C       172.16.28.144/28 is directly connected, Vlan144
```

Connectivity between the VLANs is functional (test point: PC0)

```
C:\>ping 172.16.28.45

Pinging 172.16.28.45 with 32 bytes of data:

Reply from 172.16.28.45: bytes=32 time<1ms TTL=127
Reply from 172.16.28.45: bytes=32 time<1ms TTL=127
Reply from 172.16.28.45: bytes=32 time=15ms TTL=127
Reply from 172.16.28.45: bytes=32 time=11ms TTL=127

Ping statistics for 172.16.28.45:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 15ms, Average = 6ms
```

```
C:\>ping 172.16.28.148

Pinging 172.16.28.148 with 32 bytes of data:

Reply from 172.16.28.148: bytes=32 time<1ms TTL=127
Reply from 172.16.28.148: bytes=32 time=13ms TTL=127
Reply from 172.16.28.148: bytes=32 time=71ms TTL=127
Reply from 172.16.28.148: bytes=32 time=25ms TTL=127

Ping statistics for 172.16.28.148:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 71ms, Average = 27ms
```

Default Static Routing and Default Route Injection:

We can see that Routerx1 has all needed routes (learned from ospf) and has a default static route to the internet:

```
Routerx1>sh ip route | ex L
       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
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 201.201.201.201 to network 0.0.0.0

     172.16.0.0/16 is variably subnetted, 15 subnets, 5 masks
C       172.16.28.0/27 is directly connected, FastEthernet0/0
O       172.16.28.32/27 [110/130] via 172.16.28.162, 00:11:33, Serial0/0/0
O       172.16.28.64/28 [110/65] via 172.16.28.162, 00:11:33, Serial0/0/0
O       172.16.28.80/28 [110/65] via 172.16.28.162, 00:11:33, Serial0/0/0
O       172.16.28.112/28 [110/130] via 172.16.28.162, 00:11:33, Serial0/0/0
O       172.16.28.128/30 [110/129] via 172.16.28.162, 00:11:33, Serial0/0/0
O       172.16.28.132/30 [110/129] via 172.16.28.162, 00:11:33, Serial0/0/0
O       172.16.28.144/28 [110/130] via 172.16.28.162, 00:11:33, Serial0/0/0
C       172.16.28.160/30 is directly connected, Serial0/0/0
O       172.16.28.164/30 [110/128] via 172.16.28.162, 00:11:33, Serial0/0/0
C       172.16.28.192/29 is directly connected, Serial0/0/1
     201.201.201.0/24 is variably subnetted, 2 subnets, 2 masks
C       201.201.201.200/29 is directly connected, FastEthernet0/1
S*   0.0.0.0/0 [1/0] via 201.201.201.201
```

We can see that this default route is distributed via OSPF to other routers:

```
Routerx4>sh ip route | section O
       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
       * - candidate default, U - per-user static route, o - ODR
O       172.16.28.0/27 [110/65] via 172.16.28.161, 00:12:08, Serial0/0/1
O       172.16.28.32/27 [110/66] via 172.16.28.166, 00:12:08, Serial0/0/0
O       172.16.28.112/28 [110/66] via 172.16.28.166, 00:12:08, Serial0/0/0
O       172.16.28.128/30 [110/65] via 172.16.28.166, 00:12:08, Serial0/0/0
O       172.16.28.132/30 [110/65] via 172.16.28.166, 00:12:08, Serial0/0/0
O       172.16.28.144/28 [110/66] via 172.16.28.166, 00:12:08, Serial0/0/0
O       172.16.28.192/29 [110/128] via 172.16.28.161, 00:12:08, Serial0/0/1
O*E2 0.0.0.0/0 [110/1] via 172.16.28.161, 00:12:08, Serial0/0/1
```

We can see that this route is functional, and distant PCs can reach the internet:
From PC2 on the multilayer switch network:

```
C:\>ping 202.202.202.100

Pinging 202.202.202.100 with 32 bytes of data:

Reply from 202.202.202.100: bytes=32 time=2ms TTL=123
Reply from 202.202.202.100: bytes=32 time=2ms TTL=123
Reply from 202.202.202.100: bytes=32 time=13ms TTL=123
Reply from 202.202.202.100: bytes=32 time=11ms TTL=123

Ping statistics for 202.202.202.100:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum = 13ms, Average = 7ms
```

Dynamic Routing:

The ISP does not have dynamic routing:

```
ISP>sh ip route | ex L
       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
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 201.201.201.202 to network 0.0.0.0

