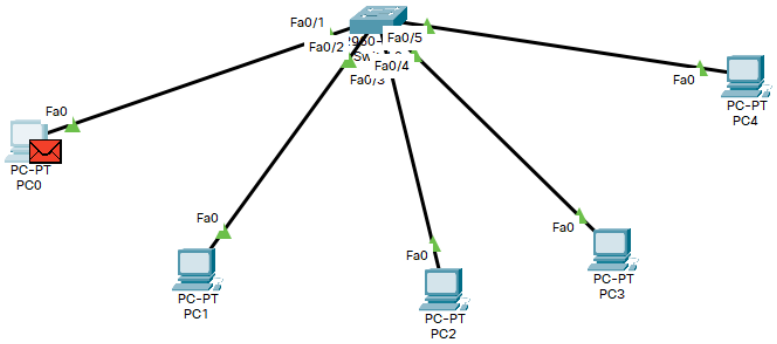
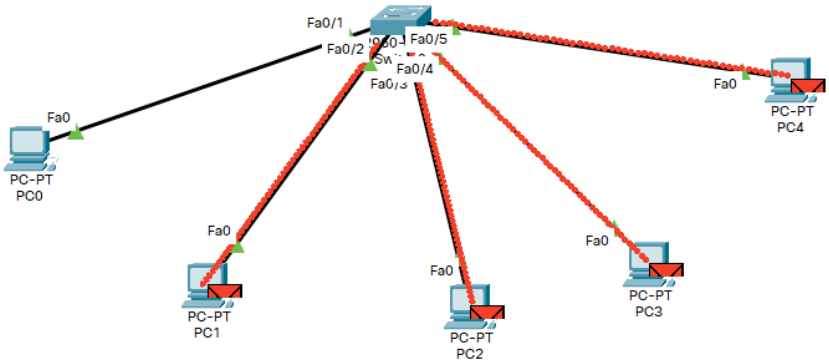
In the previous lab, you created a simple switched network. However, that network is quite limiting in terms of features and security. All the devices in the network exist on the same broadcast domain. This means that any broadcast packets sent over the network will be forwarded to all other devices on the same network. Ideally the network needs to be divided into multiple smaller networks, each with their own IP range. This allows for easier management and improved security as network policies can be applied to individual subnets instead of globally, such as only allowing SSH traffic to the server network from the IT network.



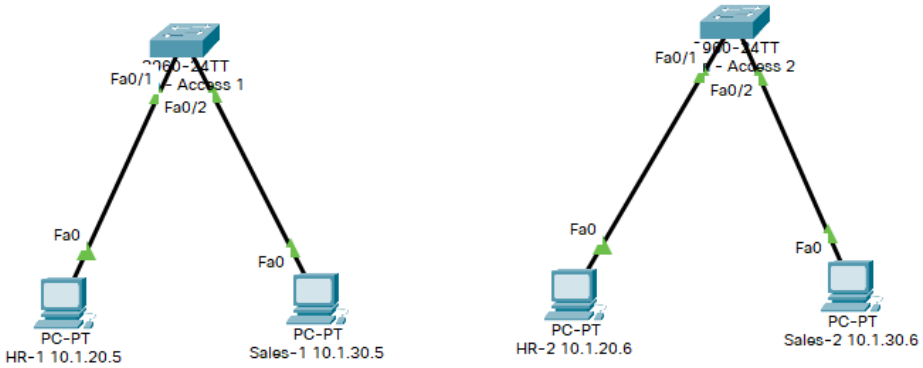


In the example above, you can see PING packet sent to the broadcast address being forwarded to all the other devices on the network.