     20.0.0.0/32 is subnetted, 1 subnets
     201.201.201.0/24 is variably subnetted, 2 subnets, 2 masks
C       201.201.201.200/29 is directly connected, FastEthernet0/1
     202.202.202.0/24 is variably subnetted, 2 subnets, 2 masks
C       202.202.202.0/24 is directly connected, FastEthernet0/0
S*   0.0.0.0/0 [1/0] via 201.201.201.202
```

Edge routers have all the needed learned routes:

```
Routerx1>sh ip route | ex L
       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
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 201.201.201.201 to network 0.0.0.0

     172.16.0.0/16 is variably subnetted, 15 subnets, 5 masks
C       172.16.28.0/27 is directly connected, FastEthernet0/0
O       172.16.28.32/27 [110/130] via 172.16.28.162, 00:11:33, Serial0/0/0
O       172.16.28.64/28 [110/65] via 172.16.28.162, 00:11:33, Serial0/0/0
O       172.16.28.80/28 [110/65] via 172.16.28.162, 00:11:33, Serial0/0/0
O       172.16.28.112/28 [110/130] via 172.16.28.162, 00:11:33, Serial0/0/0
O       172.16.28.128/30 [110/129] via 172.16.28.162, 00:11:33, Serial0/0/0
O       172.16.28.132/30 [110/129] via 172.16.28.162, 00:11:33, Serial0/0/0
O       172.16.28.144/28 [110/130] via 172.16.28.162, 00:11:33, Serial0/0/0
C       172.16.28.160/30 is directly connected, Serial0/0/0
O       172.16.28.164/30 [110/128] via 172.16.28.162, 00:11:33, Serial0/0/0
C       172.16.28.192/29 is directly connected, Serial0/0/1
     201.201.201.0/24 is variably subnetted, 2 subnets, 2 masks
C       201.201.201.200/29 is directly connected, FastEthernet0/1
S*   0.0.0.0/0 [1/0] via 201.201.201.201
```

The layer 3 switches have OSPF implemented:

```
L3Switch0#sh ip route | ex L
Codes: C - connected, S - static, I - IGRP, 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
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 172.16.28.133 to network 0.0.0.0

     172.16.0.0/16 is variably subnetted, 12 subnets, 5 masks
O       172.16.28.0/27 [110/130] via 172.16.28.133, 03:27:13, FastEthernet0/1
C       172.16.28.32/27 is directly connected, Vlan1
O       172.16.28.64/28 [110/66] via 172.16.28.133, 11:53:11, FastEthernet0/1
O       172.16.28.80/28 [110/66] via 172.16.28.133, 11:53:11, FastEthernet0/1
C       172.16.28.112/28 is directly connected, Vlan112
O       172.16.28.128/30 [110/2] via 172.16.28.133, 00:16:34, FastEthernet0/1
                         [110/2] via 172.16.28.115, 00:16:34, Vlan112
                         [110/2] via 172.16.28.147, 00:16:34, Vlan144
C       172.16.28.132/30 is directly connected, FastEthernet0/1
C       172.16.28.144/28 is directly connected, Vlan144
O       172.16.28.160/30 [110/129] via 172.16.28.133, 11:53:11, FastEthernet0/1
O       172.16.28.164/30 [110/65] via 172.16.28.133, 11:53:11, FastEthernet0/1
O       172.16.28.192/29 [110/193] via 172.16.28.133, 03:27:13, FastEthernet0/1
O*E2 0.0.0.0/0 [110/1] via 172.16.28.133, 03:27:13, FastEthernet0/1
```

PCs can ping to other networks (example is PC2 to PC1)

```
C:\>ping 172.16.28.11

Pinging 172.16.28.11 with 32 bytes of data:

Reply from 172.16.28.11: bytes=32 time=27ms TTL=124
Reply from 172.16.28.11: bytes=32 time=12ms TTL=124
Reply from 172.16.28.11: bytes=32 time=12ms TTL=124
Reply from 172.16.28.11: bytes=32 time=11ms TTL=124

Ping statistics for 172.16.28.11:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 11ms, Maximum = 27ms, Average = 15ms
```

Access Control Lists:

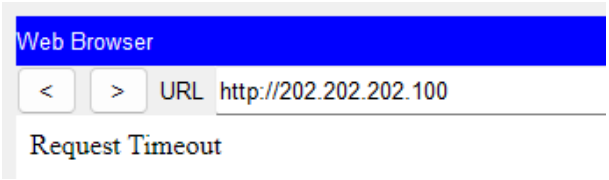
Verify the Web-Server has the HTTP Service configured and operating correctly.
Deny HTTP access from PCx1 access to the Web-Server.
Allow all other traffic from any host to traverse this interface.

The ACL is configured on the edge router for the network (Routerx1):