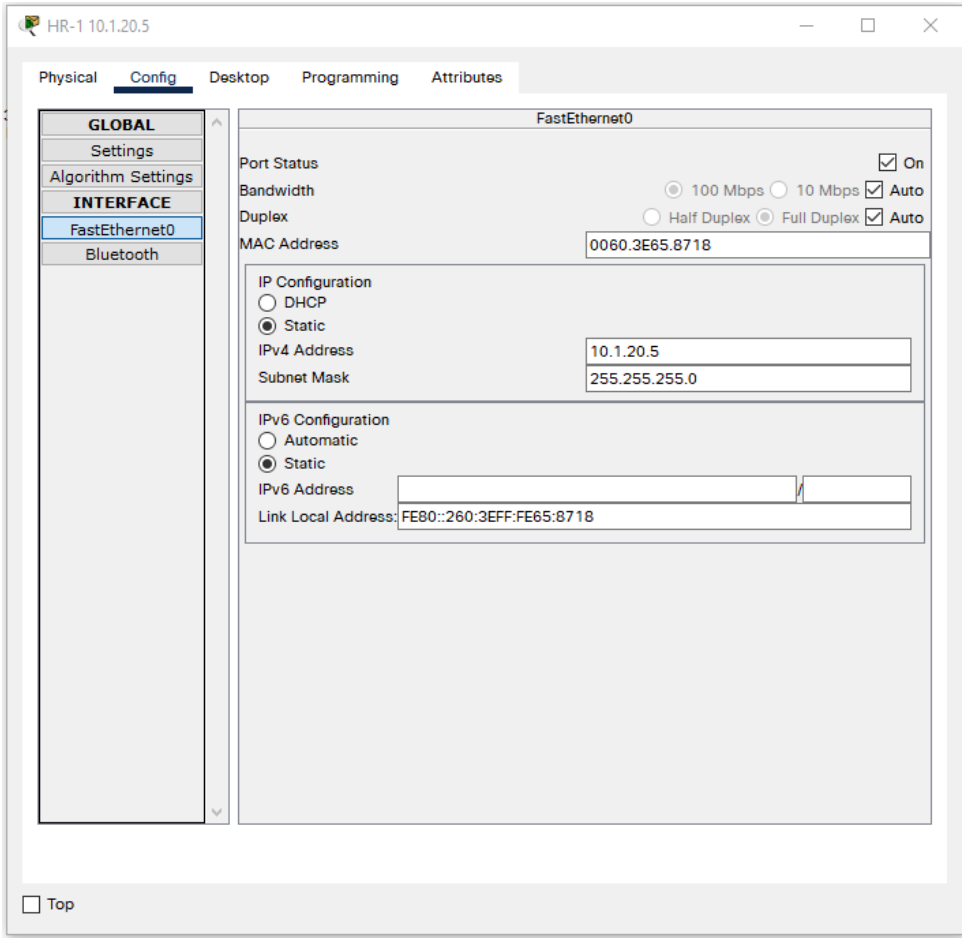
For our switched network, we are going to apply this using VLANs (Virtual Local Area Networks). This essentially segments our switches into multiple smaller networks. Every port on the switch can be assigned to a specific VLAN. This is done using the 802.1q protocol. When an ethernet frame is received by the switch, it is tagged with a VLAN ID. The switch will only forward that frame to ports that are in that same VLAN.

Configuring VLANs

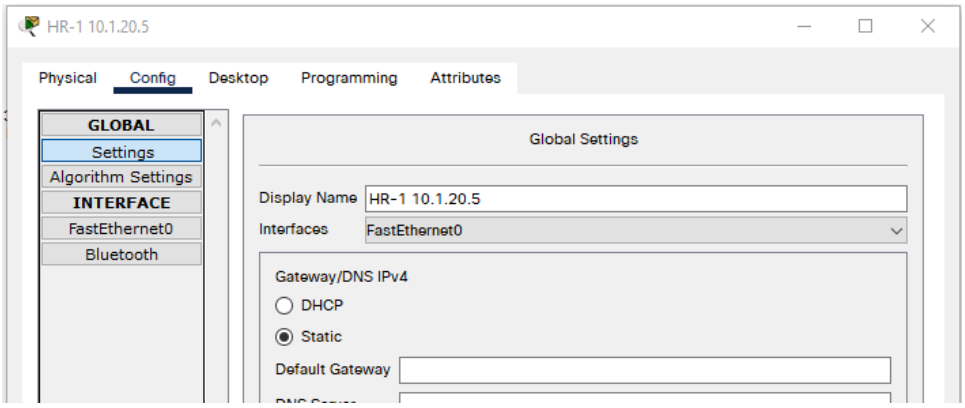
Firstly, we are going to layout our network. This network will be expanded upon in future labs.

1. For this network, we are going to create two departmental subnets, HR and Sales. Every VLAN needs a unique ID. Often, it makes sense to align VLAN IDs with your subnets. We will use the following.
    a. HR – 20
    b. Sales – 30
2. Add two of the 2960 switches to your network. Then connect two PCs to the first available fast-ethernet ports available on each of the switches.
3. Give the hostname Main-Access1 and Main-Access2 respectively.
4. 

5. Now, assign an IP address to each of the PCs.
    a. HR-1 – 10.1.20.5 255.255.255.0
    b. HR-2 - 10.1.20.6 255.255.255.0
    c. Sales-1 – 10.1.30.5 255.255.255.0
    d. Sales-2 – 10.1.30.6 255.255.255.0

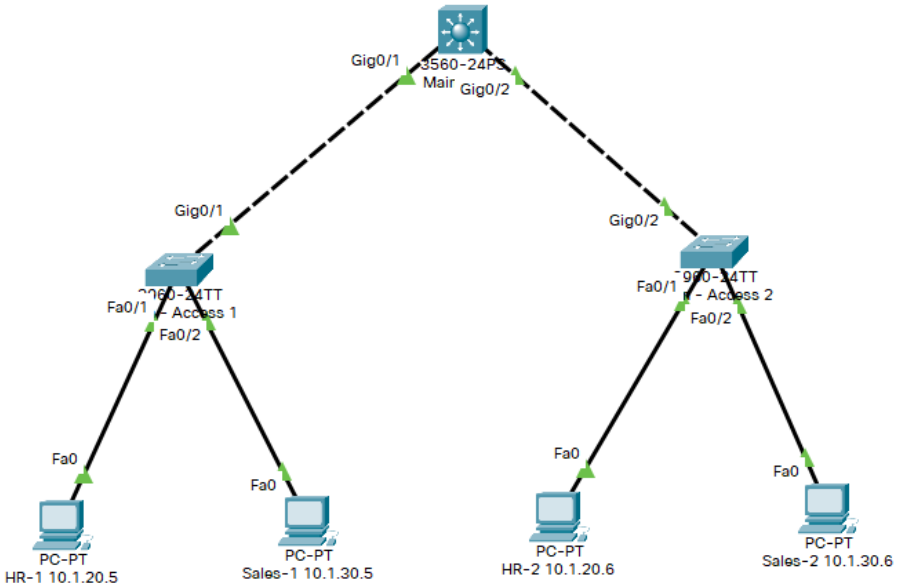


6. Also, Change the Display Name in the Global Settings tab to reflect the hostname and IP address. This will make working with these devices much easier in the future.



7. Now, We are going to connect our two switches with a Layer 3 switch that will act as our network core. Add a 3560 switch and connect your other two switches to it using a crossover cable (the dotted cable) connected to the Gigabit Ethernet ports.
    a. Give this swith the name Main-Core

8.



Now, We will create these VLANS on each of the three switches

9. Enter Configure mode on the core switch
10. Enter the following configuration commands
    a. **`Switch(config)#`** `vlan 20`
    b. **`Switch(config)#`** `name HR`
11. Now, repeat this process with the other VLANs and then repeat the full process on the other two switches

```
Main-Access1>enable
Main-Access1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Main-Access1(config)#vlan 20
Main-Access1(config-vlan)#name HR
Main-Access1(config-vlan)#vlan 30
Main-Access1(config-vlan)#name Sales
Main-Access1(config-vlan)#
```