```
Extended IP access list BLOCK-PC1-HTTP
    10 deny tcp host 172.16.28.11 host 202.202.202.100 eq www (12 match(es))
    20 permit ip any any (9 match(es))
```

PC2 can access the web server:

PC1 cannot:



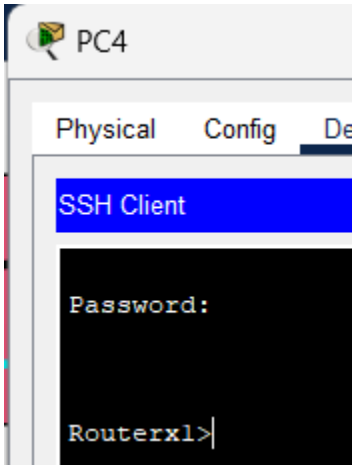
PC1 can still ping the web server however, since we only blocked HTTP:

```
C:\>ping 202.202.202.100

Pinging 202.202.202.100 with 32 bytes of data:

Reply from 202.202.202.100: bytes=32 time=23ms TTL=123
Reply from 202.202.202.100: bytes=32 time=11ms TTL=123
Reply from 202.202.202.100: bytes=32 time=12ms TTL=123
Reply from 202.202.202.100: bytes=32 time=30ms TTL=123

Ping statistics for 202.202.202.100:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 11ms, Maximum = 30ms, Average = 19ms
```

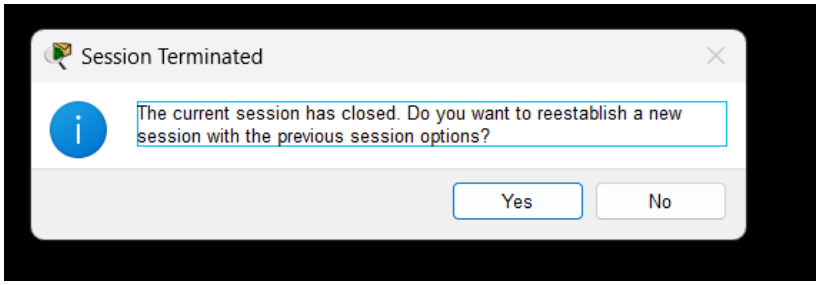
SSH:

Enable SSH on all devices, ensure PCx4 is the only PC allowed to access all devices via SSH. Telnet should not be allowed.

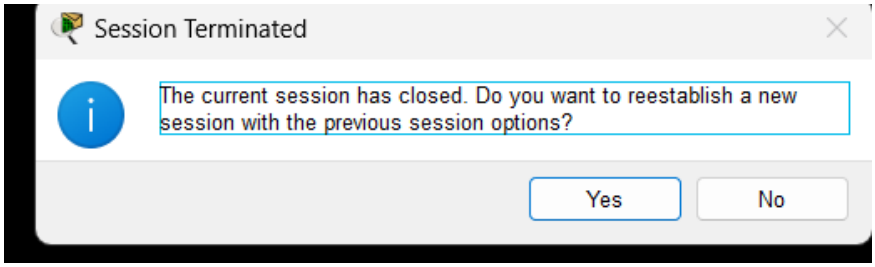
PC4 can SSH into every network device:



Other PCs do not have this privilege:



No PC can telnet:



DHCP:

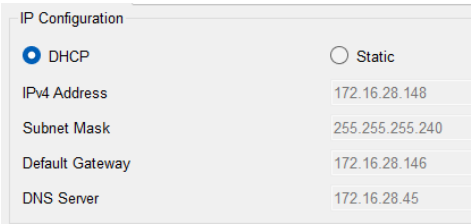
Configure the DHCP server for the appropriate networks according to the network topology.
Ensure the relay agent is in place, if required.
The IP Address range should begin with the IP Address specified on the specific device, such as a PC.
The gateway should be set to the first available address within the appropriate range.
Make sure a DNS server and DNS suffix is specified within every DHCP scope configured.

IPs are being distributed:

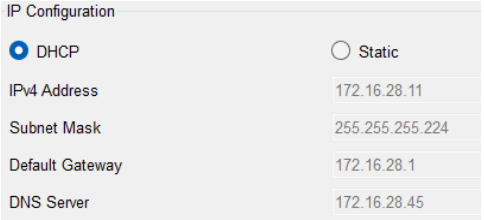
```
Routerx4#sh ip dhcp binding
IP address       Client-ID/              Lease expiration        Type
                 Hardware address
172.16.28.68     0010.11C1.D0A7           --                     Automatic
172.16.28.11     000C.CF34.4EBA           --                     Automatic
```