12. Afterwards, you should be able to use the `show vlan` command to confirm the creation of the VLANs

```
Main-Access1>enable
Main-Access1#show vlan

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                Fa0/9, Fa0/10, Fa0/11, Fa0/12
                                                Fa0/13, Fa0/14, Fa0/15, Fa0/16
                                                Fa0/17, Fa0/18, Fa0/19, Fa0/20
                                                Fa0/21, Fa0/22, Fa0/23, Fa0/24
                                                Gig0/1, Gig0/2
20   HR                               active
30   Sales                            active
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
```

As you can see, all of the ports are still assigned to the first VLAN. Next, we will assign these ports to the appropriate VLANs.

Assigning an Interface to a VLAN

Now, we need to actually assign the interfaces that our PCs are connected to the correct VLAN.

1. Go into Config mode and then go into the interface config mode for the specific interface you want to configure.
2. Then, we will use the '`switchport access vlan`' keywords followed by the VLAN ID
3. **`Switch(config-if)#`** `switchport access vlan 20`
4. Repeat this process for all interfaces with a PC connected to it. (HR in 20, sales in 30)

```
Main-Access1>enable
Main-Access1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Main-Access1(config)#interface f0/1
Main-Access1(config-if)#switchport access vlan 20
Main-Access1(config-if)#interface f0/2
Main-Access1(config-if)#switchport access vlan 30
Main-Access1(config-if)#
```

Configuring VLAN trunks

The keen eyed among you may see a problem with the current configuration. Devices on the same VLAN, but on different switches cannot communicate with one another, even if the switches are connected. We will resolve this using network trunks. A trunk is a special type of network port that will forward traffic from multiple VLANs (by default, all VLANs currently configured on the switch). This will allow us to expand our network significantly.

Configuring VLAN trunks

1. First, we will configure trunking on the core switch

a. Enter the interface config mode for the link to the first access switch (gigabitethernet 0/1)
b. Enter the following configuration commands on the core switch
    i. **`Switch(config)#`** `switchport trunk encapsulation dot1q`
        1. Note. This command may not be needed on many switches. Some older models of switches supported VLAN tagging other than the 802.1q standard. Newer devices now only support this standard.
    ii. **`Switch(config)#`** `switchport mode trunk`
c. Repeat this process on all other switch-to-switch link gigabitethernet 0/2

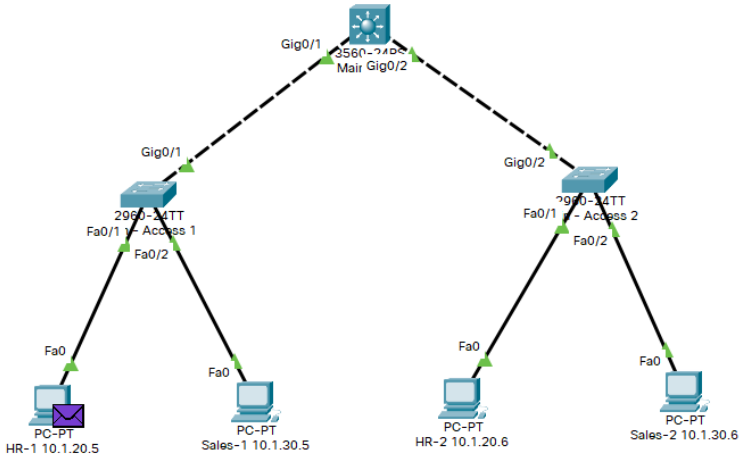
```
Main-Core>enable
Main-Core#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Main-Core(config)#interface g0/1
Main-Core(config-if)#switchport trunk encapsulation dot1q
Main-Core(config-if)#switchport mode trunk

Main-Core(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state to up

Main-Core(config-if)#
```

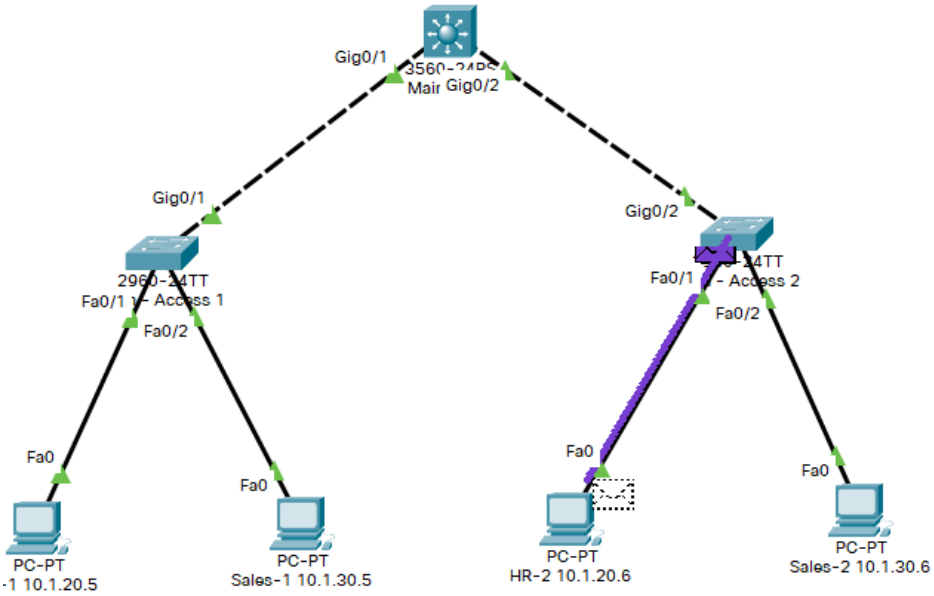
2. Next, configure trunking on the access switches using the same method but omit the '`switchport trunk encapsulation dot1q`' command as it is deprecated on these switches.

```
Main-Access1>enable
Main-Access1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Main-Access1(config)#interface g0/1
Main-Access1(config-if)#switchport mode trunk
Main-Access1(config-if)#
```

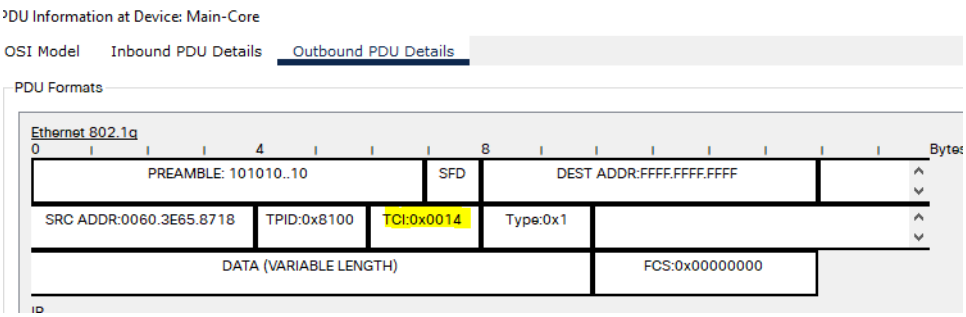
Testing VLAN Segmentation

1. Enter simulator mode in Packet Tracer.
2. Ping the broadcast address for one of your subnets (The last address in your subnet.)
    a. 10.1.20.255 for the HR VLAN
3. You should see that packet forwarded to just the other devices in the same VLAN.





In addition, opening one of the packets in the simulation can let us view the VLAN information



The identifier 'TCI' is the VLAN ID in hexadecimal. In this example, 0x0014 is equal to 20, our HR VLAN=

Now your devices on the HR VLAN can contact one another, even across different switches. However, the same cannot be said for the HR PCs accessing the Sales PCs.

As currently configured, only devices on the same VLAN can communicate with one another. Even though they are connected to the same switch, they are unable to communicate with one another as they are on separate VLANs. In the next segment, we will configure simple routing on our core switch so that all of our network devices can communicate with one another.

Enabling Routing between the VLANs

Enabling inter-VLAN routing is fairly simple compared to configuring other types of routing as all of the networks are locally connected, which we will do in a later lab when we add two other remote branches to our network.