```
L3Switch2>sh ip dhcp binding
IP address       Client-ID/              Lease expiration        Type
                 Hardware address
172.16.28.116    0001.430D.0A11           --                     Automatic
172.16.28.148    0000.0C75.D972           --                     Automatic
```

The PC clients are receiving the correct information for their pool:



Routerx1 has a helper address so PC1 can obtain an address:




```
Routerx1#sh ip int f0/0
FastEthernet0/0 is up, line protocol is up (connected)
  Internet address is 172.16.28.1/27
  Broadcast address is 255.255.255.255
  Address determined by setup command
  MTU is 1500 bytes
  Helper address is 172.16.28.162
```

NAT/PAT:

Configure dynamic NAT with PAT using a pool of four public IP Addresses on the router that has both RFC1918 Addressing as well as public IP Addressing.
Make sure you are only allowing the subnets used throughout the entire network topology to be translated to the public IP Address range. Nothing more!

We can see only the subnets used on the network are allowed:

```
Routerx1#sh access-list
Standard IP access list 25
    10 permit 172.16.28.0 0.0.0.31 (8 match(es))
    20 permit 172.16.28.64 0.0.0.15 (8 match(es))
    30 permit 172.16.28.80 0.0.0.15 (8 match(es))
    40 permit 172.16.28.32 0.0.0.31 (8 match(es))
    50 permit 172.16.28.112 0.0.0.15 (8 match(es))
    60 permit 172.16.28.144 0.0.0.15 (26 match(es))
    70 deny any
```

We can see the pool has only 4 addresses:

```
Routerx1#sh ip nat stat
Total translations: 13 (0 static, 13 dynamic, 13 extended)
Outside Interfaces: FastEthernet0/1
Inside Interfaces: FastEthernet0/0 , Serial0/0/0 , Serial0/0/1
Hits: 35  Misses: 33
Expired translations: 20
Dynamic mappings:
-- Inside Source
access-list 25 pool PUBLIC-NAT-POOL refCount 13
 pool PUBLIC-NAT-POOL: netmask 255.255.255.240
       start 195.168.5.1 end 195.168.5.4
       type generic, total addresses 4 , allocated 0 (0%), misses 0
```

We can see NAT & PAT are working as devices connect to the internet:

```
       type generic, total addresses 4 , allocated 0 (0%), misses 0
Routerx1#sh ip nat trans
Pro  Inside global     Inside local       Outside local      Outside global
icmp 195.168.5.1:5     172.16.28.45:5     202.202.202.100:5  202.202.202.100:5
icmp 195.168.5.1:6     172.16.28.45:6     202.202.202.100:6  202.202.202.100:6
icmp 195.168.5.1:7     172.16.28.45:7     202.202.202.100:7  202.202.202.100:7
icmp 195.168.5.1:8     172.16.28.45:8     202.202.202.100:8  202.202.202.100:8
tcp 195.168.5.1:1025   172.16.28.148:1025 202.202.202.100:80 202.202.202.100:80
```

HSRP:

L3Switchx0 should be the Active Path for VLAN1 and VLAN112 while L3Switchx2 should be the Active Path for VLAN144 (both L3Switches should backup the other in case of a failure). The first available IP Address should be used as the Virtual IP Address (VIP) for each VLAN HSRP is configured for.

We can see L3Switchx0 is the active path for VLANs 1 & 112 and the IPs are correct:

```
L3Switch0#sh standby bri
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State    Active          Standby         Virtual IP
Vl1         1    150 P Active   local           172.16.28.35    172.16.28.33
Vl112       112  150 P Active   local           172.16.28.115   172.16.28.113
Vl144       144  105 P Standby  172.16.28.147   local           172.16.28.145
```

We can see L3Switchx2 is the active path for VLAN 144 and the IPs are correct:

```
L3Switch2#sh standby bri
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State    Active          Standby         Virtual IP
Vl1         1    105 P Standby  172.16.28.34    local           172.16.28.33
Vl112       112  105 P Standby  172.16.28.114   local           172.16.28.113
Vl144       144  150 P Active   local           172.16.28.146   172.16.28.145
```

We can see that HSRP is functioning by bringing down interfaces on L3Switchx0:

```
L3Switch2#
%HSRP-6-STATECHANGE: Vlan1 Grp 1 state Standby -> Active

%HSRP-6-STATECHANGE: Vlan112 Grp 112 state Standby -> Active
sh standby bri
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State    Active          Standby         Virtual IP
Vl1         1    105 P Active   local           unknown         172.16.28.33
Vl112       112  105 P Active   local           unknown         172.16.28.113
Vl144       144  150 P Active   local           172.16.28.146   172.16.28.145
```

Thanks for a great semester, you have kindled my interest in networking and I can't wait to start my job and see you in internet security!