VLANS can be treated just like a network interface. So, we can assign an IP address to the VLAN

1. Log into the console on your core switch
2. From config mode, enter the following:
    a. **Switch(config)#** `interface vlan20`
    b. **Switch(config)#** `ip address 10.1.20.1 255.255.255.0`
3. **Switch(config)#** `no shutdown`
4. This will create the virtual interface, assign an IP address to it and then bring it online.
5. Repeat this process for Sales VLAN 30, assigning it the 10.1.30.1 address

```
Main-Core>enable
Main-Core#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Main-Core(config)#interface vlan 20
Main-Core(config-if)#
%LINK-5-CHANGED: Interface Vlan20, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan20, changed state to up

Main-Core(config-if)#ip address 10.1.20.1 255.255.255.0
Main-Core(config-if)#no shut
Main-Core(config-if)#int vlan 30
Main-Core(config-if)#
%LINK-5-CHANGED: Interface Vlan30, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan30, changed state to up

Main-Core(config-if)#ip address 10.1.30.1 255.255.255.0
Main-Core(config-if)#no shut
Main-Core(config-if)#
```

Now, we will enable local IP routing between the VLANs on our core.

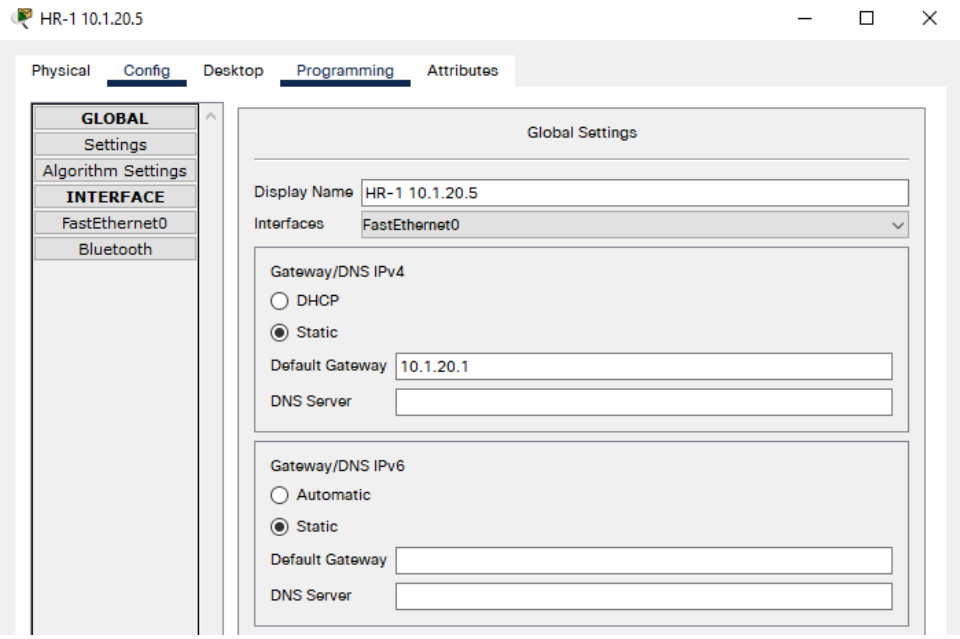
6. From config mode, enter the following:
    a. **Switch(config)#** `ip routing`

```
Main-Core>enable
Main-Core#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Main-Core(config)#ip routing
Main-Core(config)#
```
e

7. Now, if you run the command '`show ip route`', then you should see that the switch has added its local networks to the routing table.

```
Main-Core#show ip route
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
       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

     10.0.0.0/24 is subnetted, 2 subnets
C       10.1.20.0 is directly connected, Vlan20
C       10.1.30.0 is directly connected, Vlan30

Main-Core#
```

8. Now, assign the VLAN IP addresses as the default gateway on each of your PCs in the global settings tab.



9. Now, our HR pc should be able to contact its default gateway and a PC in the sales VLAN

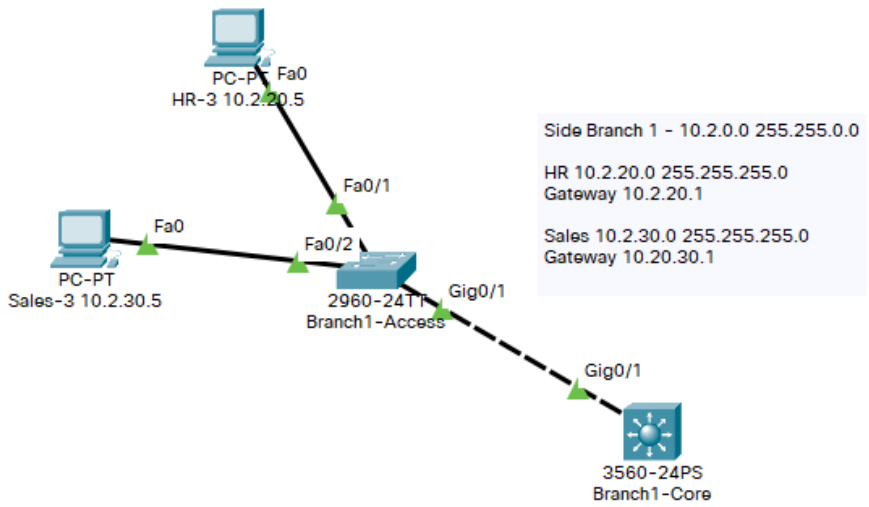
```
C:\>ping 10.1.30.6

Pinging 10.1.30.6 with 32 bytes of data:

Reply from 10.1.30.6: bytes=32 time<1ms TTL=127
Reply from 10.1.30.6: bytes=32 time<1ms TTL=127
Reply from 10.1.30.6: bytes=32 time<1ms TTL=127
Reply from 10.1.30.6: bytes=32 time<1ms TTL=127

Ping statistics for 10.1.30.6:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

Testing what you know:

Now, we are going to add two more smaller branches to our network. Each will have a single core switch, a single access switch, and just two PCs.

Side Branch 1

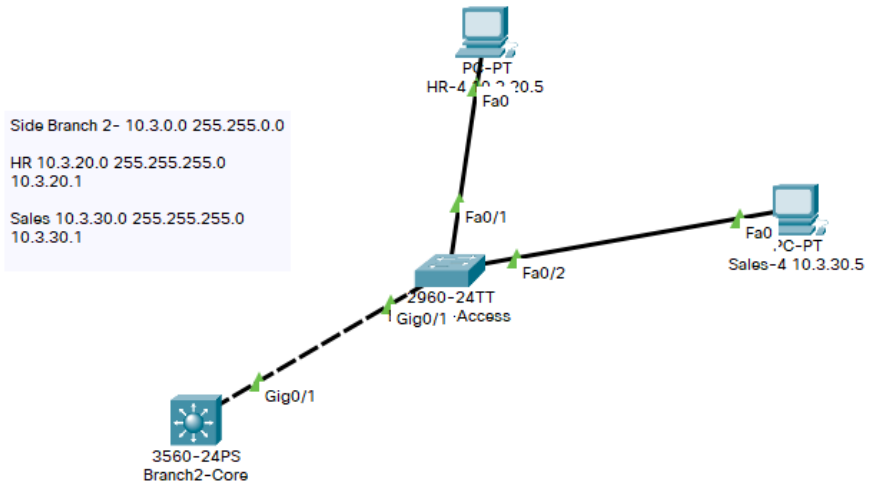
- Branch1–Core
- Branch1–Access
- PCs
    - HR-3
    - Sales-3



Side Branch 2

- Branch2–Core
- Branch2–Access
- PCs
    - HR-3
    - Sales-3

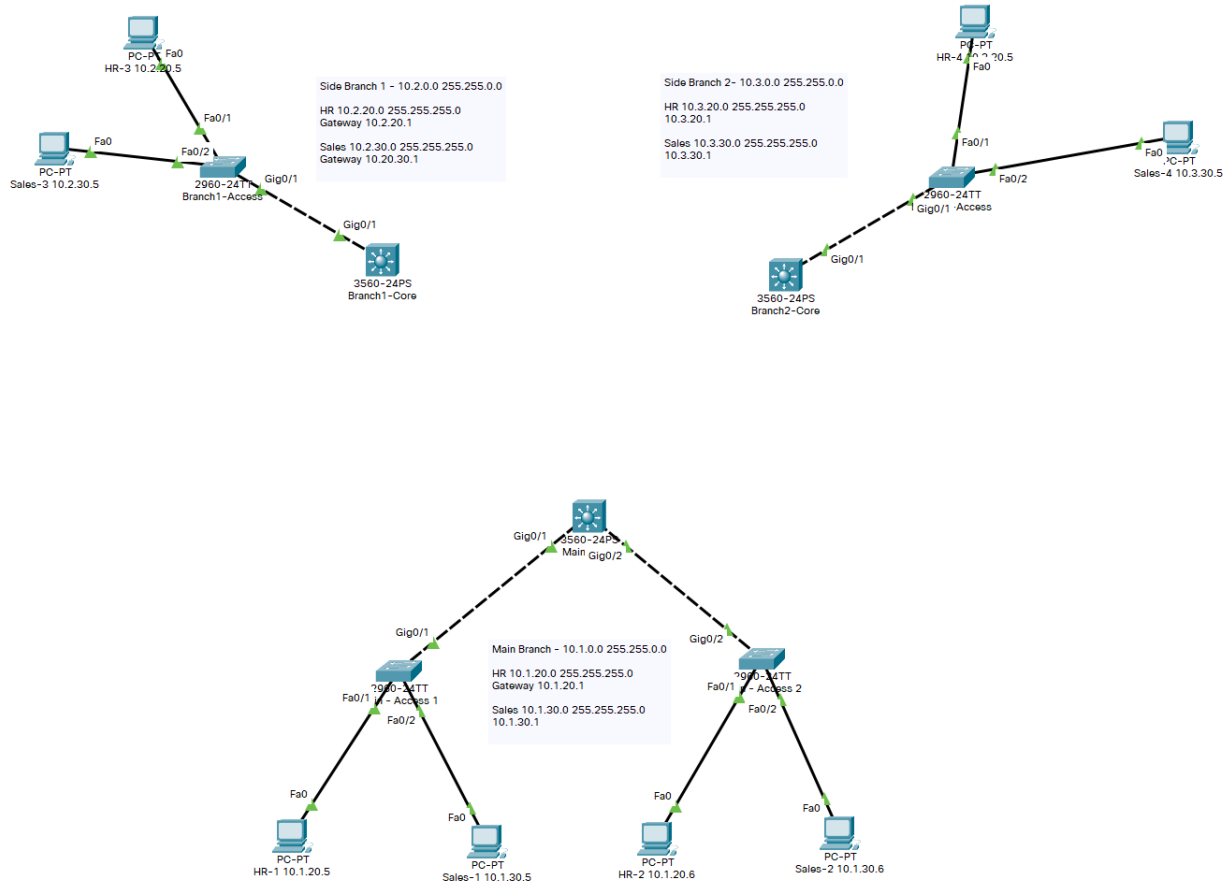
The IP addressing scheme will essentially be the same with the second octet being 2 and 3 instead of 1 on the core.



Complete the following tasks for both of the networks

1. Assign IP addresses and default gateways to the PCs.
2. Create VLANs on the access and core
3. Enable Trunking between the access switch and the core
4. Create VLAN interface and assign the gateway address to that interface.

Once Finished, the two PCs on each of your branch networks should be able to communicate with one another. And your network should look something like the following.



In the next lab, you are going to add a router to each of the sites to allow all three of your branches to communicate with one another.